INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

C.C.I.R.

DOCUMENTS OF THE

VIth PLENARY ASSEMBLY

GENEVA 1951

VOLUME I

RECOMMENDATIONS MADE BY THE COMMITTEE
QUESTIONS TO BE STUDIED
STUDY PROGRAMMES
REPORTS
RESOLUTIONS ADOPTED BY THE COMMITTEE
LIST OF STUDY GROUPS

INTERNATIONAL TELECOMMUNICATION UNION
GENEVA

Note by the Director of the C. C. I. R.

Due to an oversight the draft Recommendation, the text of which is given below, and which was drawn up by working group 6 B (Geneva Doc. No. 357), and then adopted by 18 votes against 8 at a joint meeting of Study Groups Nos. IV, V and VI (Geneva Doc. No. 662), was not submitted to the Drafting Committee. It therefore has not been discussed in a plenary meeting. It concerns the carrying out, both experimentally and theoretically, of ionospheric absorption studies, as mentioned in Recommendation No. 8 (Study Group No. VI).

The Director of the C.C.I.R. has therefore had this draft Recommendation added to Volume I as a loose sheet.

DRAFT RECOMMENDATION

(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

1. That a detailed knowledge of the magnitude of ionospheric absorption is necessary for the efficient use of the available frequency spectrum and for the practical design and engineering of radio broadcasting and communication circuits and services ;

2. That the task of investigating ionospheric absorption and devising methods for applying the information to the problems of radio broadcasting and communication is primarily one that must be undertaken by scientific and research organizations working on radio wave propagation ;

3. That the necessary investigations would be greatly assisted if the facilities of existing high power transmitters could be made available at times for the studies ;

4. That the report of the working group of Committee III at the IXth General Assembly of the U.R.S.I., Zurich, 1950, and also documents submitted to the VIth Plenary Assembly of the C.C.I.R., Geneva, 1951 (particularly documents Nos. 61, 138, 139, 229, 247 of the VIth Plenary Assembly of the C.C.I.R. and Documents Nos. 113 and 129 of Washington 1950 and Document No. 15 submitted by Japan to the VIth Plenary Assembly of the C.C.I.R.) contain information of use to the Administrations and organizations participating in these studies ;

RECOMMENDS :

(a) That Administrations and research organizations expedite theoretical and practical studies of the absorption of radio waves propagated by way of the ionosphere at vertical incidence, as well as oblique incidence, with the object of obtaining the data and results required for the efficient utilization of the available radio frequency spectrum ;

(b) That the importance of obtaining such information in tropical regions, as well as in other parts of the world, should not be overlooked ;

(c) That all organizations participating in these studies collaborate and exchange information among themselves and with the U.R.S.I.

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NUMBERING

of Recommendations, Questions, Study Programmes, Reports and Resolutions (Opinions) of the C.C.I.R.

The Recommendations, Questions, Study Programmes, Reports and Resolutions (Opinions) of the C.C.I.R. are numbered consecutively in five series each starting at No. 1. The series of Recommendations, Questions and Resolutions (Opinions) were started at the Vth Plenary Assembly, Stockholm (1948), the series of Study Programmes and Reports at the VIth Plenary Assembly, Geneva (1951).

Recommendations made at the Vth Plenary Assembly, Stockholm (1948), which still remain for study after the VIth Plenary Assembly, Geneva (1951)—(Recommendations Nos. 17, 18, 24, 25 and 29)—have been given new numbers in the Question series and have become Questions Nos. 48, 54, 56, 58 and 64, respectively.

The following table serves as a guide to the numbering of C.C.I.R. documents :

C.C.I.R. Plenary Assembly	Recommendations Nos.	Questions Nos.	Study Programmes Nos.	Reports Nos.	Opinion * Resolution Nos.
Vth Stockholm	1 to 35	1 to 45**	Nil	Nil	1 and 2
VIth Geneva	36 to 85	46 to 73	1 to 38	1 to 15	3 to 9

* At Stockholm the word " Opinion " was used to translate the French word " vœu ".
At Geneva the word " Resolution " was used to transalte the French word " vœu ".

