XVII A.P.
DÜSSELDORF
21.5-1.6 1990
CCIR

XVIIth PLENARY ASSEMBLY
DÜSSELDORF, 1990

INTERNATIONAL TELECOMMUNICATION UNION

QUESTIONS OF THE CCIR, 1990

VOLUME XV–1

SG 1	SPECTRUM MANAGEMENT TECHNIQUES
SG 12	INTER-SERVICE SHARING AND COMPATIBILITY
SG 5	RADIO WAVE PROPAGATION IN NON-IONIZED MEDIA
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SG 7	SCIENCE SERVICES

CCIR INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

Geneva, 1990

CCIR

1. The International Radio Consultative Committee (CCIR) is the permanent organ of the International Telecommunication Union responsible under the International Telecommunication Convention "... to study technical and operating questions relating specifically to radiocommunications without limit of frequency range, and to issue recommendations on them..." (International Telecommunication Convention, Nairobi 1982, First Part, Chapter I, Art. 11, No. 83).*

2. The objectives of the CCIR are in particular:

a) to provide the technical bases for use by administrative radio conferences and radiocommunication services for efficient utilization of the radio-frequency spectrum and the geostationary-satellite orbit, bearing in mind the needs of the various radio services;

b) to recommend performance standards for radio systems and technical arrangements which assure their effective and compatible interworking in international telecommunications;

c) to collect, exchange, analyze and disseminate technical information resulting from studies by the CCIR, and other information available, for the development, planning and operation of radio systems, including any necessary special measures required to facilitate the use of such information in developing countries.

* *See also the Constitution of the ITU, Nice, 1989, Chapter I, Art. 11, No. 84.*

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XVIIth PLENARY ASSEMBLY
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INTERNATIONAL TELECOMMUNICATION UNION

QUESTIONS OF THE CCIR, 1990

VOLUME XV–1

STUDY GROUPS 1, 12, 5, 6, 7

CCIR INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

92-61-04331-3

Geneva, 1990

PLAN OF VOLUMES I TO XV
XVIIth PLENARY ASSEMBLY OF THE CCIR

(Düsseldorf, 1990)

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All references within the texts to CCIR Recommendations, Reports, Resolutions, Opinions, Decisions and Questions refer to the 1990 edition, unless otherwise noted; i.e., only the basic number is shown.

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DISTRIBUTION OF TEXTS OF THE XVIIth PLENARY ASSEMBLY OF THE CCIR IN VOLUMES I TO XV

Volumes and Annexes I to XV, XVIIth Plenary Assembly, contain all the valid texts of the CCIR and succeed those of the XVIth Plenary Assembly, Dubrovnik, 1986.

1. Recommendations, Resolutions, Opinions are given in Volumes I-XIV and Reports, Decisions in the Annexes to Volumes I-XII.

1.1 *Numbering of texts*

When a Recommendation, Report, Resolution or Opinion is modified, it retains its number to which is added a dash and a figure indicating how many revisions have been made. Within the text of Recommendations, Reports, Resolutions, Opinions and Decisions, however, reference is made only to the basic number (for example Recommendation 253). Such a reference should be interpreted as a reference to the latest version of the text, unless otherwise indicated.

The tables which follow show only the original numbering of the current texts, without any indication of successive modifications that may have occurred. For further information about this numbering scheme, please refer to Volume XIV.

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* Not reprinted, see Dubrovnik, 1986.

(1) Published separately.

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* Not reprinted, see Dubrovnik, 1986.

([1]) Published separately.

1.3.1 *Note concerning Reports*

The individual footnote "Adopted unanimously" has been dropped from each Report. Reports in Annexes to Volumes have been adopted unanimously except in cases where reservations have been made which will appear as individual footnotes.

1.4 *Resolutions*

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2. **Questions** (Vols. XV-1, XV-2, XV-3, XV-4)

2.1 *Numbering of texts*

Questions are numbered in a different series for each Study Group: where applicable a dash and a figure added after the number of the Question indicate successive modifications. The number of a Question is completed by an *Arabic figure indicating the relevant Study Group.* For example:

- Question 1/10 would indicate a Question of Study Group 10 with its text in the original state;
- Question 1-1/10 would indicate a Question of Study Group 10, whose text has been once modified from the original; Question 1-2/10 would be a Question of Study Group 10, whose text has had two successive modifications.

Note – The numbers of the Questions of Study Groups 7, 9 and 12 start from 101. In the case of Study Groups 7 and 9, this was caused by the need to merge the Questions of former Study Groups 2 and 7 and Study Groups 3 and 9, respectively. In the case of Study Group 12, the renumbering was due to the requirement to transfer Questions from other Study Groups.

2.2 *Assignment of Questions*

In the plan shown on page II, the relevant Volume XV in which Questions of each Study Group can be found is indicated. A summary table of all Questions, with their titles, former and new numbers is to be found in Volume XIV.

2.3 *References to Questions*

As detailed in Resolution 109, the Plenary Assembly approved the Questions and assigned them to the Study Groups for consideration. The Plenary Assembly also decided to discontinue Study Programmes. Resolution 109 therefore identifies those Study Programmes which were approved for conversion into new Questions or for amalgamation with existing Questions. It should be noted that references to Questions and Study Programmes contained in the texts of Recommendations and Reports of Volumes I to XIII are still those which were in force during the study period 1986-1990.

Where appropriate, the Questions give references to the former Study Programmes or Questions from which they have been derived. New numbers have been given to those Questions which have been derived from Study Programmes or transferred to a different Study Group.

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QUESTIONS CONCERNING STUDY GROUP 1

SPECTRUM MANAGEMENT TECHNIQUES

(Spectrum engineering, planning, sharing,
monitoring and utilization)

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QUESTION 1-2/1

DESIGNATION OF EMISSIONS

(1959-1982-1986)

The CCIR,

CONSIDERING

(a) that the World Administrative Radio Conference, Geneva, 1979, adopted in Article 4 of the Radio Regulations a new method for designating emissions based on CCIR Recommendation 507 (Kyoto, 1975);

(b) that an essential part of this new method is the classification of emissions;

(c) that the new method of classifying emissions distinguishes between basic characteristics (first, second and third symbol) and additional characteristics (fourth and fifth symbol);

(d) that the full classification of emissions consists of all of these five symbols;

(e) that the list of the additional characteristics given in Appendix 6, Part A of the Radio Regulations may not be sufficiently complete to take account of future new technologies and may require relatively frequent supplementing;

(f) that a list of examples for the full designation of emissions is given in Appendix 6, Part B of the Radio Regulations;

(g) that this list, however, is not exhaustive and that for this reason No. 265 of the Radio Regulations stipulates that further examples may appear in the latest CCIR Recommendations and that these examples may also be published in the Preface to the International Frequency List;

(h) that this new method for designating emissions does not always prove adequate to meet international monitoring requirements,

NOTING

Recommendation No. 62 of the World Administrative Radio Conference, Geneva, 1979, inviting the CCIR to take appropriate action on this matter;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what further additional characteristics for classifying emissions can be recommended in order to cater for new technologies without, however, changing those additional characteristics which have already been agreed upon and which are contained in Appendix 6, Part A of the Radio Regulations;

2. which examples can be provided for the full designation of emissions which are not contained in Appendix 6, Part B of the Radio Regulations also taking into account the studies mentioned in § 1 above*?

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* Studies required by Recommendation No. 63 of the World Administrative Radio Conference, Geneva, 1979, for providing formulae and examples for the calculation of necessary bandwidths are covered by Question 77/1.

QUESTION 4-3/1

LIMITATION OF UNWANTED RADIATION FROM ELECTRICAL APPARATUS AND INSTALLATIONS

(1953-1963-1978-1982-1986)

The CCIR,

CONSIDERING

(a) that Resolution No. 5, annexed to the International Telecommunication Convention, Buenos Aires, 1952, required the study of the influence of intentional or parasitic oscillations on radio services, especially broadcasting and mobile services, with a view to the possible establishment of standards permitting a harmonious co-existence of radio services with electrical installations producing radio oscillations;

(b) that the harmonious co-existence of radio services with electrical installations and equipments producing radio oscillations, involves close collaboration between organizations representing the manufacturers and users of these installations on the one hand, and the radio services on the other, for which the existing collaboration between the CCIR and the International Special Committee on Radio Interference (CISPR) provides;

(c) that the interference effect of unwanted radiation is dependent on the level and the waveform of the radiation, the amount of coupling between interference source and receiver and on the characteristics of the affected receiver;

(d) that the CISPR has already extensively studied, and continues to study, the methods for measuring the level of radiation arising from electrical apparatus and installations;

(e) that the CISPR has recommended limits for unwanted radiations from electrical appliances and installations based on economical and statistical considerations to attain adequate protection, especially for broadcast transmissions;

(f) that the CISPR has submitted this information in a number of publications which should form a basis for studies leading to the preparation of national and international regulations;

(g) that it is the task of the CCIR to properly protect all radiocommunication services;

(h) that for this purpose the CCIR should define the minimum field strengths to be protected, together with necessary protection ratios for each service and type of interference,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the maximum level of interference, that is tolerable in a complete radio system, caused by industrial, scientific and medical installations using radio frequency, as well as by other types of electrical equipment;

2. what are the parameters of the unwanted radiations that should be measured;

3. what are the characteristics of the measuring instrument and measuring methods, taking into account the instrumentation and measuring methods recommended in the CISPR publications indicated in Recommendation 433;

4. what is the statistical distribution of the amount of coupling between interfering sources and receivers;

5. what is the susceptibility of receivers of different services to various types of unwanted signal waveforms;

6. what are the values of the minimum field strength to be protected, and the necessary protection ratio, for each service and type of interference;

7. what are the most appropriate means of determining the level of intentional or parasitic radiations produced by these electrical apparatus and installations:

8. to what levels is it practicable to reduce such radiations?

Note 1 – Some examples of electrical equipment liable to cause disturbance are: high voltage and electrical traction equipment, motor vehicles, household appliances and fluorescent lighting.

Note 2 – In this study, the CCIR should, to avoid duplication of work, keep itself informed of the results of the studies of the CISPR on the same subject.

Note 3 – See Recommendation 433, Opinion 2 and Decision 54.

QUESTION 10-1/1

RADIATED AND CONDUCTED INTERFERENCE FROM RECEIVERS

(1953-1956-1959-1970-1986)

The CCIR,

CONSIDERING

(a) that receivers may produce unwanted radio frequency energy which could cause harmful interference to different radio services;

(b) that adequate suppression and measurement of radiated and conducted interference is necessary to prevent harmful interference;

(c) that methods of measurement for radiated and conducted interference from radio receivers and RF equipment respectively are laid down in IEC Publications 489-3, 489-3A and 489-5 (for receivers used in the mobile services), CISPR Publication 13 (for sound-broadcast and television receivers) and CISPR Publication 16 (for RF equipment);

(d) that the CISPR has, as a matter of priority, first established limits and methods of measurement of radio interference characteristics of sound and television receivers mainly in order to protect broadcast reception,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent is it necessary for the CCIR to establish limits and methods of measurement for radiated and conducted interference from receivers;

2. are the methods established by the IEC for measuring radio interference charactersitics of certain radio receivers and RF equipment also suitable for measuring the interference characteristics of other classes of receiver; what methods should be used where existing IEC and CISPR Publications are not applicable;

3. what are typical values of field strengths, radio-interference voltages and other relevant radio interference parameters in the different bands and, possibly, for different types of services and different decoupling conditions, that should not be exceeded by these emanations;

4. what are the best receiver design techniques to avoid or suppress harmful interference to radio services?

QUESTION 18-3/1*

SYSTEM DESIGN FOR MAXIMIZING THE EFFICIENCY AND UTILITY OF SPECTRUM USE

(1951-1956-1966-1970-1972-1978-1982)

The CCIR,

CONSIDERING

(a) that the radio spectrum is a limited resource having economic and social value;

(b) that the maximum economic and social value may not always be realizable because of inefficient use of the spectrum;

(c) that systems must operate in the presence of unwanted signals and external noise, as well as in the presence of inherent system noise, together with distortion and fading introduced by the medium of propagation;

(d) that minimizing the bandwidth occupied by each signal does not necessarily result in the most efficient use of the spectrum; for example, when frequencies are shared by several users such minimization may not reduce interference;

(e) that, nevertheless, the spectrum is used more efficiently when more users can operate efficiently at the same time;

(f) that when the system design parameters and geographical distribution of stations are both known, frequency assignment techniques and technical planning can improve usage of the frequency spectrum;

(g) that spectrum utilization may be enhanced through the maximizing of the amount of information transmitted through a given telecommunication channel with a given power, either in a given time using a minimum bandwidth, or with a given bandwidth in a minimum time, by the use of pulse code modulation;

(h) that improvement may be expected in the efficiency of existing communication systems as a result of the application of the theory of information;

(j) that improvement in spectrum utilization may be possible by using bandwidth expansion techniques including orthogonal signal modulation and techniques such as spread spectrum modulation (i.e., systems in which the average energy of the transmitted signal is spread over a bandwidth which is much wider than the information bandwidth, thereby reducing power spectral density);

(k) that Recommendation No. 65 of the WARC-79 recognizes that advances in technology, particularly by digital radiocommunications techniques and new encoding, modulation and access schemes, such as packet radiocommunications, interference cancellers and spread-spectrum techniques, are making practicable new sharing schemes that offer technological advantages for increasing the efficiency of spectrum sharing and band utilization,

UNANIMOUSLY DECIDES that the following question should be studied:

1. how can modern methods of communication theory be used to increase efficiency in spectrum use and hence increase spectrum availability, both in the case of single systems and in the case of multiple systems sharing the same frequency bands;

2. how can such factors as coding, signal processing, antenna design, technical characteristics of the channels, and appropriate cost-value criteria of performance, be employed, under suitable energy and bandwidth constraints, to obtain the desired result;

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* This Question is brought to the attention of all Study Groups.

3. what are possible "trade-offs" between such factors as power, available bandwidths, message and signal durations, types of waveform, coding, antenna beam pattern structure, classes of interference and background noise, decision thresholds, equipment costs, frequency assignment techniques and technical planning, which would promote an increased efficiency of spectrum usage;

4. how can bandwidth expansion techniques, such as spread spectrum or other orthogonal signal modulation techniques, be used to increase communication capacity and efficiency in the use of the radio spectrum;

5. how can new technology systems be most effectively used to enhance the use of the spectrum and what criteria are required for spectrum management purposes to ensure compatibility and interworking of systems;

6. what protocols and procedures in the use of digital radio techniques and new encoding, modulation and access schemes, such as packet radiocommunications, interference cancellers and spread-spectrum techniques, can be used to increase most effectively the communication capacity and the efficient use of radio spectrum?

Note – See Recommendation 337 and Reports 528, 665, 830, 831, 832 and 833.

QUESTION 22-1/1

FREQUENCY MEASUREMENTS AT MONITORING STATIONS

(1956-1963-1970-1982)

The CCIR,

CONSIDERING

that it is desirable to improve the accuracy, speed and convenience of frequency measurements, particularly under conditions of fading, interference, carrier instability, etc., including the case of suppressed or keyed carriers,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what accuracy and speed is attainable for frequency measurements at monitoring stations, especially under the conditions set forth above;

2. what are the difficulties in meeting the required accuracy (Recommendation 377) due to limitations set by;

2.1 the measuring equipment;

2.2 propagation effects such as fading;

2.3 interference due to other transmissions;

2.4 the type of modulation, particularly for wideband transmissions;

3. to what extent and in what statistical form is it desirable to present the results of a series of measurements of the same emission, when these measurements are taken at different times (for example, the relative deviation of the average frequency compared with tolerance and r.m.s. error);

4. what are practical methods for assessing the highest and the average accuracy of frequency measurements in the course of routine operation of a monitoring station and what are the parameters to be borne in mind when evaluating this accuracy, taking into account both stable signals and signals subject to fading?

Note – See Recommendation 377 and Reports 272 and 277.

QUESTION 24-1/1

FIELD-STRENGTH MEASUREMENTS AT MONITORING STATIONS AND EXPEDITIOUS METHODS FOR MAKING THESE MEASUREMENTS

(1965-1970-1982)

The CCIR,

CONSIDERING

(a) that Recommendation 378 (Accuracy of field-strength measurements by monitoring stations) does not cover all aspects of the problem, and that it recommends that studies relating to methods and equipment for use at monitoring stations, should be continued;

(b) that the importance of collecting comparable field-strength data for the purpose of making propagation studies is increasing;

(c) that the accuracies prescribed in Recommendation 378 are not always necessary in monitoring observations, an accuracy better than ± 6 dB being sufficient for some purposes in certain frequency bands;

(d) that it would be desirable to improve the existing methods for the expeditious measurement of field strength by adding new methods and techniques to the material already contained in Report 368,

UNANIMOUSLY DECIDES that the following question should be studied:

1. taking into account the previous work of the CCIR in this field, what are the preferred equipment and the preferred methods for measuring the field strength of emissions for propagation studies at monitoring stations,

among other factors the following should be studied:

- the methods for measuring the field strength,
- the measuring and recording equipment,
- the total frequency range,
- the calibration equipment,
- the methods for analyzing the records,
- the most effective form of presentation and distribution of these data for the benefit of various bodies, for example the IFRB;

2. what are the equipment and methods to be preferred for measuring the field strength of the various classes of emission;

3. what type of equipment is the most suitable for the expeditious measurement of field strength at monitoring stations;

4. what specifications should be adopted for the performance of the equipment (antenna, transmission line, receiver and calibrating source)?

Note – See Recommendation 378 and Reports 273 and 277.

QUESTION 26-2/1*

BANDWIDTH MEASUREMENTS AT MONITORING STATIONS

(1965-1966-1970-1986-1990)

The CCIR,

CONSIDERING

(a) that determination of the occupied bandwidth of an emission, by the method of measuring total power and out-of-band power, in accordance with the present definition of occupied bandwidth (see No. 147 of the Radio Regulations), is not generally applicable to measurements made at a distance from the transmitter;

(b) that the IFRB requires practical optimum standards concerning bandwidth measurements at monitoring stations;

(c) that Recommendation 443 states that monitoring stations should adopt, provisionally, as an estimate of bandwidth, a method consisting of measuring the bandwidth at 6 dB and at 26 dB;

(d) that Note 1 to Recommendation 443 (Geneva, 1974) defines "an '*x* dB' bandwidth" in relation to the peak level of an emission, as indicated by a spectrum analyzer;

(e) that for some emissions (e.g., broadband emissions with suppressed or reduced carrier) the estimated bandwidth as determined by the method described in Recommendation 443 may differ greatly from the bandwidth as defined by No. 147 of the Radio Regulations,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the most suitable equipment and methods for bandwidth measurement at monitoring stations of the various classes of emission, both on stable signals and signals subject to fading and in the presence of noise and interference;

2. while awaiting the development of such a suitable method:

2.1 what are the values which should be adopted for the term "*x* dB" for the various classes of emission, to achieve values for the bandwidth in reasonable agreement with the occupied bandwidth for the same classes of emission as defined by No. 147 of the Radio Regulations;

2.2 what are the zero level values with respect to which the "*x* dB" levels are determined and what are the optimum methods for establishing these values;

2.3 what is the accuracy obtainable at monitoring stations when using the bandwidth estimation procedure described in Recommendation 443, when compared with measurements made at or near the transmitter by the methods described in Recommendation 328?

Note 1 – See Recommendation 443 and Reports 275 and 277.

Note 2 – Determination of the appropriate "*x* dB" values should preferably be based upon measurements made under conditions such that interference and noise will not introduce appreciable errors.

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* This Question includes text from Study Programme 26A/1 (Geneva, 1986).

QUESTION 27-1/1

MONITORING AT FIXED MONITORING STATIONS OF RADIO EMISSIONS FROM SPACECRAFT

(1959-1965-1970-1986)

The CCIR,

CONSIDERING

(a) the rapid advances in recent years in space technology;

(b) that radio plays a major part in these space activities as regards communication, navigation and data collection and transmission;

(c) that artificial Earth-satellites find a variety of uses in the telecommunication field;

(d) that the accurate measurement at a fixed monitoring station of frequency, spectrum occupancy, power flux-density at the Earth's surface and certain other technical characteristics of emissions from transmitters on the spacecraft tend to be more difficult than on fixed or relatively slow moving sources of emission on or near the Earth,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent will the techniques of measurement, from fixed monitoring stations on the Earth, of emissions from spacecraft, differ from those for emissions originating from or near the Earth;

2. what are the methods of measurement and the requirements for the equipment for performing frequency, spectrum occupancy, power flux-density and other measurements of emissions from spacecraft at the surface of the Earth;

3. what practical means can be devised for identification, by monitoring stations, of emissions from specific spacecraft?

Note 1 – It would be most desirable that results of measurements of field strength or power flux-density made by monitoring stations be assembled by the respective administrations, to assist in propagation studies made by other Study Groups of the CCIR.

Note 2 – See Report 276.

QUESTION 28-2/1

DIRECTION FINDING AT MONITORING STATIONS

(1963-1970-1974-1978)

The CCIR,

CONSIDERING

(a) that direction-finding measurements in some cases have very great significance for administrations and the IFRB in the investigation of harmful interference and in their concern with efficient use of the radio-frequency spectrum;

(b) that advances continue to be made in the techniques of direction finding at all frequencies;

(c) that the methods and procedures best suited to the international monitoring system are not yet fully established;

(d) that the accuracy of bearings and the method used for determining the most likely position of an emission source may be improved by certain procedures, e.g. by the statistical treatment of multiple bearings or by taking reference bearings on known stations,

UNANIMOUSLY DECIDES that the following question should be studied:

what methods of direction finding, in all frequency ranges and particularly at frequencies above 30 MHz, and what procedures for improving the accuracy of bearings and for increasing the probability of locating the most likely position of an emission source can be recommended for:

- fixed monitoring activities;
- mobile monitoring activities;
- portable monitoring activities?

Note – See Reports 372 and 834.

QUESTION 29-3/1

AUTOMATIC MONITORING OF THE RADIO-FREQUENCY SPECTRUM

(1956-1963-1970-1978-1982-1986)

The CCIR,

CONSIDERING

(a) that complex, multi-channel frequency/time-division and other emissions are rapidly increasing in number;

(b) that there is a need to obtain data on the occupancy of the radio-frequency channel for spectrum management purposes;

(c) that the centre frequency, the modulation characteristics, the channel occupancy, the occupied bandwidth and the field strength of emissions in actual traffic may be interdependent;

(d) that advanced techniques could combine spectrum analyzers, frequency synthesizers and micro-computers to form a new type of integrated monitoring equipment;

(e) that automatic monitoring can provide an effective method of measuring the parameters of emissions and also an effective means of determining the occupancy of radio frequency channels,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the advantages and disadvantages of automatic monitoring systems;

2. what are the most desirable characteristics of equipment for automatic monitoring;

3. how may monitoring equipment be integrated to permit the simultaneous measurement of emission characteristics in actual traffic;

4. what are the most effective methods of using automatic monitoring equipment;

5. what is the best method of storage and presentation of automatic monitoring data for rapid retrieval;

6. what are the most efficient automatic monitoring techniques for the determination of the occupancy of radio-frequency channels;

7. how do automatic monitoring techniques have application in areas with high transmitter density compared to areas with low transmitter density;

8. what is the preferred medium and format for spectrum monitoring data records to permit efficient processing and sharing of data among various users;

9. what methods are preferred for controlling directional antennas by automatic radio frequency-spectrum monitoring systems?

Note – See Recommendation 182 and Reports 668 and 835.

QUESTION 30-2/1

VISUAL MONITORING OF THE RADIO-FREQUENCY SPECTRUM

(1959-1970-1974-1990)

The CCIR,

CONSIDERING

(a) that visual monitoring should be employed at monitoring stations;

(b) that it is possible to obtain on a screen (CRT) or a plotter a panoramic view of a portion of the radio-frequency spectrum by the employment of suitable sweep circuits in the radio receiver or associated panoramic adaptor;

(c) that the simultaneous presentation of a broad range of the spectrum would provide for the rapid determination of spectrum occupancy, frequency, amplitude and harmonic content of individual signals and broadband coverage characteristics of signals, including interference;

(d) that, although the visual monitoring techniques mentioned in *(b)* and *(c)* are employed to a certain extent in monitoring stations as an adjunct to aural monitoring, it appears that more information can be obtained by visual monitoring by observers, particularly in the case of a broadband visual presentation of the spectrum,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred equipment and methods for visual monitoring of a broad range of the radio-frequency spectrum with regard to:

1.1 receivers and associated frequency-sweep circuits;

1.2 visual presentation methods;

1.3 antennas and associated broadband amplifiers and impedance-matching circuits;

1.4 remote operation;

2. what are the desirable characteristics of spectrum analyzers for use in monitoring stations;

3. what are the desirable operating methods and techniques to obtain maximum benefit from visual monitoring with a radio-frequency spectrum analyzer either when used alone or when used as an adjunct to aural monitoring;

4. what radio-frequency ranges can be presented simultaneously on a screen taking into consideration the frequency characteristics of the antennas, amplifiers and receivers to allow relative comparisons throughout the portion of the spectrum under visual observation?

Note – See Report 279.

QUESTION 31/1*

ANTENNAS FOR MONITORING STATIONS

(1965-1970)

The CCIR,

CONSIDERING

(a) that the effectiveness of a monitoring station, in providing adequate surveillance over the radio-frequency spectrum, is determined to a major extent by the electrical characteristics of the available monitoring antennas;

(b) that substantial progress has been made in recent years in the development of broadband antennas having improved characteristics as regards frequency coverage, directivity and gain;

(c) that the anticipated future need for providing monitoring station facilities to permit observations and measurements of transmissions from spacecraft will require specialized antennas, taking into account the relatively weak signals involved and the high antenna directivity required,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent do currently available antennas fulfil the requirements of the monitoring stations, taking into account such aspects as: means of varying both horizontal and vertical directivity, gain, space limitations;

2. what are the desirable characteristics of antenna systems for monitoring in the various frequency bands of interest and for various propagation modes;

3. in which areas should further antenna development work be directed in an effort to improve monitoring antenna characteristics (for instance: directivity, bandwidth, dimensions, possibilities of orientation)?

Note – See Recommendation 575 and the Handbook for Monitoring Stations.

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* The XVIIth Plenary Assembly recommended to Study Group delete this Question (some elements of this Question may need to be incorporated in revised Questions on monitoring).

QUESTION 32-3/1

MONITORING SERVICES ASSISTANCE TO RADIOCOMMUNICATIONS DEVELOPMENT IN THE WORLD

(1963-1970-1978-1982-1986)

The CCIR,

CONSIDERING

(a) the various requests over the years for the CCIR to study the needs of developing countries for monitoring services;

(b) the importance of radio-frequency monitoring in the improvement of general operation of the expanding radio services;

(c) that monitoring stations in the international monitoring system exist for the purpose of increasing the effectiveness of radiocommunications throughout the various radio services;

(d) that the use of the international monitoring system needs to be improved in accordance with Resolution No. 39 (Mob-83) of the World Administrative Radio Conference for Mobile Services;

(e) the need for establishing more radio monitoring stations in the various parts of the world, which up to now have had very little or no radio monitoring services capable of participating in the international monitoring services;

(f) reliance of the International Frequency Registration Board on monitoring data submitted from stations participating in the international monitoring system;

(g) that in accordance with Article 20 of the Radio Regulations, technical standards recommended by the CCIR shall be recognized by the IFRB as optimum practicable standards for those stations participating in the international monitoring system, but that to meet certain requirements for monitoring data, stations observing lower technical standards may participate in the international monitoring system at the discretion of their administrations;

(h) that in accordance with No. 1878 of the Radio Regulations, stations observing lower technical standards may participate in the international monitoring system at the discretion of their administrations;

(j) the aid that an efficient monitoring service can be to any nation with evolving radio spectrum management programmes, particularly in areas of frequency allocation, interference resolution, and regulation infringement notification;

(k) that techniques progress so rapidly, particularly in new fields such as space communications, that conditions may exist whereby neither the administration concerned nor the international monitoring system may be aware of the full potentialities of monitoring functions for rendering assistance to radio services;

(l) that the attention of all CCIR Study Groups and all administrations should be called to available monitoring functions for the purpose that they be alerted to keep the international monitoring system advised of types and methods of assistance that could be initiated or expanded to use full potentialities of that system,

UNANIMOUSLY DECIDES that the following question should be studied:

1. which radio monitoring services should be started by the developing countries in this field;

2. what guidance can be given in the establishment and organization of a radio monitoring service;

3. what facilities should the monitoring equipment provide and what are the suitable characteristics for such equipment;

4. what standard set of parameters can be recommended to be monitored within the international monitoring system;

5. which of these parameters could be monitored with a lower technical standard to enable more monitoring stations to participate in the international monitoring system in accordance with No. 1878 of the Radio Regulations;

6. what changes, if any, in the Handbook for Monitoring Stations (see Resolution 62) are appropriate for providing guidance specifically to developing nations in establishing priorities for phasing in monitoring services as they are initiated, usually on a modest level, and then expanded to fully meet a nation's requirements;

7. how can administrations of developing countries be encouraged to participate in the International Monitoring System;

8. what monitoring functions, not now being performed, or not being rendered to full capability, could be initiated or expanded to provide improved assistance to administrations or to the IFRB?

Note 1. – There is a great need for applying the monitoring service for conservation of spectrum space, for the avoidance of harmful interference and for finding new frequencies which the developing countries need for their radio services. Guidance in these matters would be helpful.

Note 2 – Special consideration should be given to the order of priority for the provision of the recommended facilities for the establishment and organization of a monitoring service.

Note 3 – See Recommendation 575, Report 371, Resolutions 15 and 62, Decision 53 and Opinion 35.

QUESTION 34-2/1

IDENTIFICATION OF RADIO STATIONS BY MANUAL OR AUTOMATIC MEANS

(1953-1959-1963-1970-1974-1986)

The CCIR,

CONSIDERING

(a) that Article 25, Section I of the Radio Regulations, requires that the identifying signal be transmitted by methods which, in accordance with CCIR Recommendations, do not need special terminal equipment for reception, but which allows, where practicable, automatic identification of stations in appropriate services and under certain circumstances;

(b) that it is not always feasible or convenient to give manual identification;

(c) that, however, there may be now, or in the future, some classes of emission to which the presently recommended methods of identification cannot be applied satisfactorily,

(d) that sources of harmful interference often remain unidentified for long periods, with consequential delay in measures that might be taken to minimize the interference;

(e) that automatic identification procedures, where appropriate, may help overcome some of the disadvantages of manual identification;

(f) that footnote 2055.1 to No. 2055 of Article 25 of the Radio Regulations recognizes that the transmission of identifying signals for certain radio systems (e.g. radiodetermination, radio-relay systems and space systems) is not always possible;

(g) that automatic transmission of call sign or other signals may provide a means of identifying the types of stations for which identification is not always possible;

(h) the desirability of fostering a common automatic identification method to facilitate effective implementation of the provisions of Article 25 of the Radio Regulations, to avoid the proliferation of many different systems and modulation techniques that might be used for this purpose,

UNANIMOUSLY DECIDES that the following question should be studied:

1. which are the classes of emission that cannot be identified by the methods of identification recommended by the CCIR or set forth in the Radio Regulations;

2. what satisfactory methods can be evolved for the identification of such emissions;

3. what techniques or methods of automatic identification of stations are available for implementing a common universal system, including standard modulation techniques, for application in accordance with Article 25 of the Radio Regulations with due consideration to the needs of the different services and types of stations?

Note – See Report 978.

QUESTION 44-1/1

SYSTEM MODELS FOR THE EVALUATION OF COMPATIBILITY IN SPECTRUM USE

(1972-1986)

The CCIR,

CONSIDERING

(a) that a multitude of mathematical representations of system parameters have been developed, e.g., models of emission spectra, receiver selectivity, antenna patterns, propagation attenuation, etc., for the purpose of evaluating interference, minimizing mutual interference and optimizing overall spectrum utilization;

(b) that the majority of these models have been developed in order to be applied to certain specific problems, leading to assumptions, simplifications, limitations and qualifications that may not be obvious to potential users;

(c) that in reality there exist many non-linear, stochastic, and non-Gaussian processes which are represented in many cases by linear, deterministic and Gaussian models, respectively, only applicable to very specific cases;

(d) that considerable progress has been made in the development of comprehensive mathematical models, and their use in computers, to estimate performance of radio systems, to predict the degradation of such performance due to interference and to study the efficient use of the radio-frequency spectrum;

(e) that for a long time data have been sought on receiver selectivity, sensitivity, spurious responses, and on other receiver system characteristics that relate to, but are not always usable, in spectrum utilization models;

(f) that such models serve, given the complex description of wanted and interfering input signals, to evaluate quantitatively the modified wanted signal at the output of the receiver, and thus to determine the degradation of the wanted signal in the presence of interference;

(g) that for the purpose of examining potential interference situations among the different classes of emission and types of services, it is essential to use a model of receiver performance, which can take account of appropriate values of the pertinent characteristics;

(h) that good spectrum management requires maximum proper use of available basic models for efficient spectrum utilization and that complete system models can be built using these basic models, if their inputs and outputs are properly chosen, and their adequacies and limitations are fully accounted for,

UNANIMOUSLY DECIDES that the following question should be studied:

1. how may currently available basic models of system parameters of both desired and interfering systems, e.g., emission spectra, receiver selectivity, antenna patterns, propagation attenuation, etc., be logically combined in response to specific spectrum utilization problems;

2. what are the limitations of such basic system models in regard to their adequacy in providing data directly pertinent to the spectrum utilization problems based on their inherent limitations and the limitations of the input data;

3. what would be an appropriate general model of receiver system for each class of emission and type of service which would serve to compute receiver output signal characteristics in the presence of interference, taking account of all relevant receiver characteristics such as filtering, mixing, spurious responses, and non-linear processing;

4. what must be further developed so as to provide an accepted set of models for spectrum management so that decisions based on the models will be non-ambiguous and acceptable?

Note – See Recommendations 331 and 332, Reports 184, 521, 522, 526, 528, 533, 654, 655, 830, 839, 840 and 972, Resolution 71, Opinion 32 and Decision 27.

QUESTION 45-2/1 *

TECHNICAL CRITERIA FOR FREQUENCY SHARING

(1972-1982-1986)

The CCIR,

CONSIDERING

(a) that frequency sharing is an important aspect of efficiency of frequency spectrum utilization;

(b) that the reorganization of the CCIR Study Groups has placed a principal responsibility for the study of problems of frequency sharing with Study Group 1;

(c) that there are in existence a number of questions in the various Study Groups that deal with problems of radio frequency sharing;

(d) that work within and between Study Groups in relation to sharing is relatively far advanced;

(e) that Study Group 1 should be cognizant of the work resulting from such questions;

(f) that frequency sharing may have a much wider potential applicability than so far reflected in its practical use;

(g) that in collaboration with other Study Groups, Study Group 1 should study problems common to two or more Study Groups;

(h) that any one Study Group encountering problems concerning frequency sharing may request assistance from Study Group 1;

(j) that the WARC-79, in Recommendations Nos. 61 and 708, asks the CCIR to consider as a matter of priority, the submission of contributions on various technical sharing criteria between space radiocommunication and terrestrial radiocommunication services;

(k) that it is desirable to determine the level of interference and the associated percentage of time at which an emission, radiation or induction affects a radio service beyond specific limits established to ensure the quality and the reliability of performance, in order to derive criteria for frequency sharing;

(l) that sharing criteria have not been developed yet for every case in which a frequency band is allocated for use by more than one service and that new sharing situations may arise;

(m) that, for many of these systems, constraint in their design may be applied to enable the radio-frequency spectrum to be shared more effectively,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is meant by the terms acceptable (or unacceptable) interference, and harmful interference, with a view to formulating clear definitions appropriate to the radioastronomy service and to the various space radiocommunication and terrestrial radiocommunication services and, in particular,

1.1 what are the maximum permissible values of interference and the associated percentages of time which permit the provision of a satisfactory service in the event of sharing with another service;

1.2 what are the limits within which these values of interference and the associated percentages of time may vary without significantly affecting the quality and reliability of the service;

2. what are the general technical criteria for sharing and what are appropriate techniques and design factors conducive to improving the efficiency of spectrum utilization in shared frequency bands;

3. what are the specific technical criteria for sharing, where more than one Study Group is involved, particularly in cases which have not previously been investigated; for example, sharing between space and radio-location services;

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* The XVIIth Plenary Assembly decided that this Question should be categorized as an URGENT Question and needs to be replaced with a set of specific Questions.

4. what are those sharing criteria problems which lie wholly within the province of one Study Group, but which might require assistance from Study Group 1;

5. what related areas of work in progress in the other Study Groups would benefit from advice or guidance which Study Group 1 might provide;

6. in what way may the technical parameters of systems be adjusted to make sharing with other services feasible;

7. what procedures are necessary on the introduction of new types of system which differ significantly from the models assumed in the determination of feasibility?

Note 1 – All Study Groups are invited to furnish appropriate information to Study Group 1 that will assist it in studying sharing problems. As an example, this information could include types of emission, typical power, bandwidth of emission, recommended signal/interference protection ratios, etc.

Note 2 – See Reports 525, 528, 656, 659, 827, 828 and 829, Resolution 71, Opinion 64 and Decision 27.

QUESTION 46-1/1*

RADIO NOISE

(1972-1978)

The CCIR,

CONSIDERING

(a) that radio noise of natural or man-made origin may often determine the practical limit of performance for radio systems and thus is an important factor in planning efficient use of the spectrum;

(b) that much has been learned about the origin, character and general levels of both natural and man-made noise, but that more information is needed for planning of telecommunication systems, particularly as regards "wideband" characteristics of man-made noise, directions of arrival of atmospheric (thunderstorm) noise, other noise originating in the troposphere and improved predictions for situations where direct measurements are unavailable;

(c) that uniform methods of measurement, and of expression of results of measurement and of prediction, are needed to realize the greatest advantage from such information;

(d) that, for the determination of system performance and spectrum utilization factors, it is essential to specify the noise parameters described in Reports 322 and 413 (Oslo, 1966), namely; power spectral density, amplitude probability distribution, duration and spacing of pulses, and crossing rates for various amplitude levels;

(e) that effective techniques, as described in URSI Special Report No. 7, in § 8 of Report 413, and references therein, exist for measuring statistically those various parameters,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the important sources and characteristic levels of man-made radio noise in industrial, urban, suburban and rural areas, which constitute potential local interference to radiocommunications, as for example from motor vehicles, electric power lines, machinery and appliances, industrial or medical radio-frequency equipment, or unintended radiation from transmitters and receivers; particular attention is directed to the prediction of levels of noise for situations where direct measurements are not available, and for "wideband" radiocommunications reception (i.e., bandwidths up to several megahertz or more);

2. what are the levels of natural radio noise originating in thermal radiation from the Earth and its atmosphere including, for example, emissions from molecular oxygen and water vapour, as well as galactic and solar emissions at frequencies above about 50 MHz;

3. what are the characteristic levels, temporal and geographical variation, and directions of arrival of radio noise arising from atmospheric thunderstorms (lightning) or of galactic or ionospheric origin, or from distant man-made sources, at frequencies below about 50 MHz;

4. how may the radio noise data specified in *(d)* above be used to determine degradation to radiocommunication system performance?

Note 1 – § 1 of this Question is within the competence of Study Group 1 and cooperation of CISPR is requested; § 2 of this Question is within the competence of Study Group 5; § 3 of this Question is within the competence of Study Group 6.

Note 2 – See Recommendation 508 and Report 670; see also Question 29/6 and associated Recommendations and Reports.

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* The XVIIth Plenary Assembly decided that some aspects of this Question should be considered by other Study Groups.

QUESTION 47/1

DEFINITION OF EFFICIENCY AND UTILITY OF SPECTRUM USE

(1974)

The CCIR,

CONSIDERING

(a) that the spectrum is a limited resource which has economic and social value;

(b) that demands for use of the spectrum are increasing rapidly;

(c) that the use of the radio spectrum involves such considerations as frequency, bandwidth, time, geographical area, type of modulation, etc.;

(d) that by use of improved techniques, in particular in the fields of communication theory, directive antennas, etc., considerable improvement in the use of the spectrum may be obtainable, and thus the growing demands for the spectrum might be more readily accommodated;

(e) that, although an "ideal" system which would make the best use of the spectrum may not be practicable, comparison of actual systems with an "ideal" system would be desirable;

(f) that there is at present no commonly accepted way of defining efficiency of spectrum use, but such a definition is needed for assessing the value of new or improved techniques;

(g) that reduction of the bandwidth of individual transmissions, for example, does not necessarily increase the efficiency of spectrum use,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the appropriate methods of describing "spectrum utilization" and how can such utilization be compared for different radiocommunication services;

2. what is the best way of defining "efficiency of spectrum use" and how should this efficiency be calculated?

Note – See Recommendations 332, 337 and Report 662.

QUESTION 51/1*

METHODS OF REDUCING INTERFERENCE BETWEEN THE BROADCASTING SERVICE (TELEVISION) AND THE LAND MOBILE SERVICE

(1974)

The CCIR,

CONSIDERING

(a) that the number of television receivers and of stations in the land mobile service is continually increasing;

(b) that mobile stations frequently operate in residential areas in close proximity to television receivers;

(c) that some bands allocated to the land mobile service adjoin bands allocated to the broadcasting service (television);

(d) that interference with television reception has been recorded arising from insufficient selectivity of television receivers;

(e) that interference with land mobile service receivers has been caused by television transmitters in adjacent bands;

(f) that restrictions are thereby imposed on the planning of both services;

(g) that there is a considerable variation in the performance of different designs of television receivers with respect to protection against out of band signals;

(h) that television receivers are designed to meet the channel planning standards within the television bands and may not meet those required at the band edges,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent can the selectivity of television receivers be improved especially for channels near the edges of the bands adjoining bands allocated to the land mobile service;

2. to what extent can television receiver immunity be improved to prevent reception of interfering signals other than by way of the antenna;

3. to what extent should radiation from television receiver local oscillators be suppressed to avoid interference to the land mobile service;

4. to what extent can unwanted radiation from television transmitters be further reduced to avoid interference to the land mobile service;

5. to what extent should the characteristics of transmitting and receiving land mobile equipment be improved to reduce interference to and from television broadcasting?

Note 1 – See Recommendation 239 and Question 55/1.

Note 2 – Contributions to this Question are also to be brought to the attention of Study Groups 8 and 11.

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* The XVIIth Plenary Assembly recommended to the Study Group that this Question should be deleted.

QUESTION 52-2/1

SAFETY ASPECTS OF RADIO-FREQUENCY RADIATIONS FROM EARTH STATIONS AND TERRESTRIAL STATIONS

(1970-1974-1978-1986)

The CCIR,

CONSIDERING

(a) that radio-frequency energy is known to have harmful effects on the human body when absorbed in a certain quantity;

(b) that radio-frequency energy may induce harmful electric potentials in conducting material;

(c) that radio-frequency energy is known to have harmful effects on apparatus (such as radiocommunication apparatus, navigation instruments, cardiac pacemakers, scientific or medical equipment, etc.);

(d) that radio-frequency energy may lead to inadvertent ignition of inflammable or explosive material such as explosive gas mixtures, gas and dust mixtures as well as the premature ignition of electrically controlled blasting accessories;

(e) that determinations of hazardous radiation levels and electric potentials are being made by competent authorities;

(f) that persons not associated with earth stations or terrestrial stations may be exposed inadvertently to such radiation (including travellers by air) or to such electric potentials;

(g) that the subject is partially treated in Reports 385, 543 and 682,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the radio-frequency power flux-densities and/or electric and magnetic field strengths to be expected from earth stations and terrestrial stations;

2. what measuring methods are suitable for measuring the power flux-densities and/or the electric and magnetic field strengths, especially in the near field zone;

3. what design precautions and technical operational procedures at transmitting stations and what precautions within areas in the vicinity of such stations, in which hazardous radio frequency radiation may occur, are necessary to prevent the exposure of human beings, apparatus and inflammable or explosive materials to hazardous radio frequency radiation?

Note – See Report 671.

QUESTION 54-1/1

FREQUENCY TOLERANCE OF TRANSMITTERS

(1977-1986)

The CCIR,

CONSIDERING

(a) that Appendix 7 to the Radio Regulations specifies permissible frequency tolerances for transmitters applicable to certain categories of stations in the frequency range from 9 kHz to 40 GHz;

(b) that in many cases, an improvement in spectrum utilization, depending on economic and environmental considerations, could be obtained by a further reduction in frequency tolerance, resulting in narrowing the bandwidth required for a given emission;

(c) that for some services, an improvement in frequency tolerance would be useful in order to improve the quality of transmission;

(d) that it will be of considerable assistance in the future planning of services and provision of equipment, to know those frequency tolerances which can be considered to be the ultimate useful minimum value for stations when using existing techniques and methods of operation,

UNANIMOUSLY DECIDES that the following question should be studied:

1. for which categories of radio transmitting stations and frequency bands between 9 kHz to 40 GHz should frequency tolerances be specified and what priority should they be given;

2. what are the appropriate frequency tolerances for these categories of stations and frequency bands, taking into account efficiency of spectrum utilization and economic and environmental considerations;

3. what are the ultimate values of tolerances, and where would it be unnecessary to make them more stringent under currently known conditions of operation?

Note – See Report 181.

QUESTION 55-3/1

SPURIOUS EMISSIONS

(1977-1978-1982-1986)

The CCIR,

CONSIDERING

(a) that the spurious emissions of a transmitter provided for one service may interfere with other services in other parts of the frequency spectrum;

(b) that Appendix 8 to the Radio Regulations specifies the maximum permitted level of spurious emissions in terms of the mean power supplied by a transmitter to the antenna transmission line at the frequency, or frequencies, of any spurious emission;

(c) that Article 5 (Nos. 304 and 306) of the Radio Regulations stipulates that stations must conform to the tolerances specified in Appendix 8 for spurious emissions; that, moreover, every effort should be made to keep spurious emissions at the lowest values which the state of the technique and the nature of the service permit;

(d) that between 960 MHz and 17.7 GHz, systems using digital modulation techniques and stations in the space services are not included and that above 17.7 GHz there are no specific unwanted emission limits at all;

(e) that although field strength measurements of spurious emissions, at locations distant from a transmitter, provide a direct means of expressing the intensities of such emissions, the field strength so measured bears no simple relation to the mean power of spurious components supplied to the antenna transmission line;

(f) that, in dealing with emissions on the fundamental frequencies, administrations customarily establish the power supplied to the antenna transmission line, and measure the field strength at a distance, to aid in determining when an emission is causing interference with another authorized emission; that a similar procedure would be helpful in dealing with spurious emissions (see Article 18, No. 1813, of the Radio Regulations);

(g) that unwanted emissions are often radiated from the transmitter itself and not from the antenna system;

(h) that for the most economical use of the frequency spectrum, it is necessary to lay down general maximum limits of spurious emissions, while recognizing that lower limits may be required for some services;

(j) that part of the spurious emissions from amplitude-modulated sound-broadcasting transmitters which employ pulse-width modulation techniques appear at multiples of the switching frequency on either side of the carrier as a result of pulse-width modulation techniques,

UNANIMOUSLY DECIDES that the following question should be studied:

1. how should the limits of spurious emissions be specified (e.g. as power supplied to the antenna transmission line, in terms of mean power relative to the fundamental or absolute levels, or as field strength at a distance);

2. should certain classes of emission be specified as "peak envelope power" as well as, or in place of, "mean power";

3. what limits should be applied to spurious emissions from transmitters of different powers and service operating on fundamental frequencies in the range 9 kHz to 275 GHz;

4. what method of measurement of spurious emissions should be used under conditions in which the result obtained depends on the bandwidth, the integration time and other characteristics of the measuring equipment;

5. what is the relationship between the power of spurious components supplied to the antenna transmission line and the field strength resulting from the radiation of these components, taking into account the radiation characteristics of the antenna system and, where necessary, also the propagation characteristics;

6. what precautions should be taken in stations comprising several transmitters operating at neighbouring frequencies and feeding a common antenna, or several antennas placed close to each other, to reduce the generation of spurious emissions by intermodulation between different fundamental emissions;

7. are there any special requirements relating to:

- harmonic emissions produced by high-power transmitters,
- spurious emissions resulting from amplitude-modulated sound-broadcasting transmitters employing pulse-width modulation techniques?

Note – See Recommendation 329 and Reports 838 and 839.

QUESTION 56/1

INTERFERENCE BETWEEN SERVICES IN ADJACENT BANDS

(1977)

The CCIR,

CONSIDERING

(a) that interference may occur between services in adjacent bands;

(b) that constraints can thereby be imposed on the planning and operation of those services;

(c) that there is considerable variation in the performance of receivers with respect to protection against out-of-band signals;

(d) that the design of receivers to meet planning standards within the bands allocated to that service may not take account of services in adjacent bands,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent should out-of-band emission from transmitters be reduced in order to avoid interference to services in adjacent bands;

2. to what extent can the performance of receivers be improved, especially for channels near the edges of adjacent bands;

3. to what extent can receiver immunity to signals entering other than by way of the antenna be improved?

Note – The Director, CCIR, is requested to draw the attention of the IEC and the CISPR to this Question.

QUESTION 59-1/1

METHODS FOR DETERMINING POWER OUTPUT OF TRANSMITTERS

(1978-1986)

The CCIR,

CONSIDERING

(a) that it is important to have a uniform and clearly understood method of transmitter peak envelope power measurement, particularly in the reduced and suppressed carrier cases or for transmitters designed for complex emissions;

(b) that any transmitter power measurement must take into account any significant power contributed by intermodulation distortion products as indicated in § 3.1.2.3 of Recommendation 326;

(c) that the International Electrotechnical Commission (IEC) has been studying methods of measuring transmitter power output levels and may offer results that could be of value to the CCIR in its studies,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what methods of determining transmitter power levels might be defined particularly for those transmitters of which the carrier power levels are not adjustable;

2. what values are appropriate for "acceptable intermodulation level" particularly for single-sideband single-channel radiotelephone emissions (H3E, R3E and J3E) without a privacy device;

3. under what conditions might it be possible to estimate transmitter output power from a distance, and if possible, what degree of tolerance should be expected with the estimation?

Note – See Recommendation 326.

QUESTION 60/1

SPECTRA AND BANDWIDTHS OF EMISSIONS

(1982)

The CCIR,

CONSIDERING

(a) that Article 5, No. 307, of the Radio Regulations requires that the bandwidths of emissions shall be such as to ensure the most efficient use of the radio-frequency spectrum and that Part B of Appendix 6 is provided as a guide for the determination of the necessary bandwidth;

(b) that Article 5, No. 305 of the Radio Regulations also requires that transmitting stations shall not exceed the maximum permitted power levels for out-of-band emissions and that, in the absence of such specifications in the Radio Regulations, transmitting stations shall satisfy, to the maximum extent possible, the requirements relating to the limitation of the out-of-band emissions specified in CCIR Recommendations;

(c) that the data concerning the necessary bandwidth given in Part B of Appendix 6 to the Radio Regulations are still incomplete and do not cover all classes of emission in common use;

(d) that Recommendation 328 deals with only a limited number of classes of emission, especially as far as the specification of the permissible out-of-band power and the limitation of the emitted spectra are concerned;

(e) that, on account of the insufficient material at present available, it will be necessary to continue the study of appropriate methods for the measurement of occupied bandwidth and emitted spectra,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the values of necessary bandwidth and permissible out-of-band power for the various classes of emission in common use and in what way can they be determined;

2. what alternative or additional requirements may be imposed on the emitted spectrum, particularly with respect to the permissible out-of-band spectrum and its slope, with a view to reducing interference to neighbouring radio channels;

3. what are the appropriate methods for measuring the bandwidth occupied by a given emission and the power density spectrum (or power spectrum, when the spectrum consists of discrete components), both under simulated and actual operating conditions?

Note – See Recommendations 327, 328 and Reports 324 and 837.

QUESTION 62/1

LIGHTNING PROTECTION OF RADIO EQUIPMENT

(1982)

The CCIR,

CONSIDERING

(a) that the WARC-79, in Resolution No. 64, invited the CCIR, in consultation with the CCITT, to provide Recommendations related to the protection of telecommunications equipment from lightning discharges;

(b) that there are areas in the world where, although protective devices against lightning have been installed, equipments constantly deteriorate, often very seriously, following discharges produced during electrical or violent storms;

(c) that large electromagnetic pulses (lightning) can couple a considerable amount of energy into antennas and interconnecting cables and that many of these coupling mechanisms are not, as yet, completely understood;

(d) that modern telecommunication systems, especially multichannel systems requiring high reliability, are becoming increasingly more vulnerable to over-voltages and over-currents than conventional systems,

UNANIMOUSLY DECIDES that the following question sho uld be studied:

1. what measurement techniques and equipment can best be used to determine the characteristics of the electromagnetic fields near to and produced by lightning discharges;

2. what are the levels and other characteristics of the near electric and magnetic fields generated by lightning discharges;

3. what are the mechanisms by which lightning generated fields introduce destructive energy into telecommunications equipment;

4. what protective techniques and devices are necessary for the efficient and economic use by designers and users of telecommunications equipment?