** The Questions Nos. 34 to 45 have been submitted to the C.C.I.R. between the Vth and VIth Plenary Assemblies (see Appendix at the end if this Volume.)

ORIGIN

of certain documents referred to in this volume

The documents referred to in this volume as " of Stockholm ", " of Geneva ", " of Washington ", " of Mexico " and " of Florence/Rapallo " are respectively the documents of the Vth and VIth Plenary Assemblies of the C.C.I.R., held in Stockholm in 1948 and in Geneva in 1951, those of meetings of C.C.I.R. Study Groups Nos. VI and X held in Washington in 1950, and those of the High Frequency Broadcasting Conferences of Mexico City in 1948/49 and of Florence/Rapallo in 1950.

RECOMMENDATIONS

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RECOMMENDATION No. 36

BANDWIDTHS OF EMISSIONS *

(Recommendation No. 3)

The C.C.I.R.,

CONSIDERING :

(a) That it is of the utmost importance to ensure economy of the radio spectrum by reducing the spacing between assigned frequencies ;

(b) That, to this end, it is necessary to reduce the spectrum occupied by each emission, in compliance with the rules of Art. 13, § 4, of the Radio Regulations ; that, moreover, the Radio Regulations have prescribed in Art. 17, § 2, that the bandwidths mentioned in App. 5 must be considered as a guide, until more recent recommendations of the C.C.I.R. are published ;

(c) That, for the determination of a spectrum of minimum width, the whole transmission circuit, as well as all its technical working conditions, and particularly, propagation phenomena, must be taken into account ;

(d) That one cannot, strictly speaking, mention bandwidth without having previously adopted quantitative definitions of the various bandwidths by fixing well determined points on the complete spectrum ;

(e) That the definition of the bandwidth occupied, being the only definition mentioned in the Radio Regulations and satisfying the previous conditions, is useful to specify a given emission ;

(f) That, however, this definition does not suffice when consideration of the complete problem is involved ; and that one should be in a position to establish general rules limiting, on the one hand, the bandwidth occupied to the value strictly necessary in each case, and on the other hand, the amplitudes of the emitted components in that part of the spectrum which could interfere with adjacent channels ;

(g) That one can thus realise the usefulness of three conceptions which can be defined and applied according to the following principles :

g.1 The bandwidth necessarily occupied should be established at the smallest value possible, while including the spectrum components useful to a good receiver to ensure communication with the quality required by the two correspondents (that is to say, for example, maintaining the telephone quality laid down, or the percentage of errors admitted in telegraphy), in the presence of given technical conditions ;

The engineering of the radio equipment must take into account the values of bandwidths necessarily occupied ;

The definition for the bandwidth necessarily occupied must be so chosen that it makes it readily comparable with the bandwidth actually occupied.

g.2 The bandwidth occupied, as defined in the Radio Regulations, enables the operating agencies, the national and international organizations to carry out measurements of the bandwidth actually occupied by a given emission and so to ascertain, by comparison with the bandwidth necessarily occupied, that such an emission does not occupy an excessive bandwidth in view of the service to be provided, and is, therefore, not likely to create harmful interference beyond the limits laid down for this class of emission.

* This recommendation replaces Recommendation No. 3.

The use of this concept appears then to be a useful way of requiring the operating agencies to restrict the amplitude of emitted components outside the bandwidth necessarily occupied.

g.3 The emitted spectrum outside the bandwidth necessarily occupied must be determined by reconciling the following requirements :

— the necessity to limit to a strict minimum the interference caused to the adjacent channels ;
— the technical and economic possibilities of filtering ;
— the limitation to a permissible value of the shaping or distortion of the signal caused by filtering ;

(h) That, however, one must always bear in mind the fact that the three concepts are not independent and that, for example, given a specific emission, the knowledge of each one provides partial information on the emitted spectrum ; the emission is completely determined only by its entire spectrum.

RECOMMENDS :

1. Definitions.

1.0 That in addition to the definition of bandwidth occupied by an emission, given in Chap. 1, Art. No. 58, of the Radio Regulations, and which is quoted for reference in § 1.1 below, the following definitions and explanatory notes should be employed as convenient conventions to facilitate and clarify the consideration of bandwidth problems.

1.1 *Bandwidth occupied by an emission:*

The band of frequencies comprising 99% of the total radiated power extended to include any discrete frequency on which the power is at least 0.25% of the total radiated power.

1.2 *Bandwidth necessarily occupied by an emission:*

The minimum value of the bandwidth occupied by an emission, sufficient to ensure the transmission of information of required quality at the output of the receiving equipment for the class of emission, the system employed, and for specified technical conditions. (1) (3)

1.3 *Out of band radiation of an emission:*

The power radiated by an emission outside the bandwidth necessarily occupied. (1) The out of band radiation does not include radiations on remote frequencies such as harmonics and parasitic emissions. (2) (3) (4)

1.4 *Build up time of the signal:*

The time during which the telegraphic current passes from one tenth to nine tenths (or vice versa) of the maximum value reached at the steady state. (5)

1.5 *Note* (1) — Such radiation useful for the good functioning of the receiving equipment, as for example, the radiation corresponding to the carrier of reduced carrier systems should be included in the bandwidth necessarily occupied, and not in the out of band radiation.

Note (2) — It is not intended that radiation on frequencies remote from the useful part of the emission, such as radio frequency harmonics, be included in the defined out of band radiation, as these are covered by separate regulations (see App. 4, Radio Regulations).

Note (3) — The bandwidth occupied by an emission which could be considered as perfect from the standpoint of bandwidth economy equals the bandwidth necessarily occupied. In this case the out of band radiation generally equals 1% of the total radiated power. For other cases the percentage will, in general, be higher.

Note (4) — The concept of out of band radiation gives a convenient means to indicate the relative imperfection of an emission. However, a complete description of the spectrum of the out of band radiation is indispensable for the determination of interference caused on adjacent channels.

Note (5) — In the case of asymmetric signals, two different values corresponding to this definition can exist, representing the build up times at the beginning and end of the signal.

2. Limitations of the Emitted Spectra

2.0 That the Administrations should endeavour to limit the emitted spectra, as shown below for various classes of emission, taking into account that most present A1 emissions do not conform to these standards ; that the bandwidths necessarily occupied and the other limitations of spectra described should be considered by the next Ordinary Administrative Radio Conference as a basis of amendments to the rules given in the Radio Regulations and, in particular, in App. 5.

2.1 *Class A1 emissions, with fluctuations.*

For single channel, amplitude modulated, continuous wave telegraphy (class A1) using Morse code, when large fluctuations of the field strength are present :

2.1.1 Bandwidth necessarily occupied.

The bandwidth necessarily occupied is equal to five times the keying speed in Bauds (later referred to as B) with an attenuation of the components at the edges of the band equal to at least 3 db, in comparison with the level of the same components of the spectrum representing a series of equal rectangular dots and spaces at the same keying speed. This relative level of -3 db corresponds to an absolute level of 27 db below the level of a continuous mark.

2.1.2 Spectrum of the out of band radiation.

Outside the bandwidth defined above, the envelope of the spectrum should lie below a curve starting at the points ($\pm \frac{5B}{2}$, -27 db) defined above, and presenting a slope of 30 db per octave and extending over at least one octave, that is, out to the points ($\pm 5B$, -57 db). From these points onward, the level of all the components emitted should be below -57 db.

2.1.3 Build up time of the signal.

The spectrum limited precisely as described above, corresponds to a build up time of the signal equal to about 15% of the initial duration of the telegraph dot. This build up time is likely to vary slightly around that figure, depending upon the exact nature of the filters employed for the shaping of the signals.

2.2 *Class A1 emissions, without fluctuations.*

For amplitude modulated, continuous wave telegraphy, in conditions where large fluctuations of the field strength do not affect transmission quality, the bandwidth necessarily occupied can be reduced to three times the keying speed in Bauds.