QUESTION 63-1/1*

MONITORING OF THE BAND 406-406.1 MHz

(1983-1986)

The CCIR,

CONSIDERING

(a) the monitoring programmes to be organized by the International Frequency Registration Board as instructed by Resolution No. 205 (Mob-83) of the World Administrative Radio Conference for Mobile Services;

(b) that interference cases caused to the mobile-satellite (Earth-to-space) service (satellite EPIRBs) in the band 406-406.1 MHz have already been reported;

(c) that the IFRB has requested it to study techniques for monitoring the band 406-406.1 MHz,

UNANIMOUSLY DECIDES that the following question should be studied as a matter of urgency:

what are the preferred monitoring techniques for the detection and identification of sources of interference liable to degrade the mobile-satellite (Earth-to-space) service (satellite EPIRBs) in the band 406-406.1 MHz?

Note – See Report 979.

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* The Director, CCIR, is requested to bring this Question to the attention of the International Maritime Organization (IMO).

QUESTION 64/1

SPECTRUM USAGE AND SHARING CRITERIA ABOVE 40 GHz

(1986)

The CCIR,

CONSIDERING

(a) that there is extensive development being carried out to provide telecommunication services utilizing the spectrum above 40 GHz including systems which operate in the infra-red and visible light regions;

(b) that while the number of operating systems using the spectrum above 40 GHz is somewhat limited in number at the present time, utilization criteria are required to ensure orderly development and to minimize interference situations;

(c) that the Plenipotentiary Conference (Nairobi, 1982) has endorsed Opinion 61-1 of the CCIR Plenary Assembly (Geneva, 1982) and has required the CCIR to study technical and operating questions relating specifically to radiocommunication without limit of frequency range,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the kinds of telecommunications systems that can use the spectrum above 40 GHz and what are the preferred frequency bands for each type of system;

2. what are the sharing criteria, interference considerations and coordination arrangements that should be taken into account for using the spectrum above 40 GHz?

Note – See Reports 663, 664, 665, 666 and 667.

QUESTION 65/1*

IMPROVED METHODS OF EXCHANGING COMPUTER PROGRAMS AND DATA FOR SPECTRUM MANAGEMENT PURPOSES

(1986)

The CCIR,

CONSIDERING

(a) that Recommendation No. 31 of the WARC-79 requested that a CCIR Handbook on spectrum management and computer-aided techniques be prepared, and that such a Handbook has been prepared and issued (see Report 841);

(b) that there are numerous computer programs catalogued in the Handbook, and further application computer programs are expected to become available in the future;

(c) that there is a need to exchange these computer programs and spectrum management data among interested administrations (see Decision 27);

(d) that computer programs and spectrum management data can be directly transferred between computer systems using telecommunications;

(e) that transfer of computer programs and spectrum management data via telecommunications generally involves some administrative and maintenance tasks;

(f) that transfer of computer programs and spectrum management data could substantially facilitate and improve the cooperation existing among administrations in the field of spectrum management;

(g) that some administrations have been successful in using these techniques,

UNANIMOUSLY DECIDES that the following question should be studied as a matter of urgency:

1. how can the current methods of software and data exchange be improved through the use of modern telecommunication techniques;

2. what are the conditions (e.g. network considerations, baud rates, data formats, block sizes, error detection schemes, application level protocols, level 7 of the 7-level standard, etc.) required to implement these techniques in practice?

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* This Question should be brought to the attention of the CCITT. The XVIIth Plenary Assembly decided that this Question should be categorized as an URGENT Question.

QUESTION 66/1

METHODS AND ALGORITHMS FOR FREQUENCY PLANNING

(1990)

The CCIR,

CONSIDERING

(a) that the demands for the use of the radio-frequency spectrum are increasing rapidly and improved frequency management systems are required;

(b) that frequency management systems should include techniques for greater frequency re-use and increased sharing between services;

(c) that detailed calculations of radio-frequency propagation, using a terrain data base, are often required in the assessment of frequency re-use and sharing;

(d) that the rational selection of electromagnetic compatibility (EMC) models and computer-aided techniques for data management and frequency planning will result in substantial economies in the use of the radio-frequency resource;

(e) that algorithms developed separately by administrations for particular frequency management tasks should produce consistent results and be portable to allow their use on a wide range of available computers,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what frequency assignment algorithms and methods, in accordance with the provisions of the Radio Regulations and other regulatory documents, can be used in automated systems for tasks with real dimensions;

2. how should the formalized tasks of frequency assignment be classified and what models based on actual spectrum management practice should be used;

3. what standardized methods are there for presenting the initial data for frequency assignment tasks;

4. what sort of evaluations should be made of the effectiveness of frequency assignment algorithms, their adequacy for the initial data and the methods for selecting a specific algorithm?

Note – See Report 842 and Question 72/1.

QUESTION 67/1

METHOD OF MEASURING THE MAXIMUM FREQUENCY DEVIATION OF FM BROADCAST EMISSIONS AT MONITORING STATIONS

(1990)

The CCIR,

CONSIDERING

(a) constantly increasing occupancy of the frequency band used for VHF sound broadcasting;

(b) the growing probability of mutual interference ensuing from the increasing occupancy;

(c) that radiation by FM broadcasting transmitters exceeding the maximum permissible frequency deviation may contribute to harmful adjacent channel interference;

(d) the lack of a specification defining which values measured by monitoring stations should be considered as non-compliance with the maximum permissible frequency deviation;

(e) the necessity of such a definition of non-compliance with the maximum permissible frequency deviation for handling interference events at the national and international level,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what methods can be recommended for the measurement of the maximum frequency deviation of FM sound-programme broadcasting transmitters by monitoring stations;

2. what measuring time is required to determine the maximum deviation;

3. what is the minimum duration for the maximum frequency deviation to be considered as non-compliance with the limiting value?

QUESTION 68/1

SPECTRUM MANAGEMENT

(1990)

The CCIR,

CONSIDERING

(a) that due to the growing demands on the radio-frequency spectrum, there is a need to improve spectrum management techniques;

(b) that administrations are facing increasingly voluminous and complex tasks in spectrum management due to the increased use of existing telecommunications and new communications technology;

(c) that the efficient solution of spectrum management problems requires data storage, data retrieval, and complex analysis techniques,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the principles and techniques for effective spectrum management, including engineering and measurement, equipment parameter limits, computer-aided techniques and electromagnetic compatibility (EMC) techniques;

2. what are the methods for solving spectrum sharing problems, planning for effective spectrum management, and efficient use principles and applications;

3. what are the monitoring techniques which are applicable to spectrum management;

4. what are the principles guiding utilization of the spectrum when satisfying various applications?

Note – See Report 1108.

QUESTION 69/1*

THE TECHNICAL AND OPERATIONAL METHODS UTILIZED FOR THE ALLOCATION AND IMPROVED USE OF THE RADIO FREQUENCY SPECTRUM

(1990)

The CCIR,

NOTING

1. that the ITU Plenipotentiary Conference, Nice 1989, in Resolution No. 8 [PL-B/3] considered that alternatives to the way in which the radio frequency spectrum is allocated should be examined by a Voluntary Group of Experts (VGE) with a view to maximizing efficient use of the radio frequency spectrum, and to cover multi-functional radio systems;

2. that the Plenipotentiary Conference instructed the Director of the CCIR to provide the VGE with all necessary assistance required,

CONSIDERING

that, while the CCIR has carried out technical studies and issued Recommendations on a wide range of techniques for efficient use and sharing of the spectrum, alternative methods by which the frequency spectrum can be allocated and shared have not yet been explicitly studied in the CCIR,

UNANIMOUSLY DECIDES that the following question should be studied:

1. how can improved use of the radio frequency spectrum be obtained by modifying, from a technical and operational point of view, the existing:
- methods of allocating the radio frequency spectrum;
- definitions used in the Radio Regulations;
- sharing methods;

2. how could the transition be made from the present allocation process and what is the expected impact of the alternatives;

3. what Recommendations associated with these alternatives can be issued by the CCIR?

* The XVIIth Plenary Assembly decided that this Question should be categorized as an URGENT Question.

QUESTION 70/1 *

LIMITATION OF RADIATION FROM INDUSTRIAL, SCIENTIFIC AND MEDICAL (ISM) EQUIPMENT

(1990)

The CCIR,

CONSIDERING

(a) that WARC-79, in Resolution No. 63, invites the CCIR to continue, in collaboration with the CISPR and IEC, its studies relating to radiation from ISM equipment;

(b) that limits should be imposed on radiation from ISM equipment inside and outside the bands designated for their use in the Radio Regulations;

(c) that WARC-79, in Resolution No. 63, invites the CCIR to specify these limits in the form of Recommendations;

(d) that priority should be given to study limits in the following recently designated frequency bands:

6765	-	6795	kHz
433.05	-	434.79	MHz
61	-	61.5	GHz
122	-	123	GHz
244	-	246	GHz

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the limits for the radiation of ISM equipment in those parts of the spectrum which are not designated for use of ISM equipment;

2. what are the limits for the radiation of ISM equipment in the frequency bands which are designated for their use, taking into account the needs for present and future ISM applications?

Note 1 – See CISPR Publication 11 (1975) – Limits and methods of measurement of radio interference characteristics of ISM radio frequency equipment (excluding surgical diathermy apparatus), with its Amendment No. 1 (1976) and first supplement CISPR 11A (1976).

Note 2 – See Decision 54.

Note 3 – This Question should be studied in collaboration with the CISPR and the IEC.

* Previously Study Programme 4D/1. The XVIIth Plenary Assembly decided that this Question should be categorized as an URGENT Question.

QUESTION 71/1*

BANDWIDTH EXPANSION TECHNIQUES AND SPECTRUM SHARING

(1990)

The CCIR,

CONSIDERING

(a) that while bandwidth expansion techniques may improve spectrum utilization, new approaches to spectrum sharing may be necessary;

(b) that many bandwidth expansion systems employing a variety of techniques are being developed;

(c) that through the use of various bandwidth expansion techniques, ranging and communication systems have been and are being developed to permit highly reliable operation under difficult conditions of low signal-to-noise ratio, low signal level, and low detectability by other systems;

(d) that frequency sharing between bandwidth expansion systems may vary with the particular technique;

(e) that in some cases, spread-spectrum systems may share the same frequency band with narrowband and other broadband systems;

(f) that in order to efficiently share the spectrum, measures and criteria for the use of bandwidth expansion techniques need to be determined,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the time and frequency domain characteristics that describe typical bandwidth expansion techniques and review how they differ from conventional narrow-band modulation techniques;

2. what are the advantages and disadvantages for spectrum utilization that can accrue through the development, implementation, and deployment of systems that employ low power spectral density spread-spectrum techniques;

3. how does radiocommunication system performance change as increasing numbers of conventional and/or bandwidth expansion systems share the same spectral space;

4. how efficiently do bandwidth expansion techniques use the spectrum relative to information transfer, reliability, and interference immunity;

5. what criteria and procedures are applicable to the use of bandwidth expansion techniques in order to allow spectrum sharing;

6. what characteristics besides low power spectral density could be designed into spread-spectrum systems to enhance spectrum sharing opportunities?

Note – See Reports 651, 652 and 826.

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* Previously Study Programme 18B/1.

QUESTION 72/1*

OPTIMUM NETWORK PLANNING AND FREQUENCY ASSIGNMENT TECHNIQUES

(1990)

The CCIR,

CONSIDERING

(a) that a number of world and regional administrative conferences are to be planned which require preparation of technical bases;

(b) that effective use of radio spectrum depends both on operational characteristics of systems and on techniques of radio network planning and frequency assignment;

(c) that frequency spectrum sharing is effective, under some circumstances, if it is planned in advance;

(d) that effective methods of radio network planning and frequency assignment are needed on world, regional, and national scales,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the principles for radio network planning and frequency assignment techniques in the various frequency bands as a basis for specific applications of the various services, which principles could be recommended for use on world, regional, or national scales?

Note 1 – See Resolutions No. 3, 7, 508, 509, 510, 702 and Recommendations No. 12 and 500 of the WARC-79.

Note 2 – See Report 842.

* Previously Study Programme 18C/1.

QUESTION 73/1*

DIGITAL SIGNAL PROCESSING METHODS IN RADIO MONITORING

(1990)

The CCIR,

CONSIDERING

(a) that recent progress in technology has made it possible to use digital hardware and software to process band-limited radio-frequency signals;

(b) that digital methods offer higher stability, accuracy and better repeatability as compared to analogue solutions;

(c) that it is desirable to improve the accuracy, speed and convenience of frequency, field strength, and bandwidth measurements and of direction finding and station identification,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what digital signal processing methods, instrumentations and software algorithms are best suited for the above-listed tasks;

2. what improvement in accuracy and speed is attainable in monitoring by using digital signal processing;

3. how can different instrumentations for different radio monitoring tasks, be combined in a single versatile equipment with the help of digital signal processing?

Note – See Report 1107.

* Previously Study Programme 22A/1.

QUESTION 74/1 *

MAN-MADE RADIO NOISE

(1990)

The CCIR,

CONSIDERING

(a) that knowledge of the properties of additive, undesired radiation from man-made radio noise sources is useful for efficient spectrum utilization;

(b) that the majority of previous measurements have pertained to individual sources, the principal objective being the reduction in noise rather than a determination of the composite effect;

(c) that the results of previous work have been difficult to compare, in part due to technological restraints and to the differing objectives of the individual service Study Groups;

(d) that there is evidence that man-made radio noise may be the limiting factor in the reception of radio signals over a wide frequency range,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the methods to be used for measurement of the statistical characteristics of composite man-made radio noise;

2. what is the difference in these characteristics when observed on a variety of antennas (e.g. dipole, rhombic, Wullenweber);

3. what are the methods to be used for deducing the characteristics of man-made noise that would be received on a variety of antennas when data are obtained by the use of only one particular type of antenna;

4. what is the correlation of man-made noise characteristics with urbanization (i.e. population density, industrial activity, electrical power distribution and consumption, vehicular traffic, etc.);

5. what is the variability of such characteristics as a function of geographical location, time and frequency?

Note 1 – The Director, CCIR, is requested to transmit this text to the International Union for Radio Science (URSI) for comment and to Study Groups 5, 6 and 8 and to the International Special Committee on Radio Interference (CISPR).

Note 2 – See Recommendation 508 and Report 670; see also Question 29/6 and associated Recommendations and Reports.

* Previously Study Programme 46A/1.

QUESTION 75/1*

MEASUREMENT OF RADIO NOISE

(1990)

The CCIR,

CONSIDERING

(a) that WARC-79, in Recommendation No. 68, invites the CCIR to continue existing studies and to initiate new studies on radio noise in areas where such studies have not yet been established previously;

(b) that such studies should be supported by experimental data;

(c) that these data should be measured as far as possible under standardized conditions and with equipment having specified characteristics;

(d) that comparison of experimental data and adequate evaluation are only possible if the measurements have been performed according to uniform methods and if the results are presented in a standard format,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what measuring conditions, equipment characteristics, measurement programmes and the standard format should be used for presentation of the noise data;

2. how should measurements be undertaken using these standardized methods;

3. how should the measurement results be evaluated in order to provide a basis for improving the current predictions of natural and man-made noise?

Note 1 – The Director of CCIR is requested to transmit this text to the International Union for Radio Science (URSI) for comment and to Study Groups 5, 6 and 8 and to the International Special Committee on Radio Interference (CISPR).

Note 2 – See Recommendation 508 and Report 670; see also Question 29/6 and associated Recommendations and Reports.

* Previously Study Programme 46B/1.

QUESTION 76/1*

SPECTRA AND BANDWIDTHS OF EMISSIONS

(1990)

The CCIR,

CONSIDERING

(a) that the concepts of occupied bandwidth and necessary bandwidth defined in Article 1, Nos. 146 and 147, of the Radio Regulations are suitable to specify the spectral properties of a given emission, or given class of emission, in the simplest possible manner;

(b) that the x dB bandwidth defined in Recommendation 328 may be a usable alternative for the occupied bandwidth, especially for use in monitoring stations;

(c) that, however, these concepts may not suffice when consideration of the complete problem of radio spectrum economy and interference to neighbouring radio channels is involved;

(d) that, from this point of view, it is, *inter alia*, desirable that the emitted power spectrum in its outer parts contains as small a power, and exhibits as steep a slope as practicable;

(e) that, without impairing the transmission of information at the rate and quality required, a reduction of power in the outer parts of the spectrum and an increase of its slope might be achieved;

(f) that Recommendation 328 deals with only a limited number of classes of emission especially with regard to the specification of the permissible out-of-band power,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the concepts of necessary, occupied, and x dB bandwidth, permissible out-of-band power and spectrum, and emission of a transmitter, which are optimum from the standpoint of spectrum economy and efficiency, with, *inter alia*, a view to achieving improved methods of measurement;

2. what are the methods to be used for measuring the spectra of the various classes of emission in general use under actual or simulated operating conditions or other stated conditions and to verify the theoretical prediction of the concepts set out in § 1;

3. would it be useful to establish a "specific power spectral density" defined as the power contained within a small, fixed bandwidth (or several such bandwidths) related to the type of spectra to be measured, for example 1 Hz, 1 kHz, 4 kHz, 1 MHz;

4. what is the appropriate percentage "β" for the permissible out-of-band power, as defined in Recommendation 328, for various classes of emission and for various services;

5. what are the out-of-band spectra for various classes of emission and for various services, to be used for determining to what extent the emissions outside the necessary band can be reduced with a view to imposing limits on the spectra of emissions?

Note – See Recommendations 327, 328 and Reports 324 and 837.

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* Previously Study Programme 60A/1.

QUESTION 77/1*

FORMULAE AND EXAMPLES FOR THE CALCULATION OF NECESSARY BANDWIDTHS

(1990)

The CCIR,

CONSIDERING

(a) that Article 4 of the Radio Regulations requires that the necessary bandwidth be part of the full designation of emissions;

(b) that the list of examples and formulae for the calculation of the necessary bandwidth for various classes of emission given in Part B of Appendix 6 to the Radio Regulations is incomplete, particularly with respect to the classes of emission which are currently used in satellite communications;

(c) that there is insufficient information available for the determination of the factor K and in the formulae for the calculation of the necessary bandwidth for certain classes of emission;

(d) that, especially with regard to the efficient utilization of the radio-frequency spectrum, monitoring and the notification of emissions, it is required that the necessary bandwidths for the individual classes of emission be known;

(e) that for reasons of simplification and international uniformity it is desirable that measurements for determining the necessary bandwidth be made as seldom as possible,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the additional formulae required for the calculation of necessary bandwidth for classes of emission in common use, particularly for satellite communication, and what additional examples of such calculations are required to supplement those given in Part B of Appendix 6 to the Radio Regulations;

2. what are the values of the factor K required for the calculation of the necessary bandwidth for certain classes of emission in relation to the allowable signal distortion?

Note – See Report 836.

* Previously Study Programme 60B/1.

QUESTION 78/1*

METHODS OF MEASURING SPECTRA OF EMISSIONS IN ACTUAL TRAFFIC

(1990)

The CCIR,

CONSIDERING

(a) that it is important to be able to measure accurately the bandwidth occupied by an emission and to determine its spectrum in actual traffic;

(b) that the documentary material, at present available, does not give a full idea of the value of the results obtained in actual traffic with equipment which is intended for measuring the spectrum of a periodic signal,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the difference in the results obtained on periodic signals and on actual traffic signals of comparable characteristics and of the same modulation rate;

2. what are the results obtained with different methods, such as those described in Recommendation 327;

3. what is the physical meaning of the results obtained in actual traffic, especially for those systems using digital modulation techniques and the space services, taking account of the various forms of energy distribution within their spectra;

4. what is the degree of accuracy obtainable with different methods, such as those described in Recommendation 327;

5. what are the practical measuring methods, preferably employing existing equipment, which can be used in monitoring stations?

Note – See Report 324.

* Previously Study Programme 60C/1.

QUESTION 79/1*

PROPAGATION MODELS FOR SPECTRUM MANAGEMENT AND PLANNING ABOVE 20 GHz

(1990)

The CCIR,

CONSIDERING

(a) that the WARC-79 revised the International Table of Frequency Allocations so that the frequency spectrum above 20 GHz may become available;

(b) that there is a great interest in and a necessity to use this spectrum resource;

(c) that the availability of models describing propagation above 20 GHz is still insufficient;

(d) that knowledge of such models is a necessary prerequisite for efficient frequency management in this part of the spectrum,

UNANIMOUSLY DECIDES that the following question should be studied:

what are suitable models for the frequency bands 20 to 275 GHz (and as a matter of urgency for the bands 20 to 105 GHz) for spectrum management and planning purposes for use in describing the effects on propagation of:

- gaseous attenuation, taking into account the effect of trace gases;
- attenuation by hydrometeors, taking into account the microstructure of the rain and the statistical structure of rain intensity;
- ducting?

Note – See Report 1100.

* Previously Study Programme 64A/1.

QUESTION 80/1*

DEFINITION OF INTERFERENCE AND UNITS AND METHODS OF MEASUREMENT

(1990)

The CCIR,

CONSIDERING

(a) that Recommendation No. 708 of the World Administrative Radio Conference, Geneva, 1979, asks the CCIR to study as a matter of priority the various technical sharing criteria between space radiocommunications and terrestrial radiocommunication services;

(b) that the above-mentioned Conference has adopted definitions for the certain terms of interference;

(c) that the above-mentioned definitions are essential for the development of proper criteria for the sharing of radio frequencies between stations of the aeronautical mobile, maritime mobile, land mobile and radiodetermination services (terrestrial and satellite) on the one hand and stations of other services on the other hand,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the meaning of the terms "acceptable (or unacceptable) interference" and "harmful interference" with respect to the aeronautical mobile, maritime mobile, land mobile and radiodetermination services (terrestrial and satellite);

2. what are the appropriate units in which such types of interference may be expressed, whether in terms of signal level, of percentages of time, and/or by other means as the case may be;

3. what are of the appropriate methods to be used for measurement of interference to various types of mobile services caused by other radio emissions?

Note 1 – The Director, CCIR, is requested to draw the attention of ICAO and IMO to this Question and invite them to cooperate in the study.

Note 2 – See Reports 926 and 927.

* Previously Study Programme 21A/8.

QUESTION 81/1*

ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS CONCERNING RADIOCOMMUNICATION SERVICES, IN PARTICULAR SAFETY SERVICES

(1990)

The CCIR,

CONSIDERING

(a) Opinion 2-2 on the continued cooperation between CISPR and CCIR;

(b) that Recommendation 433 recommends that administrations take into account Recommendations, Reports and publications of the CISPR;

(c) that the protection of radio services, in particular safety services, calls for proper requirements with respect to electromagnetic compatibility (EMC);

(d) that it is desirable to exchange information between CISPR and CCIR concerning the protection of radiocommunication services, in particular of safety services;

(e) that the CISPR has already extensively studied, and continues to study, the methods for measuring the level of radiation arising from electrical apparatus and installations;

(f) that the CISPR has recommended limits for unwanted radiations from electrical appliances and installations based on economical and statistical considerations to attain adequate protection,

NOTING

that some administrations and organizations are not in a position to participate both in the work of CCIR and CISPR,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what receiver characteristics are relevant in determining the susceptibility of radio systems to interference caused by undesired emissions from electrical equipment;

2. what is the field strength to be protected, the protection ratio with respect to continuous and discontinuous interference and the acceptable probability of interference for different kinds of radio services;

3. what are the effects on the various radio services of the continuous and discontinuous interference caused by electrical equipment and what is the cumulative effect of multiple sources of interference?

Note – See also Opinion 2-2.

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* The XVIIth Plenary Assembly decided that Study Group 1 will consider if there are parts to be included in other Questions and whether they are to be considered in category A2.

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QUESTIONS CONCERNING STUDY GROUP 12

INTER-SERVICE SHARING AND COMPATIBILITY

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QUESTION 1/12*

COMPATIBILITY BETWEEN THE BROADCASTING SERVICE IN THE BAND OF ABOUT 87-108 MHz AND THE AERONAUTICAL SERVICES IN THE BAND 108-137 MHz**

(1990)

The CCIR,

CONSIDERING

(a) Recommendation No. 704 of the World Administrative Radio Conference (Geneva, 1979);

(b) Recommendation No. 714 (MOB-87) of the World Administrative Radio Conference for the Mobile Services (Geneva, 1987);

(c) that two distinct and different aeronautical radionavigation systems operate in the band 108-118 MHz; namely:

- Instrument Landing System (ILS) localizer (108-112 MHz);
- VHF Omnidirectional Range (VOR) (108-118 MHz);

(d) that the aeronautical mobile (R) service operates in the band 118-137 MHz;

(e) that interference to these aeronautical services has been experienced by several mechanisms due to high-powered FM broadcast transmissions operating in the band 88-108 MHz;

(f) that high-powered FM broadcast transmitters and VHF aeronautical receivers are sometimes operated in close geographic proximity of aerodrome facilities;

(g) that high-powered FM broadcast signals are a potential source of interference to aeronautical receivers;

(h) that the performance characteristics of airborne receiver installations may also cause incompatibility between the high-powered FM broadcasting and these VHF aeronautical services;

(j) that it would be desirable to study possible methods of achieving compatibility between the aeronautical VHF services and the FM broadcasting service;

(k) that ICAO has adopted standards to come into effect on 1 January 1998, relating to the immunity characteristics of future aeronautical VHF receivers and incorporating the agreed immunity levels for intermodulation and desensitization,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the interference problems arising from the operation of the broadcasting service in the band of about 87-108 MHz and the different VHF aeronautical services in the band 108-137 MHz;

2. what is the susceptibility of existing and future aircraft receivers to the following types of interference arising from the operation of high-powered FM broadcasting stations at various power levels, frequency separations from the aeronautical frequency and relative distances between the broadcasting, aeronautical and aircraft stations:

- desensitization (front-end overloading) of the receiver;
- intermodulation generated in the receiver;
- spurious emissions from FM broadcast stations and radiation produced by non-linear interaction between FM broadcast emissions;

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* Formerly Question 61-1/8 (MOD I). The XVIIth Plenary Assembly decided that this Question should be categorized as an urgent Question.

** The Director, CCIR, is requested to bring this Question to the attention of the International Civil Aviation Organization (ICAO).

3. what are the variations in the susceptibilities of existing airborne receivers to such interference and, in particular, in what measure is this variation due to differences in avionic equipment installation practices, e.g. antenna feeder cable lengths, antenna position on airframe, type of antenna;

4. what are the protection criteria applicable to the services involved;

5. what technical methods can be used to achieve compatibility between the FM broadcast service and the VHF aeronautical services?

Note – See Recommendation 591, Report 929 and Report 1198.