2.3 *Class F1 emissions.*

For single channel, frequency shift telegraphy (class F1) with, or without, fluctuations :

2.3.1 Bandwidth necessarily occupied. (6)

The deviation, or difference, between mark and space frequencies being 2D and m being the modulation index 2D/B, the bandwidths necessary are given by one of the following formulae, the choice depending on the value of m :

$$2.5\,D + 0.5\,B \text{ for } 2.5 < m \leqslant 8$$
$$2\,D + 2.5\,B \text{ for } 8 \leqslant m \leqslant 20$$

2.3.2 Spectrum of the out of band radiation. (6)

Outside the bandwidth defined above, the envelope of the spectrum should lie below a curve of constant slope in decibels per octave, starting from points situated at the limiting frequencies for the bandwidth necessarily occupied, and at the level of -15

or -20 db, depending on the value of the modulation index, the curve extends to the level of -60 db. The levels are computed by comparison with a zero level corresponding to the amplitude of the emission ; the starting ordinates of the curve and its slopes are given in the following table, the entry depending on the modulation index :

Modulation index	Starting ordinates in db	Slope in db per octave
$2.5 < m \leqslant 3$	-15	17
$3 < m \leqslant 8$	-15	25
$8 < m \leqslant 20$	-20	30

On the frequencies more remote from the median frequency than those where the curve reaches the -60 db level, the level of all emitted components should lie below -60 db (6).

2.3.3 *Note* (6) — The figures given above for F1 emissions represent the minimum requirements which are certainly attainable in view of the existing data ; they do not represent the desirable limitations of the spectrum which can be achieved.

2.3.4 Build up time of the signal.

The spectrum limited as described above, corresponds to a build up time of the signal equal to about 8 % of the initial duration of the telegraph dot, provided that the phase distortion of the filters used for signal shaping is negligible.

2.3.5 Bandwidth occupied, in the case of unshaped signals.

Only for comparison purposes with the formulae above, it may be mentioned that for a sequence of equal and rectangular (zero build up time) mark and space signals, the occupied bandwidths are given by the following formulae :

$$\frac{8}{3}D + \frac{4}{3}B \quad \text{for } 2.5 < m \leqslant 8$$

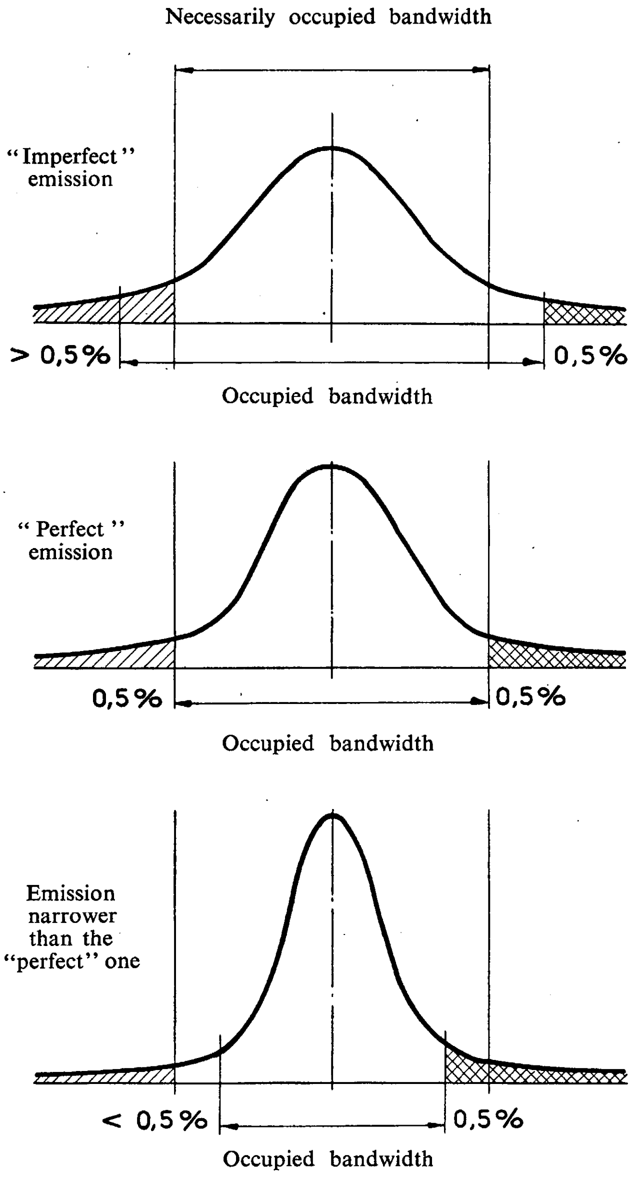
$$2.2\,D + 3.2\,B \quad \text{for } 8 \leqslant m \leqslant 20$$

ANNEX

Examples of spectra, for illustration of the definition of necessarily occupied bandwidth

Abscissae : frequencies
Ordinates : power, per unit frequency

The spectra are assumed to be symmetrical



Hatched areas represent the out of band radiation. (See definition 1.3)
Cross hatched areas represent radiation outside the occupied band. (See definition 1.1)

RECOMMENDATION No. 37

MEASUREMENT OF BANDWIDTH OF EMISSIONS

(Questions Nos. 1.a and 16)

The C.C.I.R.,

CONSIDERING :

(a) That the accurate determination of bandwidths actually occupied by emissions is of increasing importance ;

(b) That Question No. 1.a Part 2 speaks of " Practical methods of measuring the bandwidths actually occupied by emissions " ;

(c) That Question No. 16 of Stockholm refers in fact to the same problem, the measurement being made by a Monitoring Station at a distance from the transmitter ;

(d) That the methods of measurement and the equipment therefore have much in common for the two cases ;

(e) That much progress has been made in the development of equipment and the formulation of methods for the measurement by monitoring stations of occupied bandwidth (Art. 1, Section IV, of Radio Regulations 1947) ;

(f) That a practical basis must be furnished for the final determination of the bandwidth necessary for a service of appropriate quality ;

UNANIMOUSLY RECOMMENDS :

1. Methods of Measurement.

That the principle of the recommended method should consist of the analysis of the spectral composition of an emission by means of a narrow band filter.

1.1 *Measurements made near the Transmitter.*

Two separate types of measurement may be made according to the type of characteristic which it is required to determine :

1.1.a For the examination of the detailed spectral composition of the emission, the transmitter must be modulated by a periodic signal such as a succession of dots or other periodic waveform. A separate measurement is then made successively of each element of the spectrum. In this case, the frequency range of interest may be explored very slowly as for example by manual control to permit advantage to be taken of the maximum resolving power of the filter. Frequency stability of the various beating oscillators is of the greatest importance under these conditions.

1.1.b For the determination of the overall distribution of power in the spectrum in order to define the bandwidth of practical emissions, it is essential that the transmitter under measurement should be carrying normal transmissions. In this case, a more rapid exploration of the band may be obtained by the use of automatic frequency sweep, the sweep rate and the sweep repetition frequency being so chosen that the statistical results of measurement are substantially independent of minor fluctuations of the spectrum, the maximum rate of sweep being limited by the degree of filter resolution which it is desired to retain.

A provisional specification for an instrument suitable for such measurements is contained in the second part of this Recommendation.

1.2 *Measurements made at a distance from the Transmitter.*

For this type of measurement the employment of apparatus incorporating automatic sweep as indicated in 1.1.b is recommended.

In making measurements at a distance it is always necessary to take into consideration the effect of the propagation path on the accuracy of measurement. Measurements of a single station should be continued over a sufficiently long period to verify that propagation conditions are stable and permit accurate measurements to be made.

When the propagation path gives evidence of instability, one must consider that such measurements do not necessarily give a true representation of the emitted spectrum.

2. Characteristics of Measuring Equipment with Automatic Frequency Sweep.

That equipment suitable for use in analysing the spectrum of transmitters operating in the medium and high frequency range should in general possess the following characteristics :

Filter Bandwidth.