QUESTION 2/12*

SHARING BETWEEN THE BROADCASTING SERVICE AND THE FIXED AND/OR MOBILE SERVICES IN VHF AND UHF BANDS

(1990)

The CCIR,

CONSIDERING

(a) that the WARC (Geneva, 1979) increased the number of frequency bands that might be shared between the broadcasting service and the fixed and mobile services;

b) that these bands are specified in Article 8 of the Radio Regulations;

(c) that the Regional Agreement (Stockholm, 1961) contains procedures for the introduction of stations other than broadcasting in the European Broadcasting Area in the band 216-230 MHz;

(d) that the Regional Administrative Conference for the Planning of VHF Sound Broadcasting (Region 1 and part of Region 3), (Geneva, 1984) and the Regional Administrative Conference for the Planning of VHF/UHF Television Broadcasting in the African Broadcasting Area and Neighbouring Countries, Geneva, 1989, have addressed sharing and compatibility issues between the broadcasting service and the fixed and mobile services;

(e) that sharing and compatibility criteria may be the concern of a possible future Regional Administrative Radio Conference to address the shared use of the VHF and UHF bands in Region 3 and countries concerned in Region 1 (Resolution No. 1 (PL-B/1), Plenipotentiary Conference, Nice, 1989);

(f) that the CCIR, in accordance with Resolution 94 of the XVIth Plenary Assembly, has undertaken technical studies for the Conference mentioned in *(e)* above and that the "JIWP/VHF-UHF Sharing R3,1/Study Group 1" produced a report on this matter;

(g) that, although studies are being progressed in CCIR concerning the compatibility between the fixed and the mobile and the broadcasting service, there is no comprehensive information about the criteria for sharing and compatibility between these services;

(h) that, although some administrations have already introduced land mobile services into shared bands, there is a requirement for coordination procedures to facilitate the development of frequency assignment plans and equipment specifications;

(j) that some administrations have already concluded bilateral special agreements** for sharing in accordance with Article 7 of the Radio Regulations;

(k) that it is desirable that sharing criteria be developed on a worldwide basis,

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* This Question derived from Study Programme 39A/11, Study Programme 45A/1, Study Programme 46J-2/10 and Question 69/8. The XVIIth Plenary Assembly decided that this Question should be categorized as an urgent Question. The text has been adapted by the Chairman of Study Group 12 in consultation with the Director.

** a) Protocol of Accord between the Administrations of France, the United Kingdom, Germany (Federal Republic of), Belgium, Ireland, Italy, Luxembourg, Monaco, the Netherlands and Switzerland concerning the entry into service of frequency assignments for broadcasting in the Plan of Geneva-84 in the band 104-108 MHz.

b) Memorandum of Understanding between the Administrations of the United Kingdom and France concerning the use of the band 174-225 MHz.

c) Memorandum of Understanding between the Administrations of the United Kingdom and the Netherlands concerning the use of the band 174-225 MHz.

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the appropriate criteria for sharing between the fixed and mobile services and the broadcasting service (sound and television) in VHF and UHF bands;

2. what are the parameters relating to the protection of the broadcasting service in shared frequency bands in respect of interference from the fixed and mobile services;

3. what are the parameters relating to the protection of the fixed and mobile services in shared frequency bands in respect of interference from the broadcasting service;

4. what are the appropriate criteria for compatibility between the broadcasting service on one hand and the fixed and mobile services on the other in adjacent frequency bands?

Note – See Recommendation 565 and Reports 947, 1023, 1087 and 1098.

QUESTION 3/12*

SHARING BETWEEN THE EARTH EXPLORATION-SATELLITE SERVICE OR THE METEOROLOGICAL-SATELLITE SERVICE ON THE ONE HAND AND OTHER SPACE SERVICES OR THE METEOROLOGICAL AIDS SERVICE ON THE OTHER

(1990)

The International Frequency Registration Board (IFRB),

CONSIDERING

(a) the provisions of No. 326 of the International Telecommunication Convention (Nairobi, 1982);

(b) that there is not sufficient information in the CCIR texts for the application of Appendices 28 and 29 to the Radio Regulations to frequency assignment notices to space or earth stations in the Earth exploration-satellite service and the meteorological-satellite service when the Board has to examine them with respect to the provisions of No. 1060 and No. 1107 of the Radio Regulations, as well as in cases where the Board has to apply other procedures, such as the procedure of Article 14, to these notices;

(c) that in view of the urgency to treat the concerned frequency assignment notices, the Board adopted provisional Rules of Procedure in these cases (see Note);

(d) that it is necessary for the Board to develop its Technical Standards to have the required information through appropriate Recommendations of the CCIR (see No. 1582 of the radio Regulations),

REQUESTS THE CCIR:

to study the parameters which need to be used in application of Appendices 28 and 29 to the Radio Regulations when the Earth exploration-satellite service or the meteorological-satellite service shares the same frequency bands with the meteorological aids service or with other space services.

Note – The provisional Rules of Procedure have been published in Documents 2/39, 4/129, 8/27, 9/136, IFRB (1986-1990).

* Formerly Questions 26/2, 37/4 and 80/8. The XVIIth Plenary Assembly decided that this Question should be categorized as an urgent Question.

QUESTION 4/12*

COORDINATION BETWEEN AN EARTH STATION AND MOBILE STATIONS IN THE MOBILE SERVICES

(1990)

The International Frequency Registration Board (IFRB),

CONSIDERING

(a) the provisions of No. 326 of the International Telecommunication Convention (Nairobi, 1982);

(b) that the present Appendix 28 to the Radio Regulations does not contain the sharing criteria to be used for coordination between an earth station of the fixed-satellite service, the maritime mobile-satellite service, the aeronautical mobile-satellite service or the land mobile-satellite service on the one hand and a mobile station of the land mobile service, the maritime mobile service or the aeronautical mobile service on the other hand;

(c) that the Board, in its day-to-day application of the provisions of the Radio Regulations, encounters cases involving stations of the space and terrestrial services mentioned in *(b)* above and as such urgently needs guidance from the CCIR on a method to be used to determine the coordination area in such cases,

REQUESTS THE CCIR urgently to study the following question:

1. what characteristics should be used for the terrestrial mobile stations (land, maritime and aeronautical) to calculate a coordination area involving these stations;

2. what method should be used to identify administrations, the services of which may be affected when terrestrial mobile stations (ship or aircraft or a vehicle on land) and ship earth stations, aircraft earth stations or land earth stations are operating in the same area?

* Formerly Questions 35/4 and 78/8. The XVIIth Plenary Assembly decided that this Question should be categorized as an urgent Question.

QUESTION 5/12*

COORDINATION AREA OF AN EARTH STATION OF THE FIXED-SATELLITE SERVICE SHARING THE SAME FREQUENCY BAND WITH THE RADIONAVIGATION SERVICE

(1990)

The International Frequency Registration Board (IFRB),

CONSIDERING

(a) the provisions of No. 326 of the International Telecommunication Convention (Nairobi, 1982);

(b) that there is not sufficient information in the CCIR texts for the application of the method of Appendix 28 to the Radio Regulations to calculate the coordination area of an earth station in the fixed-satellite service sharing the same frequency band with the radionavigation service;

(c) that in view of the urgency to treat the concerned frequency assignment notices, the Board adopted provisional Rules of Procedure in these cases (see Note);

(d) that it is necessary for the Board to develop its Technical Standards to have the required information through appropriate Recommendations of the CCIR (see No. 1582 of the Radio Regulations),

REQUESTS THE CCIR:

to study the situation of sharing referred to above and provide, as soon as possible, the parameters of the radionavigation service to be taken into account in applying the method described in Appendix 28 to the Radio Regulations in such a case.

Note – The provisional Rules of Procedure have been published in Documents 4/130, 8/28, 9/137, IFRB (1986-1990).

* Formerly Questions 38/4 and 81/8. The XVIIth Plenary Assembly decided that this Question should be categorized as an urgent Question.

QUESTION 6/12

DETERMINATION OF THE COORDINATION AREA

Appendix 28 of the Radio Regulations

(1991)

The CCIR,

considering

a) that Appendix 28 of the Radio Regulations (RR) has been in force, without change in substance, since the World Administrative Radio Conference (Geneva, 1979) (WARC-79);

b) that the procedure set forth in RR Appendix 28 may not adequately meet the requirements of digital transmission techniques, the use of which has dramatically increased in recent years;

c) that WARC-79 adopted Resolution No. 60 to facilitate the updating of RR Appendix 28 but only with regard to propagation related aspects;

d) that a comprehensive interference propagation measurement programme (COST 210) is expected to yield new relevant propagation data by 1991;

e) that it may be desirable to update RR Appendix 28;

f) that, to permit an updating of RR Appendix 28, the relevant CCIR texts need to be first updated, necessitating close cooperation between several Study Groups,

decides that the following Question should be studied

1. What revisions, if any, should be made to the methodologies and criteria of RR Appendix 28, taking into account the most recent conclusions of the Study Groups and suggestions by the IFRB?

2. What increase in scope, if any, of the provisions of RR Appendix 28 may, in the light of technical considerations, need to be incorporated in such revisions?

3. What is the most recent information on propagation provided by the CCIR including, as appropriate, results from the COST 210 programme, which should be incorporated in such revision?

The following Notes are intended to facilitate the work of the CCIR.

Note 1 - Relevant documentation:

RR:	Appendix 28 and Resolution No. 60
Existing CCIR texts:	Report 999 (Vol. IV) Recommendation 359-5 (Vol IV/IX-2) Recommendation 620 and Report 724-2 (Vol. V)
CCIR Plenary Assembly (Düsseldorf, 1990):	Doc. 4-9/1010 (Report 382-5 (MOD F)) Doc. 5/1051 (Report 569-3 (MOD F))

Note 2 - Issues to be considered:

a) characterization of the interfered-with system/service (hypothetical reference circuit (HRC), hypothetical reference connection (HRX), other);

b) characterization of the interfering system/service (single transmitting station, transmitting service area, other);

c) permissible interfering signals (definition of the radio-frequency signal equivalents that reflect the criteria of maximum permissible interference);

d) interference transfer modes (interaction geometries and interfaces between interfering and interfered-with systems);

e) reference interference paths (definition of transmission paths which determine the coordination area);

f) required path loss (formats for the necessary propagation data);

g) calculation methods and formulae;

h) interference aggregation and number of equivalent interference entries;

i) coordination area in bidirectionally allocated frequency bands (earth station to earth station interference);

j) application of statistical correlations;

k) coordination distance cut-off;

l) numerical versus graphical methods;

m) standards and constraints;

n) propagation models and data.

QUESTION 7/12

FREQUENCY SHARING CRITERIA WITHIN THE RANGE 1-3 GHz

(1992)

The CCIR,

recognizing

a) that the World Administrative Radio Conference (Malaga-Torremolinos, 1992) (WARC-92) modified frequency allocations within the frequency range of 1-3 GHz which led to new sharing situations;

b) that Resolution No. 113 (WARC-92) "Adjustments to the Fixed Service as a Consequence of Changes to the Frequency Allocations Within the Range 1-3 GHz" invites the CCIR, among others;

"to continue its studies of the criteria for sharing between the fixed service and other services";

c) that Resolution No. 522 (WARC-92) "Further Work by the CCIR Concerning the Broadcasting-Satellite Service (Sound)" resolves that the CCIR should study, as a matter of urgency, the

"means to be employed for coordinating and avoiding mutual harmful interference between non-GSO systems, between GSO and non-GSO systems of the Broadcasting-Satellite Service (Sound), and between BSS (sound) and the systems of other services"

and that CCIR studies should focus in particular on:

"*i)* the characteristics of GSO and non-GSO BSS (Sound) systems compatible with No. **2674** of the Radio Regulations,

ii) the appropriate sharing criteria";

d) that Recommendation No. 717 (WARC-92) "Sharing Criteria in Frequency Bands Shared by the Mobile-Satellite Service and the Fixed, Mobile and other Radio Services" recommends that the CCIR:

"1. study, as a matter of urgency, the appropriate criteria for sharing between the Mobile-Satellite Service and other services in the same frequency bands, including power limits and power flux-density limits as indicated in Articles **27** and **28** of the Radio Regulations, while placing minimum restrictions on the services operating in these bands;

2. issue, as a matter of urgency, Recommendations on the subject";

noting

that Study Groups 4, 8, 9, 10 and 11 already initiated studies on protection requirements of the relevant services,

undertakes studies of the following Question as a matter of urgency

What are the sharing criteria within the frequency range 1-3 GHz to be recommended in response to the Resolutions and Recommendation of WARC-92 indicated in § b), c) and d) above?

further decides

1. that the results of the above studies should be included in (a) Recommendation(s);

2. that the anticipated completion date of this work (§ 1) is December, 1993.

QUESTION 8/12

TECHNICAL COORDINATION PARAMETERS IN APPENDIX 28 OF THE RADIO REGULATIONS

(1992)

The CCIR,

recognizing

a) that Resolution No. 712 (WARC-92) of the World Administrative Radio Conference (Malaga-Torremolinos, 1992) "Consideration by a Future Competent World Administrative Radio Conference of Issues Dealing with Allocations to Space Services Which Were not Placed on the Agenda of WARC-92" resolves that the next competent world administrative radio conference should consider, among others, "inclusion of CCIR-approved technical coordination parameters in Appendix **28** of the Radio Regulations";

b) that Resolution No. 211 (WARC-92) "Use by the Mobile Service of the Frequency Bands 2 025-2 110 MHz and 2 200-2 290 MHz" resolves, among others,

> "to invite the CCIR to continue, as a matter of urgency, the study of appropriate provisions to protect the space services operating in the bands 2 025-2 110 MHz and 2 200-2 290 MHz from harmful interference from emissions by stations of the mobile service";

c) that these Resolutions invite the CCIR to carry out the necessary studies,

noting

1. that Study Group 12 (Task Group 12/3) prepared Recommendations 847, 848, 849 and 850, dealing with the technical coordination parameters;

2. that other Study Groups continue their studies relevant to the protection of the services involved,

decides that the following Question should be studied

What provisions and technical coordination parameters should be recommended for inclusion in Appendix 28 of the Radio Regulations in response to the Resolutions indicated in § a) and b) above?

further decides

1. that the results of the above studies should be included in (a) Recommendation(s);

2. that the anticipated completion date of the work is December, 1996.

QUESTIONS CONCERNING STUDY GROUP 5

RADIO WAVE PROPAGATION IN NON-IONIZED MEDIA

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QUESTION 2-5/5

RADIOMETEOROLOGICAL DATA REQUIRED FOR THE PLANNING OF TERRESTRIAL AND SPACE COMMUNICATION SYSTEMS AND SPACE RESEARCH APPLICATION

(1966-1970-1974-1978-1982-1990)

The CCIR,

CONSIDERING

(a) that the characteristics of the tropospheric radio channel depend on a variety of meteorological parameters;.

(b) that statistical predictions of radiopropagation effects are urgently required for planning and design of radiocommunication and remote sensing systems;

(c) that, for the development of such predictions, knowledge of all atmospheric parameters affecting channel characteristics, their natural variability and their mutual dependence is needed;

(d) that the quality of measured radiopropagation data determines ultimately the reliability of prediction methods that are based on these data;

(e) that interest exists in extending the range of frequencies used for telecommunication and remote sensing purposes,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the distribution of refractivity and its gradient, both in space and time;

2. what are the distributions of atmospheric constituents and particles, such as water vapour and other gases, clouds, fog, rain, hail, aerosols, sand, etc., both in space and time;

3. how do the climatology and natural variability of the rain process affect attenuation and interference predictions, especially for tropical regions;

4. what models best describe the relationship between atmospheric parameters and radiowave characteristics (amplitude, polarization, phase, angle of arrival, etc.);

5. what methods based on meteorological information can be used in the statistical prediction of signal behaviour, especially for percentages of time from 0.1 to 10%, taking into account the composite effect of various atmospheric parameters;

6. what procedures can be used to evaluate data quality, accuracy, statistical stability and confidence levels?

Note – During the following study period, priority will be given to studies relating to DECIDES 3 and 5.

QUESTION 9-1/5*

METHODS FOR PREDICTING PROPAGATION OVER THE SURFACE OF THE EARTH

(1990)

The CCIR,

CONSIDERING

(a) that the presence of obstacles on the propagation path may modify, to a large extent, the mean value of the transmission loss, as well as the fading amplitude and characteristics;

(b) that, with increase in frequency, the influence of the detailed roughness of the surface of the Earth as well as that of vegetation and natural or man-made structures on or above the surface of the Earth becomes more significant;

(c) that propagation over high mountain ridges is sometimes of great practical importance;

(d) that diffraction and site shielding are of practical significance in interference studies;

(e) that the increase in performance and storage capacity of computers, permits the development of detailed digital terrain and clutter data bases,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the influence of terrain irregularities, vegetation and buildings, and the existence of conducting structures, both for locations within the service area around a transmitter and for the evaluation of interference at much greater distances, on the transmission loss, polarization, group delay and angle of arrival;

2. what is the additional transmission loss in urban areas;

3. what is the screening provided by obstacles near a terminal, taking into account the propagation mechanisms over the path;

4. what are the conditions under which obstacle gain occurs and the short-term and long-term variations of transmission loss under these conditions;

5. what are suitable methods and formats for describing the detailed roughness of the surface of the Earth including topographic features and man-made structures;

6. how can terrain data bases, together with other detailed information on terrain features, vegetation and buildings be applied in the prediction of attenuation, time delay, scatter and diffraction;

7. how can quantitative relationships and statistically-based prediction methods be developed which treat reflection, diffraction and scatter from terrain features and buildings, as well as the influence of vegetation?

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* This Question merges Questions 9/5 and 10/5.

QUESTION 11-1/5*

PROPAGATION DATA AND PREDICTION METHODS FOR THE TERRESTRIAL BROADCASTING AND TERRESTRIAL MOBILE SERVICES IN THE FREQUENCY RANGE ABOVE 30 MHz

(1990)

The CCIR,

CONSIDERING

(a) that there is a need to estimate the wanted and interference field-strengths or transmission loss when planning or establishing terrestrial broadcasting and terrestrial mobile services at frequencies above 30 MHz;

(b) that for both terrestrial broadcasting and terrestrial mobile services, propagation studies involve consideration of point-to-area propagation paths;

(c) that propagation data may be required to identify possibilities of frequency sharing between the broadcasting, mobile and other services;

(d) that the propagation curves given in Recommendation 370 and Report 567 are based mainly on data obtained from a limited number of regions of the world;

(e) that there are only limited measurements available above 1 GHz;

(f) that there is not enough information available on the effect of the geographical environment on propagation and in the vicinity of receiving antennas (nature of terrain, natural and artificial ground covering, natural or artificial obstacles giving rise to multipaths);

(g) that there is a noticeable increase in the use of digital systems in the broadcasting and mobile services,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what prediction method and propagation curves should be used for planning broadcasting and mobile services in different regions of the world at frequencies above 30 MHz;

2. for what percentages of locations and time should these propagation curves be established;

3. what correction factors should be applied to allow for variations in the height of the transmitting and receiving antennas;

4. what is the influence of polarization;

5. what correction factors should be applied to allow for:
- nature of terrain,
- ground covering (vegetation, buildings, etc.),
- propagation through or inside buildings;

6. how is the statistical distribution of field strength influenced by the factors given in § 3, 4 and 5 above;

7. what methods should be used for calculating field strength over mixed paths;

8. what are the characteristics of the impulse response of the channel;

9. what impairments are imposed both on analogue and digital systems by multipath propagation and, in the case of mobile reception, by the speed of the vehicle;

10. what are the best ways of presenting the required data using computerized methods?

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* This Question merges Questions 11/5 and 12/5.

QUESTION 13/5

PROPAGATION DATA REQUIRED FOR TERRESTRIAL BROADCASTING ABOVE 10 GHz

(1990)

The CCIR,

CONSIDERING

(a) that frequencies above 10 GHz are being used for sound and television broadcasting with terrestrial transmitters;

(b) that the propagation phenomena occuring in these frequency bands will have a decisive effect on the planning of broadcasting services;

(c) that recordings of field strength or transmission loss from terrestrial transmitters, over periods of up to several years, have been made in certain areas of the world,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the statistical distributions of the field strength with time and location;

2. what is the statistical field-strength distribution with time outside the service area up to several hundred kilometres;

3. what are the effects of climate, terrain and vegetation on terrestrial paths;

4. what is the influence of buildings on terrestrial paths;

5. what are the statistics of attenuation and depolarization by atmospheric constituents, including consideration of worst-month, diurnal dependence, and behaviour over large and small service areas;

6. what models should be developed giving delay spread and correlation bandwidth versus frequency for the various categories of terrain;

7. what consideration should be given to the fade level crossing rates and average fade duration;

8. what spatial correlation model should be developed to enable mobile reception to be modelled and the effect of diversity determined;

9. what are the effects of the directivity of the antennas;

10. what is the minimum height of the receiving antenna under urban and rural conditions;

11. what computer methods can be developed for calculating reliability and interference?

QUESTION 14/5

PROPAGATION DATA AND PREDICTION METHODS REQUIRED FOR LINE-OF-SIGHT SYSTEMS

(1990)

The CCIR,

CONSIDERING

that a better knowledge of the characteristics of propagation contributes greatly to the design of economic line-of-sight systems and to the improvement of system performance and in particular:

(a) that the design of digital systems is largely controlled by the availability required (as related to propagation) and that periods of adverse propagation as short as between 0.001% and 0.0001% of the time are significant over a 50 km hop to the design of digital systems;

(b) that the amplitude and group-delay distortion across a microwave radio channel have a profound effect on the bit error ratio of digital systems,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the distribution of the value of basic transmission loss resulting from multipath propagation, diffraction and absorption, etc., in the VHF (metric), UHF (decimetric), SHF (centimetric) and EHF (millimetric) bands for each month of the year including its diurnal variation averaged over each month;

2. what propagation data may be used for station site selection and for determining the height of antennas and their radiation characteristics, including the distribution of refractive-index gradient or *k*-factor during sub-refractive conditions averaged over a specified path length;

3. what are the concurrent statistical distributions of long-term rainfall attenuation and rainfall intensity, especially in tropical regions;

4. what regional factors can be applied to prediction methods to take account of different rain characteristics other than rainfall intensity;

5. what data may be obtained on multipath propagation (both fading and enhancements), in particular:

- the number of rays during multipath propagation, their relative amplitudes, delays and probabilities of occurrence;
- statistics of flat fading, selective fading (including in-band power differences and notch depths) and composite fading (flat plus selective), all as a function of the following conditions: path length, path inclination, path clearance, frequency, polarization, antenna beamwidth, terrain roughness factor and geoclimatic factor;
- conditional probabilities of flat fading, selective fading, delays and notch depth to determine the inter-dependence of the principal multipath parameters;
- dependence of all the above items on diversity (angle, space and frequency) and different types of combiner (switched, maximum power, minimum dispersion);
- dependence on channel separation of correlation of multipath fading on adjacent channels. (This is linked to correlation bandwidth of wideband measurements.);
- statistics to determine the relative probabilities of minimum phase and non-minimum phase selective fading.

Note – The residual bit error ratio (RBER) parameter has been introduced in Study Group 9 to control error performance at the system bit rate during non-faded propagation conditions. At present, there are difficulties in defining measurement procedures for RBER. There is a need to define clearly the set of conditions that must be met to identify the period of non-faded propagation.

6. what approximate models of the tropospheric channel can be used to simplify the computation of system performance, including:

- the complex transfer function of the medium, and
- representational models of the impulse response (e.g. 2-ray, simplified three-ray with and without fixed delay, etc.);

7. what is the variation, due to clear-air propagation effects, precipitation or any other cause, of the decoupling of two orthogonal polarizations, including:

- cumulative distributions of cross-polar discrimination (XPD) (conditional and unconditional with respect to co-polar attenuation (CPA)), rate of change and duration statistics of XPD;
- information concerning the relative importance of cross-polarization due to rain and multipath under various conditions;
- comparison of design procedures based on unconditional distribution XPD with procedures based on joint statistics of XPD and CPA;
- statistics of XPD, under clear-air conditions, as a function of composite fading, flat fading and selective fading;

8. what is the frequency of occurrence and duration of fades exceeding specified values and the rate of change of received signal in these fades, noting that the time resolution of measurements to obtain these statistics must be adequate to describe the rate of variation of the propagation effects.

Note – Study Group 9 particularly requires:

- that the estimation be made in such a way that the distribution of the values of noise power (dependent on transmission loss and multipath propagation) at the output of a system, averaged over 5 ms, 1 s, and 1 min., can be derived;
- simultaneous measurements of path attenuation and depolarization with a measurement period of less than 1 s and preferably less than 100 ms, expressed in such a way that statistics relating to the "worst month" may be derived;

9. what is the improvement to be gained using diversity systems in the presence of rain or multipath;

10. what are the cumulative effects of all propagation factors, on the overall system performance of multi-hop links (including one or more satellite hops), and the dependence of these factors on hop characteristics.

Note – Study Group 9 requires information on the probability that various terrestrial and satellite hops in an HRX will suffer coincident worst month propagation. In particular, Study Group 9 requests data on the coincidence of propagation activity on terrestrial and satellite paths in differing areas of the world;

11. what are the statistical properties of the propagation factors resulting in mutual interference between two links, the cumulative effects of these interference factors on the overall system performance of multi-hop links and the dependence of these factors on path length, climate and the nature of the terrain over which the path passes?

Note – During the following study period, priority will be given to studies relating to DECIDES 3 and 4.

QUESTION 15/5

PROPAGATION DATA AND PREDICTION METHODS REQUIRED FOR TRANS-HORIZON SYSTEMS

(1990)

The CCIR,

CONSIDERING

(a) that, in the planning of a communication network, it is necessary to define the overall system performance achieved for a given percentage of the time;

(b) that designers of radio systems in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands require to know, from the viewpoint of sustained satisfactory operation, the tropospheric propagation characteristics and the resulting transmission loss that is not exceeded for a large percentage of the time for each particular frequency band, over the distance corresponding to the service range, which may extend from about 200 km to more than 500 km;

(c) that the planning of systems requires a knowledge of the distribution curves, as functions of time, of the transmission loss for the most unfavourable month of the climatic zone under consideration;

(d) that the bandwidth of the system may be limited by the nature of the mode of propagation employed,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the distribution in time of the basic transmission loss (see Recommendation 341), in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands, for each month of the year (the value of the path antenna gain being specified). The recording should be performed with an instrument having a time constant of one minute (other time constants may be used, should it appear desirable, but in all cases the time constant used should be specified) and special importance should be attached to the quasi-maximum and quasi-minimum values of the transmission loss or field strength;

2. for given levels, what are the percentages of time corresponding to the worst month and corresponding to the whole year;

3. what are the hours of the day for which the greatest transmission loss may usually be expected;

4. what is the distribution in time of the fluctuation of the level of the received signal about its hourly median value (other periods of time may be used to define the median value, but these periods should be stated), when the recording is made with a time constant as short as possible;

5. what is the dependence of the distributions on the climatic zone in which the path under consideration is located, and which distinct climatic zones should be taken into consideration (in view of the paucity of data relating to propagation in climates other than temperate, administrations are urged to give special attention to the collection of data relating to other types of climate);

6. what is the dependence of the distributions on the frequency, on the distance between the stations, on the angle of elevation of the antennas at each terminal and on the nature of the terrain over which the path passes;

7. what is the extent to which these distributions can be described by simple statistical laws;

8. what are the limitations imposed on the bandwidth of the system by the propagation process (diffraction, partial reflection, scattering, etc.);

9. what are the limitations imposed on the system by the effects of solar noise and noise from other external sources?

QUESTION 16-1/5*

PROPAGATION DATA AND PREDICTION METHODS FOR FIXED-SATELLITE AND BROADCASTING-SATELLITE SERVICES

(1990)

The CCIR,

CONSIDERING

(a) that, in the design of systems for fixed-satellite and broadcasting-satellite services, it is necessary to take into account various phenomena affecting the propagation of radio waves through the troposphere;

(b) that a knowledge of the distributions in time of these phenomena, and of their dependence on various factors, is important to the determination of system performance and of interference to and from space stations;

(c) that there is a requirement for methods to estimate the field strength or the transmission loss when planning fixed-satellite and broadcasting-satellite services;

(d) that the data given in Report 565 for the broadcasting-satellite service are restricted to certain areas, and that further data concerning satellite sound broadcasting at frequencies below 3 GHz, particularly for portable receivers, are needed,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the long-term statistical distribution in time and space, including consideration of the worst month, of co-polar attenuation (CPA) and cross-polar discrimination (XPD) by atmospheric gases, precipitation (rain and ice crystals) and clouds, and sand and dust storms;

2. what is the distribution in time and space of refraction, scintillation, beam divergence, and wavefront coherence of radio waves passing through the troposphere;

3. what is the frequency of occurrence and duration of fades exceeding specified values and the rate of change of received signals in these fades;

4. what is the proportion of fades occurring during the available time as defined in Recommendation 557;

5. what is the distribution in time and space of natural noise from the Earth and from atmospheric constituents as well as galactic and solar emissions above about 50 MHz;

6. what is the dependence of these distributions on the antenna location, frequency, polarization, angle of elevation, geographic latitude, rain climate, time and atmospheric composition, as well as on the effects of terrain, vegetation and man-made structures;

7. what methods should be used for the prediction of these distributions, especially in tropical regions, and their dependence on the above parameters;

8. what regional factors can be applied to prediction methods to take account of different rain characteristics other than rainfull intensity;

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* This Question merges Question 16/5 and 17/5.

9. what are the cumulative effects of these phenomena on system performance;

10. what is the extent to which site diversity or other diversity techniques (whether Earth-based or satellite-based) can be used to overcome the problems associated with:

- attenuation and noise resulting from precipitation and cloud,
- tropospheric scintillation,
- cross-polar discrimination, and,
- interference,

i.e. the conditional probability of these variables at two separated sites;

11. what are the limitations imposed by precipitation and multipath effects on frequency re-use applying orthogonal polarization techniques;

12. what is the correlation between up-link and down-link impairments over short time intervals (of the order of some seconds) for both attenuation (for up-link power control) and depolarization (for up-link pre-compensation);

13. in the case of satellite broadcasting, how do the statistics of attenuation and depolarization depend on the time of day and how does this behaviour vary large and small service areas;

14. what are the effects of the directivity of the antennas?

Note – During the following study period, priority will be given to studies relating to DECIDES 7 and 8.

QUESTION 18/5

PROPAGATION DATA AND PREDICTION METHODS FOR SATELLITE MOBILE AND RADIODETERMINATION SERVICES ABOVE ABOUT 0.5 GHz

(1990)

The CCIR,

CONSIDERING

(a) that there is a requirement for methods to estimate the field strength or the transmission loss when planning mobile and radiodetermination services using satellites;

(b) that a number of administrations are studying satellite systems for aeronautical and maritime safety, radiodetermination, communication and control;

(c) that maritime mobile-satellite communication services have been instituted;

(d) that several administrations are also considering satellite systems for land mobile and aeronautical mobile purposes;

(e) that for VHF, UHF and SHF systems involving satellites, both the ionosphere and troposphere may affect propagation, as well as reflections from the ground, sea and/or man-made structures;

(f) that there is a requirement for propagation data and modelling, especially at low elevation angles, for studying the impairments on the slant propagation path used by satellite-mobile and radiodetermination systems;

(g) that digital modulation methods are now being employed particularly by these services,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent does the field strength or transmission loss depend on the nature of terrain, the effects of vegetation and man-made structures, antenna location, frequency, polarization, angle of elevation and climate; and how do these factors affect the selection of frequencies for such systems;

2. what are the effects due to multipath propagation and Doppler frequency changes, and how do these depend on the parameters listed in DECIDES 1;

3. what is the most suitable form of prediction method, for each radio service, for use in the preparation of national and international frequency plans;

4. what is the preferred field-strength prediction method for use with computers;

5. what are the characteristics and effects of land- or sea-reflection and multipath fading on communication or radiodetermination signals transmitted by satellites, both geostationary and otherwise, for the use of land vehicles, aircraft and ships;

6. what propagation data may be collected for modelling and statistical characterization of tropospheric and multipath-induced impairments, especially for low elevation angle slant paths, as a function of sea or land surface state (wave height or terrain irregularity), satellite elevation angle, antenna radiation pattern, local site clearance and environment, including terrain and vegetation blockage and shadowing and frequency;

7. what is the optimum polarization, bearing in mind the joint consideration of effects of hydrometeors, sea-surface, and terrain scattering on depolarization and the characteristics of realizable antennas?

QUESTION 19-1/5*

PROPAGATION FACTORS AFFECTING FREQUENCY-SHARING BETWEEN FIXED-SATELLITE SERVICE AND FIXED AND MOBILE TERRESTRIAL SERVICES

(1990)

The CCIR,

CONSIDERING

(a) that propagation data for radio paths are required when planning the sharing of frequency channels in telecommunication systems;

(b) that, in accordance with the Radio Regulations, a coordination distance or coordination area should be determined for earth stations in the frequency bands shared between space telecommunication services and the fixed and mobile terrestrial services;

(c) that in the calculation of coordination distances, all pertinent propagation mechanisms should be taken into account, in particular those of super-refraction, ducting and precipitation scatter;

(d) that in the calculation of interference between systems, more detailed consideration of the contributing propagation mechanisms is required;

(e) that in accordance with Recommendations No. 708 and 711 of the World Administrative Radio Conference (Geneva, 1979) the CCIR continues to study the possibility of improving and simplifying the method of determining coordination area and of extending the method to frequencies below 1 GHz and above 40 GHz,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is a suitable method by which contributions of known tropospheric propagation factors, including absorption by and scatter from precipitation, absorption due to atmospheric gases, reflections from aircraft and other phenomena both on and off the great circle path, can be taken into account when considering the signals received over terrestrial and Earth-space paths, including the effects of site-shielding, particularly with reference to the signal strengths exceeded for small percentages of time, such as 0.001%, 0.01%, 0.1%, 1%, 10% and 20% of a month or a year;

2. what is the distribution of signal amplitude (both fading and enhancement), and their duration, due to tropospheric mechanisms such as ducting, precipitation scatter and aircraft scatter in consideration of the points as indicated below:

- the amplitude distribution of greatest interest are the cumulative distributions of quasi-instantaneous values (a suggested averaging period is 1 min) ranging from 0.001% to 20% of the time, during periods of at least one year and also during the worst months, when the wanted signal is low or when the unwanted signal is high;
- path lengths of greatest interest are between 25 and 1000 km; however, over oceans in equatorial and tropical regions and other regions where ducting is prevalent, measurements could be useful up to much greater distances;
- studies should be made through the whole frequency range, and simultanous measurements at several frequencies over the same path would be of special interest;

3. how may the "angular-distance" procedure for clear air modes be best developed;

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* This Question merges Questions 19/5 and 20/5.

4. what are the parameters characterizing irregularity of terrain (e.g. Δh) and how may they be best applied;

5. how may intermédiate length paths (approximately 100 km) for time percentages of 10%-20% best be modelled;

6. how may site-shielding be evaluated, with special emphasis on a practical procedure for calculating its magnitude in particular situations, such as small earth stations in urban areas;

7. how may the world best be divided into broad zones to include the effects of different climatic conditions to take into account the relative importance of various tropospheric mechanisms with special reference to the classification in Report 569;

8. how may the losses to be expected over mixed paths be predicted (e.g. partly over land and partly over sea);

9. what is the effect of using high-gain antennas, taking into account the various extreme case of interest, such as those in Notes 2 and 3 which arise in considering communication-satellite and terrestrial (fixed) services above 3 GHz;

10. what are the losses due to coupling of the radio energy from the transmitting antenna into a duct and out of a duct into the receiving antenna, taking into account the effects of both site-shielding (when the antenna has a positive horizon angle) and antenna height above the surrounding terrain (negative horizon angle);

11. what is the range of angles and distances in which the scattering from rain, hail, snow and ice crystals can be considered as likely to cause interference between microwave stations and, in general, what is the relation between this range of angles and the scattering angle, distance, polarization and frequency, for frequencies above 1 GHz;

12. what is the average distribution in time and space of observed values of effective scattering cross-section per unit volume, as a function of: height above ground, time of day, season, climatic region, scattering angle and polarization of transmitting and receiving antennas;

13. how may improved models and prediction procedures be developed for precipitation scatter, to determine the practical significance of this mode and how does it depend on rainfall rate and structure and on system geometry, including:

- the case of terrestrial stations where antenna beams do not intersect and
- earth stations operating in any satellite system;

14. what are the statistics of interference arising from the correlation of fading of the wanted signal and enhancement of an interfering co-frequency signal;

15. how may the special problems in propagation affecting the prediction of interference at frequencies of about 30 GHz and above be evaluated;

16. in consideration of the above, what improvements can be recommended to the interference prediction methods contained in Report 569 and to the method for determining coordination distance contained in Report 724?

Note 1 – During the following study period, priority will be given to studies relating to DECIDES 16.

Note 2 – The antenna at one end of the path may be assumed to have gain either very close to 0 dB, or about 40 dB, with the beam directed almost horizontally along the bearing of the other antenna.

Note 3 – The antenna at the other end of the path may have a gain of about 60 dB, with the beam directed either well above the horizon or towards the other antenna at an angle of elevation of about 3° above the horizontal. (Radiation diagrams of large antennas at communication-satellite earth stations, for use in interference studies, are given in Report 391.)

QUESTION 21/5

TERRAIN SCATTER AS A FACTOR IN INTERFERENCE

(1990)

The CCIR,

CONSIDERING

(a) the increasing use of shared frequencies in the terrestrial and space services;

(b) the importance of predicting the coupling due to terrain scatter in the planning of systems using these services,

UNANIMOUSLY DECIDES that the following question should be studied:

1. how can distributed scatter from an area of irregular terrain (including vegetation) be quatified;

2. what is the effect of individual buildings, especially when located in, or close to, the main beam of terrestrial stations;

3. how do both these aspects depend on operational-type geometries, antenna heights and beamwidths?

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QUESTIONS CONCERNING STUDY GROUP 6

RADIO WAVE PROPAGATION IN IONIZED MEDIA

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QUESTION 25-2/6

IONOSPHERIC PROPERTIES

(1978-1982-1990)

The CCIR,

CONSIDERING

a) that ionized media affect the propagation of radio waves;

b) that the properties of the ionosphere and ionized regions beyond are described in Reports 725, 886, 887 and 1011,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what additional information concerning the properties of the terrestrial ionosphere and ionized regions beyond facilitates the study of aspects of propagation that are important to radio systems?

2. what physical properties and what variations in the structure of the ionosphere at or near the magnetic equator have an influence on radiocommunications?

DECIDES FURTHER

that the available information should be prepared as a Handbook.

QUESTION 27-1/6

THE SHORT-TERM FORECASTING OF OPERATIONAL PARAMETERS FOR IONOSPHERIC AND TRANS-IONOSPHERIC RADIOCOMMUNICATIONS

(1978-1990)

The CCIR,

CONSIDERING

(a) that accurate, quantitative short-term predictions of ionospheric variations a few hours or days in advance would permit more efficient utilization of radio frequencies and increase the reliability of radiocommunication services;

(b) that, in addition to the widespread disturbances associated with major geophysical or solar events, there are other hour-to-hour and day-to-day ionospheric variations (which may be local in influence) whose effects on operational characteristics of HF and VHF/UHF radio systems, such as operational MUF, and those associated with attenuation, atmospheric noise, fading, multipath interference, group path delay and scattering, cannot be predicted by well-established techniques,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the needs and techniques for the short-term prediction (a few hours or days in advance) of operational parameters for ionospheric and trans-ionospheric radiocommunications;

2. how useful are the techniques of ionospheric sounding or channel evaluation (measurement) as an aid in the real-time estimation of potential circuit performance and in the operational frequency management of radio circuit?

Note – See Recommendation 313 and Reports 249, 727, 888, 889, 890.

QUESTION 29-2/6

RADIO NOISE

(1978-1982-1990)

The CCIR,

CONSIDERING

(a) that radio noise of natural or man-made origin often determines the practical limit of performance for radio systems and thus is an important factor in planning efficient use of the spectrum;

(b) that much has been learned about the origin, statistical characteristics, and general intensities of both natural and man-made noise, but that additional information is needed, particularly for parts of the world not previously studied, for the planning of telecommunications systems;

(c) that for system design, determination of system performance and spectrum utilization factors, it is essential to determine the noise parameters appropriate in considering various modulation methods, including as a minimum, the noise parameters described in Report 322,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the intensities and the values of other parameters, the temporal and geographical variations, the directions of arrival, and the relationships to changes in geophysical phenomena, such as solar activity, of natural and man-made noise from local and distant sources, and how should measurements be made?

Note 1 – Other radio noise studies are within the competence of Study Groups 1 and 5 (see Questions 46/1, 2/5 and 16/5).

Note 2 – See Recommendation 372, Reports 254, 258, 322, 342, 1151, and Opinion 85.

QUESTION 30-1/6

SKY-WAVE SIGNAL INTENSITY AND CIRCUIT PERFORMANCE AT FREQUENCIES BETWEEN ABOUT 1.6 AND 30 MHz

(1978-1990)

The CCIR,

CONSIDERING

(a) that the methods for predicting HF sky-wave propagation characteristics (Report 894, Report 252 and Supplement to Report 252) may not always be sufficiently complete or accurate;

(b) that suitable methods for predicting HF propagation characteristics are required by:
- administrations, in connection with the establishment and operation of radio systems,
- the IFRB, for further refinement of its Technical Standards,
- the ITU, in connection with future Administrative Conference,

UNANIMOUSLY DECIDES that the following question should be studied:

what improvements may be made to the method of predicting the sky-wave signal intensity and circuit performance at frequencies between about 1.6 and 30 MHz?

DECIDES FURTHER

1. that studies should be continued as a matter of urgency so as that a report may be prepared for WARC HFBC-1993 in accordance with Resolution 112;

2. that following the completion of that report studies should be continued and that, in addition, the available information should be prepared as a Handbook.

Note – See Recommendation 533 and Reports 894, 729, 571, 253, 252 and its Supplement.

QUESTION 31-2/6

SKY-WAVE FIELD STRENGTH AND CIRCUIT PERFORMANCE AT FREQUENCIES BELOW ABOUT 1.7 MHz

(1978-1982-1990)

The CCIR

UNANIMOUSLY DECIDES that the following question should be studied:

what improvements may be to the methods of predicting the sky-wave field strength and circuit performance at frequencies below about 1.7 MHz?

DECIDES FURTHER

that the available information should be prepared as a Handbook.

Note – See Recommendations 435, 683 and 684, and Reports 265, 431, 432, 575, 895.

QUESTION 32/6*

PROPAGATION VIA SIDE- AND BACK-SCATTER

(1990)

The CCIR,

CONSIDERING

(a) that radio waves propagated via the ionosphere have been observed to arrive from azimuths which differ considerably from the great circle direction;

(b) that a radio wave propagated via the ionosphere can be scattered back by the ground or by the ionosphere itself;

(c) that ionospherically propagated side-scatter and back-scatter echoes can be used in many operational situations,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the characteristics of side-scatter and back-scatter propagation;

2. how can the resultant signal intensity and other relevant parameters be predicted;

3. how can observations of side and back scatter propagation be applied in the determination of propagation conditions?

Note – See Reports 726 and 890.

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* This Question contains text from the former Study Programme 25C/6.

QUESTION 33/6

IONOSPHERIC PROPAGATION PREDICTIONS

(1990)

The CCIR,

CONSIDERING

that accurate, quantitative predictions of ionospheric propagation are important for planning optimum spectrum utilization,

UNANIMOUSLY DECIDES that the following question should be studied:

how may current techniques for determining propagation conditions from predicted ionospheric characteristics be improved?

QUESTION 34/6

LONG-TERM PREDICTIONS OF SOLAR AND IONOSPHERIC INDICES

(1990)

The CCIR,

CONSIDERING

that long-term predictions of solar and ionospheric indices are essential for the practical use of ionospheric predictions,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the most appropriate solar and ionospheric indices for use in the prediction of ionospheric propagation, how may they be predicted and what is the comparison between the recommended indices?

Note – See Recommendation 371, Resolutions 4 and 74, and Opinions 23 and 82.

QUESTION 35/6*

VARIATIONS OF IONOSPHERIC PROPAGATION CHARACTERISTICS AND FADING

(1990)

The CCIR,

CONSIDERING

(a) that the practical requirements of radiocommunication necessitate information, not only on the median value of the received signal strength, but also on:

- the amplitude distribution,
- the rapidity of variations,
- the differential fading with diversity system antennas of the space, frequency or polarization type;

(b) that the presence of various modes and paths, which provide the component signals at the receiving antenna, significantly affects the time characteristics (pulse response), as well as the space and frequency characteristics,

UNANIMOUSLY DECIDES that the following question should be studied:

how do the characteristics (such as the amplitude, phase, time spread, frequency shift and spread) of signals vary with frequency, time, location and polarization and with the characteristics of the antennas in use; how can the statistics of the variations be included in the estimation of the reliability of a radio system?

* This Question contains text from the former Study Programme 28A/6.

QUESTION 36/6*

IONOSPHERIC INFLUENCES ON SPACE COMMUNICATIONS AT FREQUENCIES BELOW ABOUT 1.6 MHz

(1990)

The CCIR

UNANIMOUSLY DECIDES that the following question should be studied:

what is the potential usefulness of waves at frequencies below about 1.6 MHz, guided along the magnetic field lines of the Earth, as a means of communication between the Earth and space, particularly at VLF; in particular,

- what are the interference potentialities of waves propagated in and through the ionosphere, in this frequency range;
- how can the field strength or transmission loss for various terminal points of the path be calculated;
- what are the impedance and directional patterns of antennas situated in the ionosphere?

Note – See Report 262.

* This Question contains text from the former Study Programme 28B/6.

QUESTION 37-1/6

IONOSPHERIC INFLUENCES ON SPACE SYSTEMS AT FREQUENCIES ABOVE ABOUT 1.6 MHz

(1990-1992)

The CCIR,

considering

a) that, in the case of some high-performance space systems involving satellites, ionospheric effects should be considered up to the highest frequencies in use,

b) that the World Administrative Radio Conference (Malaga-Torremolinos, 1992) (WARC-92) allocated frequencies to the mobile-satellite service that are likely to be used by satellites in non-geostationary satellite networks,

decides that the following Question should be studied

1. What methods exist for measuring and predicting:

- refraction affecting in particular the direction of arrival and also the phase and group delays,
- attenuation effects,
- Doppler effect,
- Faraday effect, particularly with regard to polarization discrimination,
- scintillation effects on phase, angle of arrival, amplitude and polarization,
- the degree of isolation afforded by the ionosphere,
- the influence of the ionosphere, and in particular, natural and man-made ionospheric irregularities, in the determination of the relevant coordination area?

2. What is the influence of the ionosphere in the determination of performance characteristics of the mobile-satellite service employing non-geostationary satellite networks?

3. What is the possibility of guided propagation modes between spacecraft?

Note 1 - See Recommendation 531.

QUESTION 39/6*

IONOSPHERIC EFFECTS CAUSED BY HIGH-POWER TRANSMISSIONS

(1990)

The CCIR,

CONSIDERING

(a) that modification of the D, E and particularly the F regions of the ionosphere has been accomplished using medium and high power LF, MF and HF transmissions;

(b) that it may become technically feasible to transmit electric power to the Earth from a spacecraft by means of radio transmissions and that the high power associated with such radiation may adversely affect the propagation of radio waves for other services through the ionosphere;

(c) that the increasing use of high-power radio transmissions may increase interference problems due to ionospheric cross-modulation occuring in the D and E regions,

UNANIMOUSLY DECIDES that the following question should be studied:

under what circumstances may the ionosphere be modified by high power transmissions, what deleterious effects may be expected by such modification, and how can these effects be minimized?

Note – See Reports 574, 728 and 893.

QUESTION 40/6

ANTENNA CHARACTERISTICS

(1990)

The CCIR,

CONSIDERING

that the characteristics of antennas affect the practical performance of radio systems and should be included in predictions,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the theoretical performance characteristics of antennas used for systems involving ionospheric propagation, and to what extent are these consistent with practical data?

Note – See Report 891.

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* This Question contains text from the former Study Programme 28F/6.

QUESTION 41/6*

VHF AND UHF PROPAGATION BY WAY OF SPORADIC E AND OTHER IONIZATION

(1990)

The CCIR,

CONSIDERING

(a) that the available information on terrestrial propagation by sporadic E and other ionization is insufficient to provide statistical data of the type needed by telecommunication engineers, especially at low and high latitudes;

(b) that ionospheric irregularities including meteor ionization in the E region and the F region can affect the performance of radio systems operating in the VHF and UHF portions of the spectrum;

(c) that suitable methods for estimating VHF sky-wave field strength and signal dispersion are required by:

- administrations, in connection with the establishment and operation of radio systems,
- the IFRB, for further refinement of its Technical Standards,
- the ITU, in connection with future Administrative Conferences,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the mechanisms for VHF and UHF propagation by the ionosphere and how can the statistics of the propagation characteristics be predicted?

Note – See Recommendation 534 and Reports 251, 259.

QUESTION 42/6

MEASUREMENTS AND DATA BANKS

(1990)

The CCIR,

CONSIDERING

that measurements of signal intensity and other parameters are essential for the further improvement of methods of prediction,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what techniques for the measurement of signals and the compilation of data banks are suitable for use in connection with the study of improvements in prediction methods, taking account of the need for positive identification of signals and of the need to calibrate the measuring systems and antennas;

2. what world-wide ionospheric observation programme is necessary for numerical mapping and modelling purposes?

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* This Question contains text from Study Programme 30B/6.

QUESTION 43/6*

FADING CHARACTERISTICS OF SOUND BROADCASTING IN THE TROPICAL ZONE

(1990)

The CCIR,

CONSIDERING

(a) that sound broadcasting in the Tropical Zone has special characteristics which differ from those of HF sound broadcasting for long distances;

(b) that the fading of sound-broadcast emissions under tropical conditions has special characteristics due to equatorial type sporadic E and F region irregularities (e.g. spead F);

(c) that "surge" and "flutter" types of fading** are observed in the Tropical Zone;

(d) that the nature and origin of "surge" fading have not yet been established;

(e) that sufficient data are not available on the quantitative estimates of short-term and long-term fading in the Tropical Zone,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the types and characteristics of fading encountered in the Tropical Zone;

2. what allowances should be provided for planning sound-broadcasting services in the Tropical Zone;

3. what is the nature and occurrence of "surge" and "flutter" fading affecting reception;

4. what are the various statistical parameters for short-term and long-term fading of signals;

5. what are the values of the fading allowances based on § 3 and § 4 above?

Note – See Report 304.

DECIDES FURTHER

that the results of the above studies should be communicated to Study Group 10 for inclusion in the handbook referred to in Question 65/10.

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* Previously Study Programme 45B/10.

** As compared with "flutter fading", "surge fading" is a slower but deeper form of fading accompanied by severe distortion. This peculiar type of fading gives the impression of the signal being received in powerful "surges".

QUESTIONS CONCERNING STUDY GROUP 7

SCIENCE SERVICES

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QUESTION 101/7*

PERFORMANCE CHARACTERIZATION AND RELIABILITY OF FREQUENCY AND TIME STANDARDS

(1990)

The CCIR,

CONSIDERING

(a) that the accuracy with which standard frequencies and time signals may be transmitted depends essentially upon the performance of the frequency and time standards;

(b) that there is a need for increased accuracy of standard frequency and time signals in order to improve world-wide coordination of these emissions;

(c) that for many applications, the performance of frequencies and time standards is of primary importance;

(d) that there is a need for improved characterization of frequency time standards;

(e) that for many applications the reliability of time and frequency standards is of great importance,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the limitations in the performance of frequency and time standards;

2. what are the applicable parameters for characterizing the performance of frequency and time standards;

3. what can be done to improve the performance of frequency and time standards?

4. what is the characterization of frequency and time standards;

5. what are the techniques for measurement and evaluation of the performance of frequency and time standards;

6. what is the technology which might result in improved performance of frequency and time standards.

7. what criteria should be used for the meaningful expression of the reliability of clocks and frequency standards;

8. how reliable in operation are the existing time and frequency standards;

9. what steps can be taken to increase the reliability of time and frequency standards?

Note – See Report 898.

* This Question merges Questions 8/7, 10/7 and Study Programme 10A/7.

QUESTION 102/7*

DISSEMINATION OF STANDARD FREQUENCIES BY CARRIER-FREQUENCY STABILIZATION OF BROADCASTING EMISSIONS AND DISSEMINATION OF TIME SIGNALS BY ADDITION OF PHASE MODULATION ON AMPLITUDE-MODULATED SOUND BROADCASTING TRANSMITTERS

(1990)

The CCIR,

CONSIDERING

(a) the need for investigation of additional techniques for the dissemination of standard frequencies and time signals;

(b) that broadcasting of standard-frequency signals is carried out in some countries by stations in the broadcasting bands;

(c) that certain advantages may be obtained by the technique of stabilizing the carrier frequencies of broadcasting stations, namely:

- the possibility of providing good ground-wave coverage, free of Doppler-effect errors, at centres of population and industry;
- the rapid comparison of frequencies at receiving locations by the use of such sufficiently high carrier frequencies; and
- the use of relatively simple receiving equipment,

(d) the need for wide dissemination of time signals, without increasing the number of transmitters operating on frequencies allocated to the standard-frequency and time-signal services;

(e) the desirability of investigating additional techniques for disseminating time signals;

(f) Recommendation I.3 adopted by the International Union of Radio Science (URSI) at its XVIIth General Assembly, Warsaw, 1972;

(g) the wide geographical coverage of amplitude-modulated sound-broadcasting transmitters in bands 5 and 6,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the accuracy and stability of received signals from such broadcasts;

2. what is the influence of the location of transmitting stations on convenience of use and on propagation characteristics of signals;

3. what is the desirability of establishing a service of this nature;

4. what are the relative merits of amplitude and frequency modulation as related to the dissemination of time signals and of the use of the broadcasting bands for the dissemination of standard frequencies by carrier-frequency stabilization;

5. what is the possibility of superimposing time signals by phase modulation of the carrier of a conventional amplitude-modulated sound-broadcasting transmitter without disturbance to listeners of the broadcast programme;

6. what is the possibility of implementation of such techniques on amplitude-modulated sound-broadcasting transmitters in bands 5 and 6?