The filter bandwidth is related not only to the characteristics of the signal to be studied but also to the sweep frequency rate. It should be small in comparison with the width of the spectrum to be measured, and whilst in the present state of the art it is inappropriate to specify a single bandwidth, to the exclusion of others, it is desirable that the Static Bandwidth of the filter should not exceed 25 cycles per second. Its attenuation versus frequency characteristic should be steep-sided down to the region of 60 db.

Scanning Range.

The scanning range shall be adequate to include the outermost significant sideband components likely to be encountered. A top limit of 30 kc/s total sweep should normally be adequate. For investigating narrow band transmissions, the range should be adjustable down to 1 kc/s.

Frequency Sweep Rate.

The frequency sweep rate must be low and it is recommended that it should be in the neighbourhood of one sweep period per second and should not exceed 20 sweeps per second. At the same time, to make use of the maximum resolving power of the filter when exploring wide frequency bands, it is necessary to use lower sweeping frequencies such as one sweep in ten seconds.

Form of Display.

For direct observation the display may take the form of a cathode ray tube, but other means such as recording meters may be used.

Amplitude Range.

The range of amplitudes displayed should be such that it is possible to measure components differing in amplitude by at least 60 db. The amplitude scale of the display instrument may be linear or logarithmic. It may be desirable to measure the larger and minor components separately and by stages such as may be obtained through the use of a calibrated attenuator or calibrated scale applied to the oscilloscope screen.

Frequency Stability.

The frequency stability of the various beating oscillators must be such that the drift during the course of a measurement is small compared with the effective resolving power of the filter.

Note. — In the above text consideration is given chiefly to a measurement of the amplitude (voltage or current) of the spectral components. It is recognised that in some instances it may be desired to obtain a power distribution curve. This may be accomplished either directly in the equipment or by plotting the square of the amplitude distribution curve as displayed on a linear scale.

3. Continuation of Studies.

That studies be continued both on the measuring equipment and on the method of measurement itself, and in particular for frequencies above 30 Mc/s.

RECOMMENDATION No. 38

HARMONICS AND PARASITIC EMISSIONS

(Question No. 1.b)

The C.C.I.R.,

CONSIDERING :

(a) That App. 4 of the Radio Regulations, 1947, specifies the maximum level of harmonics (and parasitic emissions) of all transmitters operating in the frequency band 10 to 30,000 kc/s in terms of power supplied to the antenna on the frequency of the harmonic or of the parasitic emission ;

(b) That Art. 17, § 398, of the Radio Regulations, 1947, states that :

> " The bandwidths of emissions, level of radio frequency harmonics, and non-essential emissions must be kept at the lowest value which the state of technique and the nature of the service permit. App. 4 and 5 must be considered as a guide in this respect, until more recent recommendations of the C.C.I.R. are published. "

(c) That measurements of the amount of harmonic power supplied to a transmitting antenna or to a dummy load are useful in the analysis of transmitter performance with reference to purity of emissions under specific conditions, thereby encouraging the use of certain means of reducing non-essential emissions ;

(d) That the relation between harmonic power supplied to a transmitting antenna and the field strength of the corresponding harmonic signals at locations away from the transmitter may vary greatly due to factors such as complex horizontal and vertical antenna directivity at harmonic frequencies and harmonic radiation from parts of the transmitting apparatus other than the antenna proper ;

(e) That field strength measurements of harmonic emissions at locations distant from the transmitter are recognized as the direct means of expressing the intensities of interfering signals due to these harmonic radiations ;

(f) That, in dealing with emissions of the fundamental frequency, the Administrations customarily establish the power supplied to the antenna, and measure the field strength at a distance to aid in determining when an emission is causing interference with another authorized emission ; and, that a similar procedure would be helpful in dealing with harmonics in accordance with Art. 13, § 376, of the Radio Regulations, 1947 ;

UNANIMOUSLY RECOMMENDS :