Note – See Reports 576 and 577.

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* Previously Study Programmes 4A/7 and 4B/7.

QUESTION 103/7*

REQUIREMENTS FOR HIGH PRECISION TIME TRANSFER TIME KEEPING AND SYNCHRONIZATION AT LEVELS LESS THAN 1 ns

(1990)

The CCIR,

CONSIDERING

(a) that there is a growing need for world-wide time transfers to be effected to accuracies that exceed those currently available;

(b) that such refinements may be achieved economically by utilizing the inherent timing capabilities of systems with other primary objectives;

(c) that higher precision in the radio distribution of time signals necessitates, with present techniques, the use of an increased bandwidth;

(d) that newly developed techniques may, nevertheless, effect a considerable economy for a given precision;

(e) the effects of noise of all types on system performance;

(f) that time transfer is continuously available in many areas with a day-to-day standard deviation of 100 ns by means of LORAN-C;

(g) that time comparisons effected by two-way satellite links have been reported with uncertainties of 10 to 50 ns;

(h) that with refinements of satellite techniques and with laser techniques a further reduction in the uncertainty by a factor of ten appears to be possible;

(j) that such refinements are costly and their development should be guided by requirements;

k) that reference standard frequency and time signals are generated at remotely located sites and cannot at present be maintained in synchronism at nanosecond levels,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what techniques can be developed, independently or in conjunction with existing world-wide or intercontinental systems, to meet the requirements that can be foreseen for achieving higher accuracy in time transfers;

2. what are the present and projected requirements for high precision time for various applications such as: navigation systems, high-speed data networks, very long baseline radio interferometry (VLBI);

3. what is the relationship between bandwidth required and precision obtainable at present for various signal-to-noise ratios encountered in practice;

4. what are the narrow-band techniques which can be used to generate and broadcast high-precision time markers;

5. what are the characteristics of the radio paths involved that limit the accuracy of time signals as received, and how do these radio-path parameters affect the choice of an optimum method;

6. what is the ability to make intercomparisons among frequency standards at levels of less than 1 ns;

7. what are the timing limitations based on instrumentation instabilities, propagation instabilities and other corrections including relativistic effects due to the influence of the nearer celestial bodies?

Note – See Report 270.

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* This Question merges Question 5/7 and Study Programmes 3A/7, 5A/7 and 5B/7.

QUESTION 104/7*

STABILITY OF STANDARD-FREQUENCY AND TIME-SIGNAL EMISSIONS AS RECEIVED

(1990)

The CCIR,

CONSIDERING

(a) that the standard-frequency and time-signal emissions as received are less stable than at the source, owing to phenomena occurring in the propagation of radio waves in any medium, e.g. the Doppler effect, diurnal variation and multipath interference;

(b) that errors, which occur during propagation, depend on the geographical location of both the transmitter and receiver, as well as on the nature and condition of the medium, and generally differ in different regions of the radio spectrum;

(c) that special techniques of standard-frequency and time-signal emissions may improve the accuracy with which they can be received;

(d) that the accuracy with which standard-frequency and time-signal emissions can be received may depend upon the design of the receiving equipment,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the causes of the degradation in the stability and accuracy of the standard frequencies and time signals as received by the users;

2. what is the magnitude in statistical terms of the instability introduced by these causes;

3. what are the most suitable techniques for transmitting and receiving standard frequencies and time signals to obtain the best results in the reception of:

- standard frequencies and time signals as used by those requiring moderate accuracy;
- standard frequencies and time signals as used by those requiring the maximum possible accuracy?

Note – See Recommendation 486 and Report 271.

* Previously Question 3/7.

QUESTION 105/7*

METHODS FOR RELIABLE VERY LOW FREQUENCY PHASE COMPARISONS

(1990)

The CCIR,

CONSIDERING

(a) that it is often necessary to produce a mean value based on the time scales of distant clocks or groups of clocks and that, for this purpose, extensive use is made of very low frequency (VLF) phase comparisons;

(b) that, in comparisons of VLF phase, the risk exists at present that the phase continuity as received may be lost from time to time, and that each loss of the phase continuity may cause error which cannot be considered negligible;

(c) that the use of calibrated measuring devices is an essential prerequisite for a thorough study of the problems of VLF propagation;

(d) that it is advisable to measure VLF phase values at the most favourable time of the day from the standpoint of the reliability of the received signal phase,

UNANIMOUSLY DECIDES that the following question should be studied:

1. how to promote the development and application of apparatus which allows for calibration for VLF phase comparisons;

2. what is the propagation behaviour at VLF in order to determine the most favourable reception conditions for daily phase comparisons.

* The XVIIth Plenary Assembly recommended that this Question, based on Study Programme 3D/7, should be deleted by the Study Group.

QUESTION 106/7*

IMPROVEMENTS IN THE EFFECTIVENESS OF THE STANDARD-FREQUENCY AND TIME-SIGNAL SERVICE

(1990)

The CCIR,

CONSIDERING

(a) that the World Administrative Radio Conference, Geneva, 1979, called for coordination of the establishment and operation of a standard-frequency and time-signal service on a world-wide basis;

(b) that a number of stations are now regularly emitting standard frequencies and time signals in the bands allocated by this Conference;

(c) that some areas of the world are not yet adequately served;

(d) that the use of more stations than are technically necessary would diminish the utility of the service by producing harmful interference;

(e) the need for increased accuracy of standard frequency and time signals;

(f) that the present standard-frequency and time-signal emissions, as received, are degraded in accuracy due to effects in the propagation of the radio waves, such as diurnal variations and the Doppler effect;

(g) that standard-frequency stations are operated simultaneously on the same carrier frequency,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what measures can be recommended for increasing the effectiveness of the existing standard-frequency and time-signal service in the bands allocated by this Conference;

2. what measures can be recommended for the reduction of mutual interference between standard-frequency and time-signal stations operating on the same frequency and whose service areas overlap;

3. what additional techniques can be employed for improving the accuracy of disseminated standard frequencies and time signals;

4. what are the possibilities of reducing mutual interference between emissions in the standard-frequency and time-signal service by:

4.1 shortening the programme of continuous tone modulation and of announcements;

4.2 use of a modulation which gives the required information and accuracy with minimum bandwidth;

4.3 staggering the emitted frequencies in the allocated bands and using a convenient type of modulation;

4.4 a convenient coordinated time-sharing of frequencies for those areas where there is mutual interference;

4.5 avoiding unmodulated carrier emissions, not strictly necessary for the operation of the service;

5. how may standard-frequency emissions in bands 6 and 7 be coordinated with emissions in other bands to give the best overall world-wide service?

Note – See Recommendations 374, 376, 457, 458, 460, 485, 535, 536 and 537; Reports 267, 731, 732, 736 and 896; Resolution 14 and Opinions 26, 28, 71.

* This Question merges Questions 1/7 and 4/7 and Study Programme 1A/7.

QUESTION 107/7*

STANDARD-FREQUENCY AND TIME-SIGNAL EMISSIONS IN ADDITIONAL FREQUENCY BANDS

(1990)

The CCIR,

CONSIDERING

(a) that in certain regions, particularly in industrial centres, it is not always possible to obtain an adequate ratio of the wanted signal to the noise level with the existing standard-frequency and time-signal service;

(b) that the bands allocated for standard-frequency and time-signal emissions are more useful for long-distance distribution than for local distribution;

(c) that a better service is needed in certain areas and this service may be given by use of frequencies in band 8 and higher;

(d) that high-accuracy frequency and time comparisons between distribution centres can be made using frequencies in bands 4 and 5;

(e) that the usefulness of the standard-frequency and time-signal emissions in the VLF and LF bands depends upon the operational characteristics of the transmitters and upon the modulation methods and formats used,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what methods can be recommended for the distribution of standard frequencies and time signals above 30 MHz;

2. what are the technical and operational methods for transmitters and antennas, the modulation methods and signal formats to be recommended for the dissemination of standard frequencies and time signals using frequencies below about 100 kHz?

Note – See Recommendations 375, 582, Reports 518, 735, and Opinions 27, 72.

* This Question merges Question 2/7 and Study Programme 2B/7.

QUESTION 108/7*

TIME SCALE ALGORITHMS AND STATISTICAL PROBLEMS

(1990)

The CCIR,

CONSIDERING

(a) that atomic time scales are often obtained by establishing the individual time-scale averages of a large number of clocks or groups of clocks remotely located from each other;

(b) that for many applications it is important that a time scale should be as uniform as possible;

(c) that in addition, the sub-division of the time scales should be made in agreement with the accepted value of the second,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what averaging procedures should be recommended, including the determination of the statistical weight assigned to clocks or groups of clocks used in establishing the time scale;

It should be recognized that the intrinsic accuracy and stability of such clocks may differ, that commercial-type clocks, as well as laboratory models, must be considered and that the clock readings are ascertained with varying degrees of accuracy by those dealing with averaging problems;

2. what procedures should be recommended in cases where the number and/or accuracy and stability of the clocks, used to establish a time scale, changes?

Note – See Report 579.

* Previously Study Programme 10B/7.

QUESTION 109/7*

COMPARISON OF DIFFERENT METHODS FOR THE TRANSFER AND DISSEMINATION OF TIME SIGNALS AND STANDARD FREQUENCIES

(1990)

The CCIR,

CONSIDERING

(a) that according to Recommendation 460 standard frequencies and time signals are to be coordinated;

(b) that comparisons of standard frequency and time signals distributed by various methods yield important information on the capabilities of these methods,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the observed differences and fluctuations of standard frequencies and time signals distributed by various methods in order to determine the capabilities of the various methods?

Note – See Reports 363, 439 and 897.

* Previously Study Programme 3C/7.

QUESTION 110/7*

TIME CODES

(1990)

The CCIR,

CONSIDERING

(a) the need to provide a complete and unambiguous time reference for a variety of scientific and industrial applications;

(b) that a number of standard frequency and time-signal stations now transmit time codes giving, at least, minute, hour and day of year information;

(c) that it is very desirable that such codes be compatible with each other and with commonly available commercial equipment;

(d) that coded DUT1 information is necessary in some time signal emissions in order to ensure immediate availability of UT1;

(e) that details are not readily available on the various timing codes which have been developed for system applications, and that unnecessary proliferation is undesirable,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what types and formats can be recommended for the transmission of time code information;

2. what modulation characteristics will best ensure reliable decoding under conditions of noise and interfering signals;

3. what are the most convenient methods for the dissemination of DUT1;

4. how should the compilation and publication of an index of timing codes, with information about sources of full details, and an assessment to facilitate the selection of codes best suited to particular system applications, be carried out?

Note – See Recommendation 583 and Report 578.

* This Question merges Question 7/7 and Study Programme 7A/7.

QUESTION 111/7*

SIGNAL DELAYS IN ANTENNAS AND OTHER CIRCUITS FOR HIGH-PRECISION TIME TRANSFER

(1990)

The CCIR,

CONSIDERING

(a) that there is a need for accuracy in precision time transfer exceeding that currently available;

(b) that the antenna and other electrical circuits are critical elements in the radio signal path at the transmitting, relaying and receiving sites for the accuracies desired;

(c) that there is a need to account for antenna delay in radio paths for precision time signal transfer;

(d) that it is desirable to have standard antenna designs of known delay characteristics;

(e) that it is desirable to have international agreement on the measurement technology,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what methods can be recommended to determine and characterize the delay introduced by the antennas and associated circuits for transferring precision time over a radio signal path;

2. what are the antenna parameters to quantify the characteristics influencing delay in the passage of time signals, such as wavelength, aperture, bandwidth, impedance, polarization, directivity, dielectric effects, array factors, travelling wave effects, lens effects, anisotropic and inhomogeneous media effects;

3. what influence have supporting electrical circuits on signal delay;

4. what is the delay in standard type dipoles, horns or long wires suitable for covering the radio spectrum;

5. what are the environmental effects which could affect delay such as temperature, pressure, humidity, magnetic field, acceleration, relative motion and relativistic effects;

6. what is the measurement technology required to address accuracies in the microsecond, nanosecond and picosecond ranges?

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* This Question merges Question 9/7 and Study Programme 9A/7.

QUESTION 112/7*

WORLD-WIDE DISSEMINATION OF TIME SIGNALS TO AN ACCURACY OF 1 μs OR BETTER FOR INDUSTRIAL PURPOSES AT LEAST COST

(1990)

The CCIR,

CONSIDERING

(a) that there is a growing world-wide need for inexpensive time transfers to accuracies of up to 1 μs or better, which are fully automatic (in particular, capable of resuming synchronization after power losses without human intervention) and which possess adequate characteristics with respect to reliability, availability and cost;

(b) that such refinements may be achieved economically by utilizing the inherent timing capabilities of systems with other primary objectives;

(c) that electronic techniques now available at low cost enable spread spectrum transmission methods to be implemented in existing transmitters to improve their performance,

UNANIMOUSLY DECIDES that the following question should be studied:

what techniques can be developed, independently or in conjunction with existing national or world-wide systems, to meet the requirements which can be foreseen for achieving an accuracy of the order of 1 μs or better at the least cost?

* Previously Study Programme 5C/7.

QUESTION 113/7*

FREQUENCY SHARING BETWEEN SPACE RESEARCH LINKS AND OTHER SERVICES

(1990)

The CCIR,

CONSIDERING

(a) that sharing of the radio spectrum between space research links and some other radio services may be necessary, because of the limited frequency spectrum available to support the world's communication requirements;

(b) that factors which determine the ability to share the frequency spectrum are strongly interdependent,

UNANIMOUSLY DECIDES that the following question should be studied:

1. to what extent is sharing feasible between Space Research and other Services;

2. how do the following factors, among others, affect the practicability of sharing:

2.1 location of earth and space stations of a space link and the resulting zone of mutual visibility;

2.2 time of use during periods of mutual visibility;

2.3 probability of occupancy of the zones of mutual visibility by space research links and those of other services, and the associated sharing problems;

2.4 Doppler frequency variations due to spacecraft velocities relative to earth stations and the consequent bandwidth requirements;

2.5 other system parameters such as modulation techniques, antenna directivity, etc.;

2.6 natural and man-made interference;

3. what are the technical factors relating to coordination procedures;

4. what are the protection criteria for space research telecommunication links with regard to:

4.1 the practical interpretation of the definition of harmful interference to the Space Research Service with reference to Article 1, No. 163 of the Radio Regulations;

4.2 the minimum levels of wanted input signals for which receiving systems for space research are expected to be designed;

4.3 the levels of signals which can cause harmful interference to space research receiving systems, taking into account modulation of wanted signals and spectral characteristics of the interfering signal;

4.4 the interference protection criteria applicable to near-Earth and deep-space research systems, taking into account both the signal levels to be protected and the temporal probabilities of interference?

Note – See Recommendations 578, 609 and Reports 548, 581, 628, 684, 685, 687 and 985.

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* This Question merges Question 1/2 and Study Programme 1C/2.

QUESTION 114/7*

FEASIBILITY OF FREQUENCY SHARING BETWEEN DEEP-SPACE RESEARCH STATIONS AND STATIONS OF OTHER SERVICES

(1990)

The CCIR,

CONSIDERING

(a) that deep-space research earth stations, in tracking and communications with deep-space spacecraft, must gradually move their antenna pointing from the eastern horizon to the western horizon each day to compensate for the Earth's rotation;

(b) that over a period of six months to a year of operation, each deep-space earth station antenna may point from 30° South declination to 30° North declination approximately;

(c) that during certain times of the year, the earth station antenna beam may point towards a given point on the geostationary satellite orbit for several minutes each day;

(d) that future deep-space missions out of the plane of the ecliptic will increase declination angles to near ± 90° at which time the earth station antenna will for long periods of time hold a nearly fixed direction relative to the Earth;

(e) that a deep-space research earth station with a 64 m diameter antenna may transmit a beam with an e.i.r.p. of 127 dBW;

(f) that the typical received signal from a deep-space spacecraft may have a power flux density as low as -250 dB(W/m^2) at the earth station antenna;

(g) that the gain of a typical earth station antenna is greater than 0 dBi over an angular region much larger than that covered by the main beam (see Recommendation 509);

(h) that the transmitter of a near-Earth space station operating on or near the receiving frequency of the deep-space research earth station, may illuminate the deep-space research earth station antenna with a power flux density that is 30 dB to 100 dB greater than that received from the deep-space spacecraft,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the conditions for which sharing may be feasible between deep-space research stations and stations of other Services;

2. what are the probabilities of the power spectral flux densities with which deep-space research earth station antenna beams may illuminate the locations of geostationary, geosynchronous and non-synchronous near-Earth satellites;

3. what is the probability of interference between stations of terrestrial Services and deep-space research stations in shared bands;

4. what are the expected power flux densities from near Earth satellites, or aircraft stations, which will illuminate stations of deep-space research systems;

5. what are the mutual interference probabilities as a result of the power flux densities and illumination probabilities given under § 2, 3 and 4 above;

6. what are the preferred baseband and modulation characteristics which will reduce sharing problems?

Note – See Report 685.

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* Previously Study Programme 1E/2.

QUESTION 115/7*

EFFECTS OF PLASMA ON COMMUNICATIONS WITH SPACECRAFT

(1990)

The CCIR,

CONSIDERING

(a) that ionospheric plasma has been observed to have a considerable effect upon the operation of transmitting and receiving antennas mounted on rockets and spacecraft;

(b) that the plasma produced by the shock wave resulting from the entry of a spacecraft into a planetary atmosphere may have analogous effects on the performance of the satellite equipment and on the propagation of radio waves near the spacecraft;

(c) that similar effects may be caused by the plasmas associated with propulsion systems;

(d) that communication with a spacecraft during the re-entry phase may be crucial during many missions;

(e) that the optimum frequency is dependent upon the configuration of the spacecraft and its re-entry speed;

(f) that Recommendation 367 emphasizes the potentialities of frequencies above 10 GHz for re-entry communications;

(g) that because the transparency of the plasma sheath increases with frequency, it is desirable to consider frequencies up to 50 GHz and the atmospheric windows above the oxygen absorption band at about 60 GHz;

(h) that Report 222 mentions the theoretical possibility of communicating at frequencies well below the critical frequency of the plasma sheath,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the effects of plasmas on the operation of transmitters and receivers, and particularly of the antennas on board spacecraft;

2. what factors determine the formation and structure of the plasmas associated with a spacecraft;

3. what communication problems (wave propagation and noise) are represented (in particular during re-entry into the terrestrial atmosphere), as a result of the plasma;

4. what influence do these effects exert on the choice of usable frequencies, especially during the entry of a spacecraft into a planetary atmosphere;

5. what is the technical suitability of frequencies above 10 GHz for re-entry communications;

6. what is the feasibility of communicating at frequencies well below the critical frequency of the plasma sheath?

Note – See Recommendation 367 and Report 222.

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* The XVIIth Plenary Assembly recommended this Question based on Question 3/2 and Study Programme 3A/2 for possible deletion by the Study Group. The above Question is brought to the attention of URSI, by the Director, CCIR.

QUESTION 116/7*

PREFERRED FREQUENCY BANDS FOR SPACECRAFT TRANSMITTERS USED AS BEACONS

(1990)

The CCIR,

CONSIDERING

(a) that studies are desirable in the field of radio propagation from spacecraft, with the object of enhancing our knowledge of the transmission of radio waves by and through the ionized and non-ionized regions of the atmosphere;

(b) that satellite radio beacon systems operating on either one frequency or two or more fixed frequencies which may or may not be harmonically related, now provide a powerful technique for enhancing our knowledge of the nature of the ionospheric conditions which are relevant to space research;

(c) that radio methods of measurement using spacecraft beacons provide for the determination of the orbital elements of satellites,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what regions of the spectrum are suitable for radio beacons which are used for:

1.1 radio-wave propagation studies;

1.2 atmospheric measurements;

1.3 tracking measurements for scientific purposes;

2. which of the above investigations would require long-term observations;

3. what specific relationships should exist between the various frequencies used for these investigations;

4. what is the maximum interference that can be tolerated in each of these investigations;

5. what are the factors affecting the sharing of the required frequencies with other radio services, and with other users in the Space Research Service;

6. what degree of coordination in the location of earth stations will be required if frequency sharing is deemed to be practicable;

7. what are the criteria to be adopted for the protection from interference ("noise-like" or "CW-type") of observations of beacon transmissions from spacecraft?

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* The XVIIth Plenary Assembly recommended this Question, based on Question 10/2 and Study Programme 10A/2, for possible deletion by the Study Group.

QUESTION 117/7*

RADIO LINKS BETWEEN EARTH STATIONS AND SPACECRAFT BY MEANS OF DATA RELAY SATELLITES

(1990)

The CCIR,

CONSIDERING

(a) that some space research and earth exploration spacecraft (particularly those in low orbit) and some launch vehicles, will require continuous communication with the Earth;

(b) that such continuous communication using direct links between the Earth and spacecraft requires many earth stations;

(c) that the use of space stations in earth satellites for the purpose of control and data relay can considerably reduce the number of earth stations required;

(d) that the development of a space research data relay satellite system has been shown to be feasible;

(e) that the technical characteristics of links via space stations may be different from those of direct links between earth stations and spacecraft;

(f) that there may be particular advantages in the use of geostationary satellites as relay stations;

(g) that such satellites may be required to relay information to and from several satellites and launch vehicles simultaneously, particularly those in low orbit;

(h) that the use of data relay satellites may require the use of the same frequency bands in multiple directions;

(j) that this use of frequency bands may introduce new problems of interference within the various space services, and with other services in shared bands;

(k) that data relay satellites may be used for two-way communication with manned as well as unmanned spacecraft, particularly those in low orbit,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the operational and technical requirements for radio links between earth stations and spacecraft, particularly those in low orbit, by means of geostationary data relay satellites;

2. what are the desired technical characteristics of radio links between earth stations and spacecraft by means of geostationary data relay satellites;

3. what interference problems may arise within the various space services from the use of data relay satellites, particularly when these are used with several low-orbit satellites simultaneously;

4. what problems of frequency sharing with other services could arise in the operation of data relay satellite systems if the same frequency bands are used in multiple directions;

5. what constraints need to be placed on the operation of data relay satellites and the associated satellites or launch vehicles to enable frequencies to be shared with other services?

Note – See Recommendation 510 and Reports 692, 846, 847, 848, 982 and 983.

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* Previously Question 11/2.

QUESTION 118/7*

DATA RELAY SATELLITE SYSTEMS AND FACTORS WHICH AFFECT FREQUENCY SHARING WITH OTHER SERVICES

(1990)

The CCIR,

CONSIDERING

(a) that continuous communications to and from spacecraft used for space research and earth exploration and to and from launch vehicles are desirable;

(b) that with available land-based tracking stations, various factors combine to limit coverage to only a fraction of a given orbit;

(c) that frequently critical decision points in a space mission occur when the spacecraft is beyond the line-of-sight of the earth stations;

(d) that expansion of the ground network is geographically and economically not feasible;

(e) that Report 848 concludes that with a few strategically located earth stations, utilization of a data relay satellite (DRS) can provide continuous or near continuous communication between spacecraft and the Earth;

(f) that experiments and studies, such as those mentioned in Report 848, have demonstrated the feasibility of a DRS system;

(g) that frequency requirements between the mission spacecraft and the data relay satellite may be satisfied by the frequencies which would normally be used for direct communication between the mission spacecraft and the earth stations;

(h) that the data relay satellite could relay mission-gathered data, television and voice communications in manned missions, orbit-tracking data such as position and velocity of the spacecraft, and telecommands for guidance and control of the spacecraft;

(j) that use of frequencies in bands 9 and 10 permit both the near-Earth satellite and the DRS to use antennas with substantial gain and directivity;

(k) that frequency bands below about 20 GHz are heavily occupied with existing and planned services;

(l) that frequency bands between 20 and 30 GHz are becoming more heavily occupied by existing and planned services;

(m) that frequency band 11 is only just becoming useful for spacecraft telecommunications and is not yet heavily occupied;

(n) that atmospheric attenuation at the higher frequencies tends to shield space-to-space services from terrestrial services;

(o) that antennas of a given diameter will have a narrower beamwidth at higher frequencies, thus allowing more efficient use of the spectrum and the geostationary satellite orbit;

(p) that the technology for the use of frequencies above 20 GHz is being developed;

(q) that use of the DRS could reduce future frequency requirements for near-Earth space research;

(r) that use of a DRS could result in a reduction of the number of required near-Earth satellite earth stations;

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* Previously Study Programme 11A/2. The XVIIth Plenary Assembly decided that DECIDES 1, 2, 4 and 5 should be categorized as URGENT.

(s) that Report 847 concludes that sharing is feasible between a space research system involving a space station relay and terrestrial systems provided:

- that there are appropriate power flux-density limits for the relay satellite and the mission satellite;
- that careful selection of relay satellite and user spacecraft antenna will provide the required off-beam discrimination in the direction of terrestrial systems,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the parts of the radio frequency spectrum and the bandwidths preferred for data relay satellites;

2. what are the technical problems associated with the use of frequency bands above 20 GHz for data relay satellites;

3. what are the conditions under which and with what other services the sharing of the preferred frequencies for data relay satellites is practicable;

4. what are the preferred technical characteristics of telecommunications links for data relay satellites operating above 20 GHz;

5. what are the limits of power flux-density from the data relay satellites needed to protect other services sharing frequencies in bands 9, 10 and 11;

6. what are the necessary values for the data relay satellites and user spacecraft off-beam discrimination, especially in the direction of the stations of the shared terrestrial services in bands 9, 10 and 11?

Note – See Reports 847 and 848.

QUESTION 119/7*

FEASIBILITY OF FREQUENCY SHARING WITHIN AND AMONG SPACE RESEARCH SYSTEMS

(1990)

The CCIR,

CONSIDERING

(a) that some space research frequency bands are presently used for both deep-space systems and for near-Earth systems;

(b) that it may not in all cases be possible for such systems to operate in the same frequency bands without harmful mutual interference;

(c) that the types of orbit occupied by deep-space probes and by near-Earth spacecraft have a marked influence on the feasibility of operating in the same frequency bands;

(d) that the geostationary satellite orbit is of particular interest to space system designers;

(e) that space research frequency allocations do not necessarily specify the spacecraft orbits in which they are to be used;

(f) that the classification of and subsequent frequency assignment for near-Earth and deep-space systems depends upon the definition of these terms,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the general problems associated with sharing between space research systems, taking into consideration both technical and operational characteristics;

2. how do the types of orbit, and system characteristics, including those of sensors, affect sharing involving near-Earth manned and unmanned systems, and deep-space manned and unmanned systems;

3. under what conditions and to what extent is it possible for space research systems to share frequency bands with each other;

4. what are suitable calculation and prediction methods to be used by system designers in complying with the applicable criteria for interference (see Recommendation No. 708 of the Radio Regulations)?