1. That, simultaneously with other known methods of measuring the upper harmonics, the substitution method be used, when the transmitter is operated under normal conditions on its fundamental frequency and when connected to its normal antenna or a dummy load ;

2. That, for this purpose, an auxiliary generator in which the power is adjustable and the frequency is equal to that of the harmonic to be measured should be used as follows :

The auxiliary generator is substituted for the radio transmitter and is adjusted in power output until it produces the same field on the harmonic frequency as was produced by the radio transmitter, both as to intensity and polarization, at a radio receiver tuned to the harmonic and located at a distance of several wavelengths from the transmitting antenna. When a dummy load is used an indicator coupled to the load is required. Under these conditions, the harmonic power delivered by the auxiliary generator is equal to that which was originally delivered by the transmitter in question. In order to obtain the same conditions with the auxiliary generator, account must be taken of any stray couplings from the original transmitter to the radiating system and of any direct radiation from the transmitter or from feeder lines or other apparatus that may become excited by direct couplings. It is also necessary to take into account the possibility of harmonic power being supplied in a push-pull or push-push mode or a combination of both. More than one generator may be necessary when the method of excitation on the harmonic frequency is complex. It is further necessary to establish the impedance of the feeder input circuit at the harmonic frequency so that the harmonic power will not be inaccurately measured. It is advisable that several sets of measurements be made when using different receiver locations ;

3. That field strength measurements of harmonics at locations distant from the transmitter should be the direct means of expressing the intensities of interfering signals due to harmonic radiations ;

4. That all well known methods should be employed to reduce harmonics as much as possible, as for example :

— use of low pass or other output filters,
— suitable coupling circuits,
— screening of various stages in transmitters, filters and other parts of the equipment which otherwise might emit harmonic power by radiation or coupling.

RECOMMENDATION No. 39

FREQUENCY SHIFT KEYING

(Question No. 20)

The C.C.I.R.,

CONSIDERING :

(a) That frequency shift keying is employed in radio-telegraphy on fixed services and its use may be extended to the mobile services ;

(b) That it is desirable to standardize the main operating characteristics of systems employing frequency shift keying ;

(c) That various technical factors influence the choice of operating characteristics in such systems, in particular :

— the overlap of marking and spacing signals due to multipath propagation (in this respect a small deviation is preferable) ;
— the possible advantage of frequency diversity for reception (an advantage which increases with increasing deviation) ;
— the economy of bandwidth and the consequent necessity for controlling the shape of the transmitted signals ;
— instability of frequency, which is one reason for the relatively large deviation employed in many existing equipments ;
— the choice of receiving system, whether with separate filters or with frequency discriminator ;

RECOMMENDS :

1. That it is too early to standardize the actual values of frequency shift but that every effort should be made to achieve this as quickly as possible. To assist these efforts, the preferred characteristics shown below should be used as far as possible ;

2. That the value of the frequency shift employed should be the lowest compatible with the required keying speed, propagation conditions and equipment stability ;

3. That preferred values of frequency shifts of 70, 100, 140, 200, 280, 400, 560 and 840 should be used when possible * ;

4. That the value of the frequency shift should preferably be maintained within $\pm 3\%$ of the nominal value and, in any case, within $\pm 10\%$;

5. That in general the marking frequency should be the higher frequency and the spacing frequency the lower frequency.

RECOMMENDATION No. 40

INTERCONTINENTAL RADIOTELEPHONE SYSTEMS, AND USE OF RADIO LINKS IN INTERNATIONAL TELEPHONE CIRCUITS

(Questions Nos. 29 and 41)

The C.C.I.R.,

CONSIDERING :

(a) That radiotelephone systems connecting the various continents at the present time usually employ carrier frequencies under about 30 Mc/s ; **

(b) That the use of such a radio link in a long distance telephone circuit implies certain special conditions which introduce particular difficulties not encountered when purely metallic connections are used ;

(c) That such a radiotelephone circuit differs from a metallic circuit in the following ways :

c.1 Such a radiotelephone circuit is subject to attenuation variation with the special difficulty of fading.