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* Previously Question 14/2.

QUESTION 120/7*

STUDY OF THE EFFICIENT USE OF VARIOUS ORBITS FOR SPACE RESEARCH

(1990)

The CCIR,

CONSIDERING

(a) that numerous spacecraft will be required to operate simultaneously for space research purposes;

(b) that substantial simultaneous transmission from space-research spacecraft will place a heavy burden on portions of the spectrum allocated to this purpose;

(c) that space-research spacecraft in orbits of about the same mean altitude and inclination may be phased so that they are not visible from the same ground point at the same time;

(d) that by utilizing spacecraft' telemetering transmitters, the frequency of which may be changed by telecommand, several space-research spacecraft may communicate with geographically adjacent earth stations without mutual interference,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the effects of various types of orbits, communication and sensor characteristics upon frequency sharing between space-research systems;

2. what is the advantage of spacing of satellites in orbit in frequency sharing;

3. what are the advantages of switchable frequencies in telemetering transmissions from space-research spacecraft with respect to frequency utilization in the space-research service?

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* Previously Study Programme 14A/2.

QUESTION 121/7*

FREQUENCY SHARING BETWEEN DEEP-SPACE AND OTHER SPACE RESEARCH SYSTEMS

(1990)

The CCIR,

CONSIDERING

(a) that, with few exceptions, frequency allocations for space research are available for both near-Earth satellites and deep-space probes;

(b) that protection requirements for deep-space research may make frequency sharing between deep-space probes and near-Earth satellites difficult, and may involve serious problems of coordination;

(c) that the classification of and frequency assignment for near-Earth and deep-space systems depends upon the definition of these terms,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the practicability of frequency sharing between deep-space and near-Earth space research activities, taking into account:

- the statistical probability of interference between deep space bidirectional links, and the directions of transmissions of near-Earth space research systems;
- the fact that near-Earth satellites operate in various orbits either in the same or in different systems including geostationary satellites, and non-geostationary satellites, phased or unphased;

2. what are the criteria which affect the determination of the minimum elevation angles and other pointing constraints which may be required at earth stations to facilitate frequency sharing among space research systems;

3. what are the transmitter powers of space and earth stations, as they affect frequency sharing among space research systems;

4. what are the preferred technical characteristics of transmitting and receiving antennas for earth stations, from the standpoint of frequency sharing within the same system and with other space research systems;

5. what are the effects of baseband and modulation characteristics on frequency sharing among space research systems;

6. what are the definitions of distances that will be most useful in the classification of space research missions and systems, for purposes of frequency allocation and assignment, and for studies of sharing and protection criteria?

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* Previously Study Programme 14B/2.

QUESTION 122/7*

RESEARCH IN SPACE SYSTEMS TECHNOLOGY

(1990)

The CCIR,

CONSIDERING

(a) that advances in technology will affect the application of space systems in most, if not all, the functional service areas of telecommunications;

(b) that these advances will generally result from the space research programmes of administrations,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the current state of space systems technology in such areas as attitude control, station keeping, spacecraft and earth station antennas, primary and secondary power systems, generation of radio-frequency power, thermal control, modulation techniques, problems of the space environment, and technical aspects of radio-frequency radiation hazards;

2. what improvements in performance are foreseen in these areas?

Note – See Recommendation 509 and Reports 546, 672, 673, 674, 676, 677 and 843.

* Previously Question 15/2. The XVIIth Plenary Assembly recommended this Question for possible deletion by the Study Group.

QUESTION 123/7*

ANTENNAS FOR SPACE RESEARCH SYSTEMS

(1990)

The CCIR,

CONSIDERING

(a) that the limitations on the physical size and beamwidth of antennas for earth and space stations are important factors in determining the useful frequency range for space systems;

(b) that ionospheric and other atmospheric effects, and techniques of fabrication, may limit the sizes of antennas and their minimum beamwidths;

(c) that interference to and from terrestrial as well as other space services is an important problem,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what limitations to antenna beamwidth result from ionospheric and other atmospheric effects;

2. what is the state of relevant development in antenna design and fabrication;

3. what is the state of development of antennas with improved side-lobe and back-lobe characteristics;

4. what are the polarization characteristics of antennas, particularly in the side-lobe regions and in planes other than the principal planes;

5. what are the pointing accuracies and antenna beamwidth restrictions which result from system characteristics such as spacecraft attitude control and search and acquisition times;

6. what other factors limit spacecraft antennas usable gains, aperture and pointing accuracy?

Note – See Recommendation 509 and Reports 675, 676 and 677.

* Previously Study Programme 15A/2. This Question should be brought to the attention of Study Groups 5 and 6.

QUESTION 124/7*

SAFETY ASPECTS OF RADIO-FREQUENCY RADIATION FROM SPACE RESEARCH STATIONS

(1990)

The CCIR,

CONSIDERING

(a) that radio-frequency energy is known to have harmful effects on the human body when absorbed in sufficient quantity;

(b) that determinations of hazardous radiation levels have been made by competent authorities;

(c) that radio-frequency power flux-densities in excess of safe exposure levels may exist at a considerable distance ** from space research earth stations;

(d) that persons not associated with earth stations may be exposed inadvertently to such radiation, including travellers by air,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the the radio-frequency power flux-densities to be expected from space research earth stations;

2. what are the the design precautions and technical operational procedures at space research transmitting stations which are necessary to prevent the exposure of human beings to hazardous radio-frequency radiation?

Note – See Reports 543 and 682.

* Previously Study Programme 15B/2. See also Question 52/1 of Study Group 1.

** For example, the power flux-density in the antenna beam will be greater than 10 mW/cm^2 at a distance of 20 km from the 64 m diameter earth-station antenna at Goldstone, USA, when using a transmitter power of 500 kW.

QUESTION 125/7*

PROTECTION OF TELECOMMUNICATIONS EQUIPMENT FROM RADIO-FREQUENCY RADIATION FROM SPACE RESEARCH EARTH STATIONS

(1990)

The CCIR,

CONSIDERING

(a) that radio-frequency energy is known to have degrading effects on electronic equipment when such equipment is irradiated above certain specified energy levels;

(b) that determinations of degrading radiation levels will be made by competent authorities assuming specific design or operational control procedures;

(c) that radio-frequency power flux-densities in excess of allowable exposure levels may exist at a considerable distance from space-research earth transmitting stations;

(d) that electronic equipment not associated with space research earth stations may be exposed inadvertently to such radiation,

UNANIMOUSLY DECIDES that the following question should be studied:

what are the design precautions and technical operational procedures at space research transmitting stations necessary to prevent the exposure of electronic equipments to harmful levels of radio-frequency radiation?

* Previously Study Programme 15C/2. This Question should be brought to the attention of Study Groups 1, 4, 8, 9, 10 and 11.

QUESTION 126/7*

POSSIBLE HARMFUL EFFECTS OF THE SPACE ENVIRONMENT

(1990)

The CCIR,

CONSIDERING

(a) the possibility of harmful effects of the space environment on manned and unmanned spacecraft;

(b) the related texts of Study Group 6 (Reports 725, 886, 430, 887 and 727, and Recommendations 371 and 313) which, for the purpose of predicting characteristics of radio propagation in the ionosphere, address space environmental parameters and reporting methods,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what features of the space environment can have a harmful influence on equipment or personnel in space;

2. what are the technical and operational procedures and associated systems which can be adopted to minimize such harmful effects, including forecasting their occurrence?

Note – See Report 674.

* Previously Study Programme 15D/2. This Question should be brought to the attention of Study Groups 4, 6, 8, 10 and 11.

QUESTION 127/7*

RADIATION PATTERNS AND SIDE LOBE CHARACTERISTICS OF LARGE ANTENNAS USED FOR SPACE RESEARCH EARTH STATIONS AND RADIOASTRONOMY

(1990)

The CCIR,

CONSIDERING

(a) that Recommendations 509 and 611 identify a requirement to measure the radiation patterns or side lobe characteristics of antennas used in the space research and radioastronomy services;

(b) that in many cases the antennas used by the two services are similar in that they are of large diameter and operate at frequencies up to tens of GHz;

(c) that because of the large distances required to achieve far field conditions ($2D^2/\lambda$), standard antenna test range or anechoic chamber measurement techniques are inappropriate;

(d) that many terrestrial potential sources of interference to the two services will be in the near field of the antenna;

(e) that more accurate models and associated software are becoming available for the prediction of antenna radiation patterns in both the near field and the far field, and also for situations which involve interaction with additional reflectors or undesirable obstacles;

(f) that the predictions generated by such procedures can in some instances be validated by calibrated measurements,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what procedures and method of measurement, or method combining measurement with model predictions, can be utilized to determine radiation patterns of antennas used at space research earth stations;

2. what procedures and method of measurement, or method combining measurement with model predictions, can be utilized to determine the side lobe gain of antennas used for radioastronomy in:

2.1 far field conditions,

2.2 near field conditions?

* Previously Study Programme 15E/2.

QUESTION 128/7*

PROTECTION CRITERIA FOR SYSTEMS PROVIDING SPACE OPERATION FUNCTIONS

(1990)

The CCIR,

CONSIDERING

(a) that some of the frequency bands allocated to telemetering, tracking and telecommand for space research and for experimental and operational spacecraft (space operation) are shared with other services;

(b) that suitable criteria should be established as a basis for the protection of telemetering, tracking and telecommand receivers against interference from other transmissions of the space and terrestrial services;

(c) that such criteria should take into account the spectral characteristics of the interfering signals, for example, whether "CW-type" or "noise-like", and the time pattern of the interference in relation to the time pattern of the system operation;

(d) that the requirements for space operation may be less stringent than those for the transmission of research data,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the minimum levels of wanted signal input for which receiving systems for telemetering, tracking and telecommand (space operation) should be designed;

2. what are the permissible ratios of wanted signal level to interfering signal level for such receiving systems for appropriate modulation of wanted signals and for various time patterns and spectral characteristics of the interfering signals;

3. what are the protection criteria applicable to systems providing space operation functions;

4. what coordination procedure should be used to avoid mutual interference between the space operation service and other services when they share frequencies?

Note – See Recommendation 363 and Reports 845 and 981.

* Previously Question 18/2. This Question should be brought to the attention of Study Groups 1, 4, 8, 9, 10 and 11.

QUESTION 129/7*

SPURIOUS EMISSIONS RADIATED FROM AND RECEIVED BY STATIONS OF SPACE SERVICES

(1990)

The CCIR,

CONSIDERING

(a) that the radiation of spurious emissions by space stations or earth stations of all space services could cause interference to other services;

(b) that the radiation of spurious emissions by other services could cause interference to space stations and/or earth stations of the various space services;

(c) that suppression of spurious emissions to very low levels, in particular from space stations, may involve major technical problems;

(d) that the various radio services differ greatly in the sensitivity of their stations to interference;

(e) that the Radio Regulations do not define limits on spurious emissions for space systems transmitters operating on fundamental frequencies above 960 MHz,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what limits, based upon practical considerations, should be placed upon the power of spurious emissions radiated by space and earth stations of space services** in order to protect other services;

2. what levels of power flux-densities resulting from spurious emissions of stations of other services are acceptable at space and earth stations of the various space services?**

Note – See Reports 844 and 980.

* Previously Question 19/2. The XVIIth Plenary Assembly decided that this Question should be categorized as URGENT. This Question should be brought to the attention of Study Groups 1, 4, 8, 9, 10 and 11.

** This concerns mainly the space research and Earth exploration services.

QUESTION 130/7*

CHARACTERISTICS AND EFFECTS OF RADIO TECHNIQUES FOR THE TRANSMISSION OF ENERGY

(1990)

The CCIR,

CONSIDERING

(a) that it is feasible to transfer energy from satellites to Earth, between satellites, and between points on the surface of the Earth by means of radio techniques;

(b) that the transmission of energy by these techniques may be of great value in delivering energy to otherwise inaccessible locations, and also in the importation of energy from space;

(c) that the efficiency of the system depends on the frequency used;

(d) that development work has demonstrated the technical possibilities of delivering large amounts of energy over distances of several kilometres with reasonable efficiency;

(e) that the transmission of energy by radio techniques may produce biological hazards (see Question 124/7), and harmful interference to radiocommunication systems;

(f) that high intensity radio-frequency power radiated from solar-power satellites (SPS) may induce changes in the ionosphere or, in the lower atmosphere, which may adversely affect the propagation of radio waves for other telecommunication services,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the performance characteristics of systems for the transfer of energy by radio techniques;

2. what are the preferred frequency bands for the radio transmission of energy;

3. what are the factors which affect the practicability of frequency sharing between energy transmission systems and radiocommunication services;

4. in what ways can radiocommunication services be affected by spurious and other out-of-band emissions and what power flux-density limits if any, should be adopted;

5. what biological or other hazards would be posed by energy transmission systems utilizing radio techniques, both in the design mode and in conditions of malfunction?

Note – See Report 679.

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* Previously Question 20/2. This Question should be brought to the attention of Study Groups 5 and 6.

QUESTION 131/7*

CHARACTERISTICS AND TELECOMMUNICATIONS REQUIREMENTS OF SYSTEMS FOR SPACE RESEARCH

(1990)

The CCIR,

CONSIDERING

(a) that space research is carried out by using sounding rockets, Earth satellites, and deep space probes for both scientific and technological research;

(b) that the purpose of scientific space research is to investigate natural and man-made phenomena occurring on the Earth or in space;

(c) that the purpose of technological space research is the development and testing of new space techniques;

(d) that space research systems often lead to space applications;

(e) that space research utilizes sensors of many types;

(f) that for some sensing techniques involving certain natural phenomena, operation of the sensors at specific frequencies is required;

(g) that space research is conducted by means of both manned and unmanned spacecraft,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the requirements for radiocommunications between earth stations and space stations for space research;

2. what are the preferred characteristics of these radio links;

3. what are the requirements for space research sensors operating at radio frequencies;

4. what are the characteristics of these sensors?

Note – See Reports 536 and 548.

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* Previously Question 21/2.

QUESTION 132/7*

PREFERRED FREQUENCY BANDS FOR SPACE RESEARCH

(1990)

The CCIR,

CONSIDERING

(a) that space research systems are used extensively for scientific investigation and exploration of space and the Earth;

(b) that such research investigation and exploration involves the transmission of data over radiocommunication links from spacecraft to Earth;

(c) that operation of the spacecraft requires radio telecommand links from Earth to spacecraft;

(d) that the characteristics of these radio links are critical to the success of the space research missions;

(e) that the distances to deep-space vehicles typically involve attenuations of 200 dB to 300 dB, and, to near-Earth vehicles, attenuations of 100 dB to 200 dB;

(f) that the designs of the space research radio communication links may leave performance margins as low as +0.5 to +1.0 dB on a statistical basis;

(g) that the performance of a space research radio link is strongly related to the frequency dependent effects of weather, ionospheric effects, Rayleigh scattering, antenna efficiencies, and the efficiencies of radio-frequency power generation on power limited spacecraft;

(h) that space research involves both manned and unmanned missions;

(j) that both active and passive spaceborne sensors are required for the investigation of certain phenomena,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the characteristics of the space research radio links which affect the choice of frequencies;

2. what factors affect space research radio links in a frequency-dependent manner;

3. what are the relationships of these factors to the communication capability over space research radio links;

4. what are the preferred frequencies for use in space research radio links, for near-Earth and deep-space missions;

5. what are the required frequencies and bandwidths, or preferred frequency bands, which are most suitable for space research active and passive sensors?

Note – See Recommendations 364 and 576 and Reports 548, 683, 849 and 984.

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* Previously Question 22/2.

QUESTION 133/7*

PREFERRED FREQUENCY BANDS FOR DEEP-SPACE RESEARCH MANNED AND UNMANNED SPACECRAFT

(1990)

The CCIR,

CONSIDERING

(a) that deep-space craft must communicate allowing for basic transmission losses of from 200 dB to 300 dB;

(b) that certain operations during planetary missions must be carried out at critical times and within very limited time periods;

(c) that unplanned interruption of deep-space communications could be catastrophic to the mission, the equipment or the personnel of the spacecraft;

(d) that only specific frequency bands are substantially immune to natural interruption of space communications due to weather, ionospheric or solar effects or galactic noise;

(e) that deep-space tracking may require the simultaneous use of three frequencies to determine the effects of space electron or ion propagation delay;

(f) that deep-space manned missions may require communications on frequencies suited to direct spacecraft-to-Earth links as well as to local spacecraft-to-astronaut communications,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the link geometry between earth stations and deep-space manned and unmanned missions;

2. what is the statistical degradation of performance for these links as a function of frequency, taking into account the effects of the atmosphere, scattering from space plasma of free electrons or ions, fragmentary and particulate matter, etc.;

3. what are the preferred bands of frequencies for deep-space manned and unmanned space research missions?

Note – See Recommendation 576 and Reports 683 and 849.

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* Previously Study Programme 22A/2.

QUESTION 134/7*

PREFERRED FREQUENCY BANDS FOR NEAR-EARTH MANNED AND UNMANNED SPACECRAFT

(1990)

The CCIR,

CONSIDERING

(a) that near-Earth manned and unmanned satellites are used extensively for space research purposes;

(b) that use of such satellites for space research purposes places heavy demands upon the available radio frequency spectrum,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred methods of transmission for near-Earth manned and unmanned spacecraft;

2. what are the frequency bands preferred for transmission to and from near-Earth manned and unmanned spacecraft?

Note – See Recommendation 364 and Reports 548 and 984.

* Previously Study Programme 22B/2.

QUESTION 135/7*

CHARACTERISTICS OF INTER-SATELLITE LINKS

(1990)

The CCIR,

CONSIDERING

(a) that links between satellites have applications in several services, including the inter-satellite service, the space research service, the space operation service, the earth-exploration satellite service, the fixed-satellite service and the mobile satellite services;

(b) that frequencies for inter-satellite links may be shared among the above services and with other services;

(c) that Recommendation No. 707 of the Radio Regulations requests that the CCIR carry out specific studies in regard to sharing criteria with a view to later inclusion of such sharing criteria in Article 28 of the Radio Regulations,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the characteristics required for such inter-satellite links;

2. what sharing criteria are necessary and appropriate, including sharing with passive services?

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* Previously Question 24/2. The XVIIth Plenary Assembly decided that this Question should be categorized as URGENT. This Question should be brought to the attention of Study Groups 4, 8 and 9.

QUESTION 136/7*

SPACE TELECOMMUNICATION SYSTEMS OPERATING AT INFRA-RED AND VISIBLE LIGHT FREQUENCIES

(1990)

The CCIR,

CONSIDERING

(a) that systems for space telecommunication operating at infra-red and visible light frequencies, will make it possible to use a wider frequency band than conventional systems operating in the radio frequency spectrum, and that realization of these systems will contribute to alleviating the present congestion in the use of radio waves;

(b) that, if such systems are used for communications relating to space vehicles, it will be a matter of great importance whether international technical standards to keep the operation of these systems in good order will be necessary or not (see Reports 680 and 681),

UNANIMOUSLY DECIDES that the following question should be studied:

what are the technical characteristics of systems for space communication that operate at infra-red and visible light frequencies, and what are the technical problems, including atmospheric effects on propagation, in the realization of these systems?

Note – See Reports 680 and 681.

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* Previously Question 25/2. This Question should be brought to the attention of Study Group 1.

QUESTION 137/7*

EFFECTS ON STUDY GROUP 2 SERVICES OF THE USE OF INCLINED (NEAR-GEOSTATIONARY) SATELLITE ORBITS BY THE FIXED-SATELLITE SERVICE

(1990)

The CCIR,

CONSIDERING

(a) that Study Group 4 at its Interim Meeting in December 1987 and at the request of the IFRB added a new Annex V to Report 453-4 proposing to study a method of extending the operational life of space stations which are nominally geostationary;

(b) that the method proposed in CONSIDERING *(a)* involves relaxation of orbit control in the North-South direction and is also addressed in the Joint Interim Working Party Report of December 1987 (see § 13.13.11) and subsequently at the WARC ORB-88 meeting of 1988;

(c) that the Study Group 4 proposals refer to orbits with inclinations of up to 15° for satellites approaching their end of life, and operating within the fixed satellite service;

(d) that the useful lifetimes of such satellites may be extended by up to three years if left uncontrolled in the North-South direction;

(e) that the zone of radio noise around the geostationary satellite orbit (GSO) could be broadened considerably compared with that associated with truly geostationary satellites, especially if many satellites are allowed to drift up to 15° in inclination;

(f) that the IFRB has published in their rules of procedure a limit of 5° for the inclination angle;

(g) that emissions from geostationary satellites can pose a serious threat to radio astronomy observations of regions of the sky near the GSO;

(h) that when conditions allow radioastronomical observations to be made in all directions separated by more than 5° from the GSO as discussed in Reports 697 and 224, all regions of the sky can be explored from at least one existing observatory;

(j) that receiving systems used for space research (deep space) have sensitivities similar to those used for radio astronomy;

(k) that some fixed-satellite service bands may be used for feeder links and for data transmission links in support of space services (e.g. space research and earth exploration satellite),

UNANIMOUSLY DECIDES that the following question should be studied:

1. what will be the effect on the radio astronomy service and on Study Group 7 space services (especially for deep-space application) of the use of geo-synchronous, non-geostationary satellites, with inclinations up to 15°, by the fixed-satellite service with regard to:

- interference from locations near the GSO, together with any consequent pointing restrictions on ground-based receiving systems; and
- consequent restrictions on spectrum usage within frequency bands assigned to the radio astronomy and space services;

2. what will be the effect on geostationary satellites and on satellites in low orbits operating within the space research, space operation or earth exploration satellite services;

3. to what extent do Study Group 7 space services using the fixed-satellite service for feeder links need to take account of the possible use of inclinations up to 15°?

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* Previously Question AA/2 (Conclusions of the Interim Meeting of Study Group 2, 1988). This Question should be brought to the attention of Study Groups 4 and 8.

QUESTION 138/7*

RADIOCOMMUNICATION SYSTEMS FOR EARTH EXPLORATION SATELLITES, INCLUDING METEOROLOGICAL SATELLITES

(1990)

The CCIR,

CONSIDERING

(a) that the value of meteorological satellites has been demonstrated and that some types are now operating in a routine manner;

(b) that the use of satellites to survey the Earth is of great value in the discovery, assessment, development and management of the mineral, petroleum, water, timber, agricultural and fish resources of the Earth; in locating and tracking sea ice; in monitoring phenomena of nature such as earthquakes and volcanic eruptions; in monitoring air and water pollution; in geodetical studies; and in monitoring natural disasters (forest fires, tidal waves, floods), etc.,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred characteristics of radiocommunication systems for obtaining information by earth exploration satellites and returning that information to Earth;

2. what are the methods for establishing performance criteria for earth exploration satellite systems;

3. what are the methods for establishing protection criteria for earth exploration satellite systems;

4. what are the methods for establishing sharing criteria and coordination thresholds for earth exploration satellite systems?

Note – See Reports 535, 1120, 1122 and 1123.

* Previously Question 12/2.

QUESTION 139/7*

RADIOCOMMUNICATION SYSTEMS FOR EARTH EXPLORATION SATELLITES (NOT INCLUDING METEOROLOGICAL SATELLITES)

(1990)

The CCIR,

CONSIDERING

(a) that experimental earth exploration satellite systems have demonstrated their value for obtaining data for aiding food production and the improvement, use and conservation of natural resources;

(b) that these satellites may be placed in different types of orbits;

(c) that the frequency requirements of radiocommunication systems for earth exploration satellites should be subject to international agreement;

(d) that active and passive sensors may require wide bandwidths;

(e) that radiocommunication systems employed by these satellites may require wide bandwidths substantially greater than those currently used for television transmissions,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred technical characteristics and regions of the spectrum for earth exploration satellite radiocommunication systems;

2. what are the preferred types of radiocommunications for different orbits that earth exploration satellites may employ;

3. what are the criteria for sharing frequencies;

4. what are the technical parameters to be used in the application of Appendices 28 and 29 to the Radio Regulations for the coordination of frequency assignments;

5. what are the techniques for efficient spectrum utilization?

Note – See Recommendations 514 and Reports 540, 692 and 982.

* Previously Study Programme 12A/2.

QUESTION 140/7*

SENSORS USED BY EARTH EXPLORATION SATELLITES INCLUDING METEOROLOGICAL SATELLITES

(1990)

The CCIR,

CONSIDERING

(a) that many of the sensors used on earth exploration and meteorological satellites depend on the detection, and in some cases the radiation, of radio signals;

(b) that the frequencies at which these sensors operate are determined largely by the physical characteristics of the materials or environment that are under investigation;

(c) that harmful interference to passive sensors may be caused by unwanted radiations of very low power;

(d) that some active sensing systems transmit signals that may interfere with other services;

(e) that active and passive sensors may require considerable spectrum space;

(f) that the frequency requirements of sensor systems for earth exploration satellites should be subject to international agreement,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the technical characteristics and suitability of frequency bands for active and passive sensors used by earth exploration satellites;

2. what are the requirements for spectrum space that may be needed for active and passive sensors used by earth exploration satellites;

3. what are the levels of interference that can be tolerated by the various types of sensors in the different frequency bands of interest;

4. what are the power levels and signal characteristics of the active sensors that are under development or that have been proposed, and the level and nature of the interference caused by such signals to other services;

5. what are the criteria for sharing active and passive sensor frequency bands with those used by other radio services?

Note – See Recommendations 515, 516 and 577 and Reports 693, 694, 695, 850 and 987.

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* Previously Study Programme 12B/2.

QUESTION 141/7*

COMMAND AND DATA COMMUNICATION SYSTEMS FOR METEOROLOGICAL SATELLITES

(1990)

The CCIR,

CONSIDERING

(a) that meteorological-satellite systems are an important means of world-wide weather forecasting (World Weather Watch);

(b) that meteorological information is now gathered by meteorological satellites and relayed to earth stations;

(c) that these satellites may employ different type orbits – polar, equatorial or at intermediate angles and altitudes up to and including the synchronous altitude (36 000 km);

(d) that all of these orbits pass over, or are in view of, many different countries;

(e) that the international character of these systems dictates that the frequency bands employed to relay their collected meteorological data to Earth should be subject to international agreement;

(f) that this would facilitate the establishment of an international weather system and would minimize interference situations;

(g) that the evolution of such systems would be facilitated if frequency sharing with other services is practical,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the parts of the radio-frequency spectrum to be preferred for command and data communication systems of meteorological satellites;

2. what are the preferred types and characteristics of such systems, both under development and in planning;

3. what is the practicability of the sharing of frequencies and if so, with what services and under what conditions;

4. what are the technical parameters to be used in the application of Appendices 28 and 29 to the Radio Regulations for the coordination of frequency assignments?

Note – See Recommendation 362 and Reports 395, 541, 851, 1121, 1124 and 1125.

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* Previously Study Programme 12C/2.

QUESTION 142/7*

RADIOCOMMUNICATIONS FOR EARTH EXPLORATION SATELLITES

Data collection and position location systems

(1990)

The CCIR,

CONSIDERING

(a) that data collection systems for relaying data from fixed and mobile platforms, and for position location of such platforms have been proven to be feasible;

(b) that operational data collection systems are now in being, or planned, for implementation by several administrations as part of a world-wide environmental data collection system;

(c) that a need for operational systems in addition to those operating and planned in the Meteorological Satellite Service has been identified by some administrations;

(d) that the choice of preferred frequency bands for systems to meet new requirements is determined by a number of factors, including propagation effects, receiver characteristics, the feasibility of frequency sharing with other services, antenna characteristics, and power limitations,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred technical characteristics and regions of the spectrum for satellite data collection and position location systems;

2. what are the preferred radiocommunication systems for data collection and position location satellites at different orbital altitudes;

3. what are the criteria for sharing frequencies with those used by other radio services?

Note – See Report 538.

* Previously Study Programme 12D/2.

QUESTION 143/7*

RADIOCOMMUNICATIONS FOR SATELLITE SYSTEMS FOR GEODESY AND GEODYNAMICS

(1990)

The CCIR,

CONSIDERING

(a) that it has been demonstrated that radio measurement methods using spacecraft permit the highly accurate determination of:

- orbital elements of satellites,
- geocentric positions of points on the Earth's surface,
- terrestrial distances, particularly intercontinental distances,
- the spacecraft altitude over the oceans and over ice,
- the gravitational field of the Earth;

(b) that such measurements provide essential information for research and applications in geodesy and geodynamics;

(c) that several administrations have already operated, or are planning, specific systems for providing such information;

(d) that certain radionavigation-satellite systems can provide information of the same kind;

(e) that the choice of preferred frequency bands for such systems depends particularly on the precision sought, available technology, propagation effects, the possibilities of sharing frequencies with other systems and power flux-density limits as specified in the Radio Regulations;

(f) that an accurate radio reference system including points on the Earth which are precisely known (through use of very long base-line interferometer (VLBI) techniques, range measurements or range rate measurements for example) is very important to complement the measuring accuracy of satellite systems for geodesy and geodynamics,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred technical characteristics of satellite systems for geodesy and geodynamics and for the establishment of a network of accurate reference points on the surface of the solid Earth;

2. what are the preferred regions of the spectrum for radiocommunications for such systems;

3. what are the criteria for frequency sharing with other radio systems?

Note – See Report 988.

* Previously Study Programme 12E/2.

QUESTION 144/7*

RADIOCOMMUNICATION SYSTEMS FOR THE METEOROLOGICAL-AIDS SERVICE

(1990)

The CCIR,

CONSIDERING

(a) that meteorological-aids systems are an important means of world-wide weather forecasting;

(b) that new systems are being introduced into the meteorological-aids service;

(c) that such systems may be difficult to operate within the meteorological-aids service bands;

(d) that the nature of such systems dictates that the frequency bands employed may necessitate sharing with other services and should be subject to international agreement;

(e) that the evolution of such systems would be facilitated if frequency sharing with other services is practical,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred characteristics of radiocommunication systems for obtaining information by metereological-aids;

2. what are the technical characteristics of sensors and suitability of frequency bands for use by meteorological-aids;

3. what are the power levels and signal characteristics of the active sensors that are under development or that have been proposed and the level and nature of the interference caused by such signals to other services;

4. what is the feasibility of frequency sharing with other services?

* Previously Question AB/2 (Conclusions of the Interim Meeting of Study Group 2, 1988). This Question should be brought to the attention of Study Groups 1 and 8.

QUESTION 145/7*

TECHNICAL FACTORS INVOLVED IN THE PROTECTION OF RADIOASTRONOMICAL OBSERVATIONS

(1990)

The CCIR,

CONSIDERING

(a) that radioastronomy is based on the reception of natural emissions at much lower power levels than are generally used in other radio services, and may therefore suffer harmful interference which could be tolerated by many other services;

(b) that, for an understanding of astronomical phenomena, radio astronomers must observe both at specific and immutable line frequencies and also in a series of bands throughout the continuum spectrum;

(c) that existing measures to protect the radioastronomy service are based on the assumption that the radioastronomy stations are located on Earth,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the general areas of interest in the radio-frequency spectrum to the radioastronomy service;

2. what are the characteristics of radioastronomical sources and observational techniques;

3. what are the factors which affect the practicability of frequency sharing between radioastronomy and other radio services;

4. in what ways can radioastronomy observations be affected by spurious and other out-of-band emissions from radio transmitters located in other frequency bands and by other electrical equipment;

5. what factors need to be taken into account, and what protection criteria are appropriate, for radioastronomy observation from spacecraft?

Note – See Recommendations 314, 611 and Reports 224, 696, 697, 699, 852, 853 and 854.

* Previously Question 5/2. The XVIIth Plenary Assembly decided that DECIDES 3 and 4 should be categorized as URGENT.

QUESTION 146/7*

CRITERIA FOR EVALUATION OF INTERFERENCE TO RADIOASTRONOMY

(1990)

The CCIR,

CONSIDERING

(a) that under the Radio Regulations, frequency bands have been allocated to radioastronomy for both line and continuum observations;

(b) that harmful interference to radioastronomy observations may be caused by unwanted signals of very low power;

(c) that other services operate in many of the bands in which radioastronomy has allocations, or use high-power transmitters in bands adjacent to, or harmonically related to, those used for radioastronomy;

(d) that the increasing number of transmissions from spacecraft may introduce problems of interference to radioastronomy and that these cannot be avoided by choice of site for an observatory or by local protection;

(e) that the use of orbiting antennas in radioastronomy, both as array elements and as independent radio telescopes, offers advantages over terrestrial antennas for certain observations;

(f) that Recommendation No. 61 of the Radio Regulations requests information relating to criteria for harmful interference to radioastronomy;

(g) that Resolution No. 63 of the Radio Regulations invites the CCIR to continue studies relating to industrial, scientific and medical (ISM) equipment, to ensure adequate protection of radiocommunication services,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the practical interpretation for the radioastronomy service, of harmful interference as defined in No. 163 of the Radio Regulations;

2. what are the threshold levels of unwanted signals which, if exceeded for more than specified percentages of time, will cause harmful interference, and the dependence of the criteria on the nature and methods of the radioastronomical observations;

3. what are the levels of interference which may occur at typical observatory sites**, due to various sources of interference, including:

3.1 transmissions of other services operating in the bands used for radioastronomy observations;

3.2 harmonics, intermodulation products, and sidebands from transmitters in other frequency bands;

3.3 other sources of electrical interference including ISM equipment;

4. what is the influence of reflections from aircraft and earth satellites in increasing the risk of interference;

5. what is the response of typical radioastronomy receivers to signals in frequency bands adjacent to the nominal receiver acceptance band;

6. what are the special precautions which may be necessary, on the part of radio astronomers and the operators of the other services, when a transmitter which is a potential source of interference is in a spacecraft or an aircraft within the field of a radioastronomical observatory;

7. what are the conditions required to avoid harmful interference to observations involving radioastronomy antennas?

Note – See Recommendation 611 and Reports 224, 696, 697 and 853.

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* Previously Study Programme 5A/2.

** Propagation data for this study will be required from Study Groups 5 and 6.

QUESTION 147/7*

RADIOASTRONOMY IN THE VICINITY OF THE L_2 ** SUN-EARTH LAGRANGIAN POINT

(1990)

The CCIR,

CONSIDERING

(a) DECIDES 5 of Question 145/7;

(b) that inadequate provision is made to meet the spectrum requirements for radioastronomy and other passive scientific observations;

(c) that due to the gravitational field of the sun-Earth system permanent observatories can be sited in the vicinity of Lagrangian point L_2, which is a unique location for the protection of radioastronomy observations from interference,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the characteristics of orbits in the vicinity of the L_2 Lagrangian point technically suitable for permanent space observatories;

2. what are the potential total levels of spectral power flux-density, in the vicinity of the L_2 Lagrangian point, produced from transmitters on the Earth and in space;

3. what are the means for the suppression of interference from terrestrial and near-Earth transmitters in radioastronomy receivers sited in the vicinity of the L_2 Lagrangian point, and the corresponding methods for evaluating harmful interference;

4. what are the protection criteria for observations near the L_2 Lagrangian point and precautions which might be taken by services for the protection of such observations from interference;

5. what are the characteristics of radiocommunication systems for permanent observatories sited in the vicinity of the L_2 Lagrangian point?

* Previously Study Programme 5B/2.

** Libration points, or Lagrangian points, are described in Report 986 (Volume II, Dubrovnik, 1986).

QUESTION 148/7*

RADAR ASTRONOMY

(1990)

The CCIR,

CONSIDERING

(a) that radar astronomy is a part of pure science, contributing to our knowledge through studies of the reflecting properties of natural and man-made targets; advancing the study of celestial mechanics by direct measurements with great precision, of the motions and distances of orbiting bodies; and through the study of the nature and effects of the propagating medium;

(b) that the receiving techniques of radar astronomy require sensitivities equivalent to those of radio astronomy;

(c) that the problems of detection, location, tracking and determination of ephemerides are common to radar astronomy and spacecraft tracking and communication systems;

(d) that radar astronomy transmitters, antennas and receivers are seldom developed solely for this application, but are ordinarily the outgrowths of the most advanced transmitter technology developed for other purposes;

(e) that radar astronomy has immediate application to spacecraft missions in providing basic data required for the computation of trajectories and ephemerides for space objects;

(f) that radar astronomy frequencies are not generally tied to the frequencies associated with natural phenomena, the exception being special experiments on the atmospheres of the Earth and the planets,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the performance characteristics of radar astronomy systems;

2. what levels and durations of interfering signals are tolerable in radar astronomy reception;

3. what factors, both technological and scientific, are fundamental in the selection of frequencies for radar astronomy experiments?

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* Previously Question 6/2.

QUESTION 149/7*

FREQUENCY UTILIZATION ABOVE THE IONOSPHERE AND ON THE FAR SIDE OF THE MOON **

(1990)

The CCIR,

CONSIDERING

(a) that some radioastronomical and other scientific experiments are difficult, and perhaps impossible, to carry out on the surface of the Earth by reason of tropospheric absorption and scintillation;

(b) that the advent of spacecraft has already permitted scientific observations to be made from vantage points above the ionosphere, and that further developments will enable experiments to be carried out in the relatively quiet environment on the far side of the Moon;

(c) that in addition to the establishment of line-of-sight communication links for scientific and other purposes between the Earth and spacecraft, it may be necessary to establish links between spacecraft above the ionosphere and also to establish links between stations on the far side of the Moon and other stations either on or visible from the Earth;

(d) that at frequencies below the critical penetration frequency of the ionosphere, the region above the ionosphere is relatively isolated from terrestrial noise and communication signals;

(e) that on the far side of the Moon an even greater degree of isolation from terrestrial radiation is provided at all radio frequencies;

(f) that Nos. 2632-2635 of the Radio Regulations recognize the necessity of maintaining the shielded zone of the Moon as an area of great potential for observations by the radioastronomy service and for passive space research and, consequently, as free as possible from transmissions,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the preferred means and routes for communicating between:

1.1 a station on the far side of the Moon and a station just above the ionosphere;

1.2 a station on the far side of the Moon and an earth station;

2. in what frequency bands would radioastronomical measurements have marked advantages as compared with observations from the surface of the Earth, if carried out:

2.1 on a station above the ionosphere;

2.2 on the far side of the Moon;

3. what frequency protection criteria should be adopted for:

3.1 a station above the ionosphere;

3.2 a station on the far side of the Moon;

4. what is the variation of the shielding caused by the Moon, as a function of frequency, angular distance from the limb of the Moon to the centre of the far side, and the distance above the surface of the Moon?

Note – See Recommendation 479.

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* This Question merges Question 7/2 and Study Programme 7B/2.

** Information in Report 336 (Dubrovnik, 1986) of Study Group 5 is relevant to this Question.

QUESTION 150/7*

RADIOCOMMUNICATION REQUIREMENTS FOR SYSTEMS TO SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE

(1990)

The CCIR,

CONSIDERING

(a) that many scientists believe intelligent life to be common in our galaxy;

(b) that electromagnetic waves are presently the only practical means of detecting the existence of intelligent extraterrestrial life;

(c) that it is believed to be technically possible to receive radio signals from extraterrestrial civilizations;

(d) that, although it is not possible to know the characteristics nor to predict the time or duration of these signals in advance, it is reasonable to believe that artificial signals will be recognizable;

(e) that, while an artificial radio signal of extraterrestrial origin may be transmitted at any frequency, it is technologically impractical to search the entire radio spectrum, but the band searched should be sufficiently wide to make detection of a signal reasonably probable;

(f) that technological and natural factors which are dependent on frequency determine our ability to receive weak radio signals;

(g) that the search for radio signals from extraterrestrial civilizations will use increasingly sensitive systems which could receive harmful interference from very weak man-made signals;

(h) that it is necessary to share with other services the bands in which the search is conducted;

(j) that available technology will allow a search for these signals from the Earth, from earth-orbit, and, eventually, from the Moon, and to minimize interference, certain locations on Earth and in space may be preferred,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the most probable characteristics of radio signals which might be broadcast by extraterrestrial civilizations and the technical characteristics and requirements of a system to search for them;

2. what are the preferred frequency bands to be searched and the criteria from which they are determined;

3. what protection is necessary for receiving systems conducting a search for artificial radio signals of extraterrestrial origin;

4. what criteria will make the operation of a search system feasible in shared, adjacent and harmonically related bands of other services;

5. what is the optimum search method;

6. what are the preferred locations, on Earth and in space, for a search system?

Note – See Report 700.

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* Previously Question 17/2.

QUESTION 151/7*

THE FEASIBILITY OF FREQUENCY SHARING BETWEEN SPACE RESEARCH SATELLITES AND TERRESTRIAL SYSTEMS

(1990)

The CCIR,

CONSIDERING

(a) that satellites of the space research service share frequencies both on an equal and secondary basis with terrestrial systems;

(b) that many of the Regulations addressing the power flux-density levels, produced by satellites, were derived from studies of dense populations of geostationary and non-geostationary satellites. These studies may not be applicable to lesser population densities of low-orbit earth satellites considered separately (see Report 387);

(c) that low-orbit earth satellites with mean altitudes less than 1100 km are visible to terrestrial systems considerably less than 100% of the time (see Report 684);

(d) that the probability that a single 1100 km low-orbit earth satellite is within the main beam of a single terrestrial station is very low (see Report 684);

(e) that a recommended level/time distribution of permissible interference into a hypothetical reference terrestrial system, provides a boundary to be met by the aggregates of both long and short term interfering emissions produced by shared services operating on an equal allocation basis;

(f) that low-orbit earth satellites, when seen from terrestrial system locations, are continuously in motion, resulting in continuously changing coupling factors such as path loss, transmit antenna gains, receive antenna gains and Doppler effects,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the conditions under which, and the extent to which, it may be feasible for space research satellite systems to share frequencies with terrestrial services;

2. what are the criteria which affect the selection of sites for earth stations in space research satellite systems, taking into account the various bands of the radio-frequency spectrum available for space research;

3. what are the preferred technical characteristics of transmitting and receiving antennas for spacecraft and for earth stations at fixed locations, from the standpoint of spectrum sharing with other services;

4. what are the criteria which affect the determination of the maximum power (in a reference bandwidth) which may be radiated in the horizontal plane by an earth station;

5. what are the criteria which affect the determination of the minimum angle of elevation which should be used at earth stations;

6. what is the degree to which physical modification of earth station sites will provide electromagnetic shielding between these earth stations and stations in other services;

7. what are the criteria which affect the determination of the minimum practicable separation between stations in the space research service and in other services, taking into account the modulation systems used;

8. what are the technical criteria which may be used for coordination purposes to avoid mutual interference;

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* Previously Study Programme 1D/2. The XVIIth Plenary Assembly decided that DECIDES 1 should be categorized as URGENT.

9. what is the influence of the following factors on sharing between space research satellites and terrestrial systems including airborne terrestrial systems;

9.1 the population and orbital parameters of space research satellites;

9.2 the orbital motion of space research satellites;

9.3 the emission spectrum used on space research communications links and the interaction with the receiver transfer functions of terrestrial system receivers;

9.4 the configurations of terrestrial systems including antenna types, numbers of receivers and typical system locations and direction;

9.5 the typical flight and mission requirements for airborne terrestrial systems;

9.6 the atmospheric fading effects on, and diversity structures of, terrestrial systems;

10. what is the power flux-density which will not cause levels of interference exceeding those recommended as permissible (for primary or secondary allocation status) into terrestrial systems, including airborne systems, from space research satellites in the following orbits:

10.1 low,

10.2 elliptical,

10.3 geosynchronous;

11. what are the combined effects of the power flux-density from space research satellites in various orbits?

Note – See Reports 684, 687, 981 and 985.

QUESTION 152/7*

STANDARD FREQUENCY AND TIME SIGNALS FROM SATELLITES

(1990)

The CCIR,

CONSIDERING

(a) that continuing advances in science and technology have increased the requirements for accuracy and service range of standard-frequency and time-signal emissions;

(b) that the work of several CCIR Study Groups describes radiocommunication systems making use of satellites that give extensive coverage and satisfactory stability of signals over the Earth's surface;

(c) that satellite techniques provide the basis for existing and future standard-frequency and time-signal comparison and dissemination systems;

(d) that a number of satellite services (e.g., for navigation, meteorology, geosciences, television) may be used additionally for the comparison and distribution of standard frequency and time-signals,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the technical factors and quantitative measures to be considered in recommending frequencies and in determining the transmitting, modulating and receiving techniques, which are important to the development of standard-frequency and time-signal emissions from satellites.

2. what are the technical and operational requirements to be considered in incorporating standard-frequency and time-signal emissions or retransmissions in host satellites?

Note – See Reports 518, 736 and Decision 28.

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* Previously Study Programme 2A/7. The XVIIth Plenary Assembly decided that this Question should be categorized as URGENT.

QUESTION 153/7*

PROTECTION CRITERIA FOR THE SPACE SERVICES OPERATING NEAR 2 GHz IN PARTICULAR IN THE BANDS 2 025-2 110 MHz AND 2 200-2 290 MHz

(1992)

The CCIR,

recognizing

a) that the World Administrative Radio Conference (Malaga-Torremolinos, 1992) (WARC-92) allocated the bands 2 025-2 110 MHz (Earth-to-space, space-to-space) and 2 200-2 290 MHz (space-to-Earth, space-to-space) to the space research, space operation and Earth exploration-satellite services on a worldwide primary basis;

b) that WARC-92 in its Resolution No. 211 invites the CCIR to continue, as a matter of urgency, the study of appropriate provisions to protect the space services operating in the bands 2 025-2 110 MHz and 2 200-2 290 MHz from harmful interference from emissions by stations of the mobile service and to report the results of studies to the next competent conference,

taking into account

a) that WARC-92 in its Resolution No. 113 invites the CCIR to prepare new radio frequency channelling arrangements, if necessary, for the fixed service in the relevant frequency bands;

b) that the protection criteria for space services are given in CCIR Recommendations 609, 363 and 514,

undertakes studies of the following Question as a matter of urgency

1. What are the protection criteria required for the space services operating near 2 GHz, in particular in the bands 2 025-2 110 MHz and 2 200-2 290 MHz, to protect them from harmful interference from emissions by stations of the mobile service?

2. What are the acceptable levels of long-term and short-term interference to Earth-orbiting satellites, both geostationary and non-geostationary, operating in the space research and Earth exploration-satellite services in these two frequency bands?

decides

1. that the results of the above studies should be addressed to prepare new Recommendation(s) within two years.

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* This Question should be brought to the attention of Study Groups 8 and 9.

QUESTION 154/7*

POSSIBLE RELOCATION OF FREQUENCY ASSIGNMENTS TO CERTAIN SPACE MISSIONS FROM THE 2 GHz BANDS TO BANDS ABOVE 20 GHz

(1992)

The CCIR,

recognizing

a) that the World Administrative Radio Conference (Malaga-Torremolinos, 1992) (WARC-92) allocated the bands 2 025-2 110 MHz (Earth-to-space, space-to-space) and 2 200-2 290 MHz (space-to-Earth, space-to-space) to the space research, space operation and Earth exploration-satellite services on a worldwide primary basis;

b) that WARC-92 in its Resolution No. 711 invites the CCIR to study possible relocation of frequency assignments to certain space missions from the 2 GHz bands to bands above 20 GHz; to conduct the necessary studies on the evolution of the space research, space operation and Earth exploration-satellite services and the mobile services in the bands available to each service around 2 GHz and the compatibility between these services in the 2 GHz band,

undertakes studies of the following Question

1. What is the evolution of the space research, space operation and Earth exploration-satellite services and the mobile services in the bands available to each service around 2 GHz?

2. What are the possible methods that could be used to identify frequency assignments to certain space missions which might be relocated from the 2 GHz bands to bands above 20 GHz?

3. What is the compatibility between these services in the 2 GHz band?

decides

1. that the results of the above studies should be addressed to prepare new Recommendation(s) within two years.

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* This Question should be brought to the attention of Study Group 8.

QUESTION ITU-R 201/7

TWO-WAY TIME TRANSFER THROUGH COMMUNICATION SATELLITES

(1993)

The ITU Radiocommunication Asembly,

considering

a) that the theoretical accuracy and stability of the two-way exchange of timing signals through communication satellites has great promise;

b) that the experimental results on the short-term time stability are consistent with theory;

c) that sufficient experience for long-term time stability studies has not yet been obtained;

d) that systematic variations in the delays of the transmitting and receiving elements for this technique need to be better understood and documented;

e) that there is not an agreed-upon method for quantifying the time accuracy, the time stability and the frequency comparison capability of this technique;

f) that many of the world timing centres are implementing this technique because of its apparent potential,

decides that the following Question should be studied

1. What are the performance levels that can be achieved in practice when using the two-way satellite time transfer technique with respect to the following:

- the long-term time stability of this technique;
- the time accuracy of this technique;
- the frequency comparison capability of this technique; and
- comparisons of the performance of the two-way technique with similar results from alternative methods, such as use of GPS satellites?

2. What are the causes and cures for systematic delay variations that may be perturbing this technique?

3. What standard data format, if any, can be agreed upon and implemented for comparison between the different timing centres?

QUESTION ITU-R 202/7

FREQUENCY SHARING AND PROTECTION BETWEEN SPACE VLBI AND OTHER SPACE RESEARCH SYSTEMS

(1993)

The ITU Radiocommunication Assembly,

considering

a) that there are requirements to use spacecraft for conducting very long baseline interferometry (VLBI);

b) that space VLBI observations usually require wideband data transmission in the space-to-Earth direction;

c) that space VLBI systems require precision up-link and corresponding down-link phase reference signals which need to be protected from interference;

d) that there may be a potential for mutual interference when space VLBI systems are operated in the same frequency bands used by other space research systems,

decides that the following Question should be studied

1. How do the technical and operating characteristics of space VLBI systems affect the feasibility of sharing with other space research systems?

2. Under what conditions and to what extent is it possible for space VLBI systems to share frequency bands with other space research systems?

3. What frequency bands are suitable for sharing between space VLBI systems and other space research systems?

QUESTION ITU-R 203/7

CHARACTERISTICS AND TELECOMMUNICATIONS REQUIREMENTS FOR SPACE VLBI

(1993)

The ITU Radiocommunication Assembly,

considering

a) that the angular resolution of measurements made by very long baseline interferometry (VLBI) techniques is limited by the distance between two observing stations;

b) that, compared to the largest possible distance between two observing stations on Earth, this baseline distance may be substantially increased by locating one or more of the observing stations in space;

c) that by conducting VLBI measurements which utilize spacecraft, it is possible to eliminate the limitations of ground-based observations caused by the absorption, path length fluctuations and noise contributions by the atmosphere;

d) that space VLBI will eventually provide invaluable knowledge of physical parameters leading to highly accurate determination of:

- radiosources structure;
- deep-space navigation;
- geodynamics;
- astrometry;
- satellite's orbit parameters;

e) that the transmission of wideband space VLBI data from space-to-Earth is required;

f) that space VLBI systems require the transmission of highly accurate time/phase reference signals from Earth-to-space and space-to-Earth,

decides that the following Question should be studied

1. What are the technical characteristics of space VLBI systems with regard to their requirements for telecommunication links?

2. What are the orbital characteristics of spacecraft engaged in space VLBI, as they may affect the utilization of radio-frequency bands and the feasibility of sharing (see Question ITU-R 202/7)?

3. Considering the effects of radio-wave propagation, and available techniques:

- what are the frequency bands most suitable for the precise time/phase transmission;
- what are the frequency bands and bandwidths most suitable for the wideband data transmission space-to-Earth?

QUESTION ITU-R 204/7*

SHARING OF THE BAND 1 675-1 710 MHz BETWEEN THE MOBILE-SATELLITE SERVICE AND THE METEOROLOGICAL-SATELLITE AND METEOROLOGICAL AIDS SERVICES

(1993)

The ITU Radiocommunication Assembly,

recognizing

a) that the World Administrative Radio Conference (Malaga-Torremolinos, 1992) (WARC-92) decided that, in the band 1 675-1 710 MHz, stations in the mobile-satellite service shall not cause harmful interference to, nor constraint the development of, the meteorological-satellite and meteorological aids services and the use of this band shall be subject to the provisions of Resolution No. 46 (WARC-92) (Footnote 735A (WARC-92) to the Radio Regulations);

b) that Resolution No. 213 of WARC-92 "Sharing studies concerning the use of the bands 1 492-1 525 MHz and 1 675-1 710 MHz in Region 2 by the mobile-satellite service" resolves that studies be undertaken by the ex-CCIR to examine the operational and technical measures that would facilitate sharing;

c) that this Resolution invites the ex-CCIR also to study as a matter of urgency the technical and operational issues relating to the sharing of these bands,

noting

a) that, as for the band 1 675-1 710 MHz, Recommendation ITU-R SA.514** and Reports ITU-R SA.395**, ITU-R SA.541**, ITU-R SA.851** and ITU-R SA.1121** contain some information on this matter,

decides that the following Question should be studied

1. What are the operational and technical measures appropriate for preventing harmful interference to the meteorological-satellite and meteorological aids services from the mobile-satellite service in the band 1 675-1 710 MHz?

further decides

1. that the results of the above studies should be included in two Recommendations, one addressing the meteorological-satellite service, the other the meteorological aids service;

2. that the anticipated completion date of this work is December, 1996.

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* This Recommendation should be brought to the attention of Study Groups 1, 8 and 9.