c.2 Such a radiotelephone circuit suffers from noise caused by atmospherics whose intensity may reach, or even exceed, a value comparable with that of the signal which it is desired to receive.

c.3 Special precautions are necessary in the setting up and maintenance of such a radiotelephone circuit so as to avoid disturbance of the radio receiver by any radio transmitter and especially by its own radio transmitter.

c.4 So as to maintain the radiotelephone link in the best condition from a point of view of transmission performance, it is necessary to take special measures to ensure that the radio transmitter always operates so far as is possible under conditions of full loading whatever may be the nature and the attenuation of the telephone system connected to the radiotelephone circuit.

c.5 It is necessary to take measures to avoid or correct abnormal oscillation or crosstalk conditions.

c.6 Although the effectively transmitted frequency band recommended for international landline circuits has been determined by a study of the requirements of the human ear, this band (in the case of a radiotelephone circuit operating at a frequency below 30 Mc/s)

* The value of the frequency shift for a system which uses only two frequencies, one for " mark " and one for " space ", is defined, for the purposes of this Recommendation, as the difference between the frequency transmitted for a continuous " mark " and that transmitted for a continuous " space ".

** Further reference to " 30 Mc/s " in this document means " about 30 Mc/s ".

may be limited by the necessity of obtaining the maximum number of telephone channels in this part of the radio frequency spectrum, and in order that each telephone channel does not occupy a radio frequency band larger than necessary.

c.7 In general, such a radiotelephone circuit is a long distance intercontinental circuit giving telephone service between two extended networks, and this fact is of great importance from two points of view :

c.7.1 On the one hand, intercontinental conversations, in general, are of great importance to the subscribers and, on the other hand, they are made in languages which are not always their mother tongue so that high quality reception is particularly important.

c.7.2 The public should not be deprived of a very useful service under the pretext that it does not always satisfy the degree of excellence desirable for long distance communication from the point of view of transmission quality.

UNANIMOUSLY RECOMMENDS :

1. Circuits above 30 Mc/s.

That between fixed points telephone communications should be effected wherever possible by means of metallic conductors or radio links using frequencies above 30 Mc/s so as to make the allocation of radio frequencies less difficult, and where this can be realised, the objective should be to attain the transmission performance recommended by the C.C.I.F. for international telephone circuits on metallic conductors.

2. Circuits below 30 Mc/s.

2.1 That, since it becomes necessary to economise in the use of the frequency spectrum when considering intercontinental circuits which consist mainly of single long-distance radio links operating on frequencies less than 30 Mc/s, it is desirable to use single-sideband transmission to the maximum extent possible, to employ a transmitted band less than the 300 to 3400 c/s recommended by the C.C.I.F. for land-line circuits and preferably to reduce the upper frequency to 3000 c/s or below but to not less than 2600 c/s, except in special circumstances ;

2.2 That, although it will be necessary to tolerate large variations in noise level on such a radiotelephone circuit, every possible effort should be made to obtain minimum disturbance to the circuit from noise and fading by the use of such techniques as full transmitter modulation, directional antennas and single-sideband operation ; with present technical development, it is not yet practicable to recommend either a minimum value for the signal-to-noise ratio or a method of measuring the disturbing noise ;

2.3 That during the time that such a radiotelephone circuit is connected to an extension circuit equipped with echo suppressors the intensity of disturbing currents should not be sufficient to operate frequently the echo suppressor ;

2.4 That such a radiotelephone circuit should be provided with a reaction suppressor (voice-operated switching device) so as to avoid singing or echo disturbance on the complete circuit ;

2.5 That such a radiotelephone circuit should be equipped with automatic gain control so as to compensate automatically so far as possible for the phenomenon of fading ;

2.6 That the terminal equipments of such a radiotelephone circuit should be such that it may be connected, in the same way as any other circuit, with any other type of circuit ;

2.7 That in the cases where privacy equipment is used, this equipment should not appreciably affect the quality of telephone transmission ;

2.8 That when suitable automatic devices are not provided the circuit should be controlled as often as necessary by an operator in order to ensure optimum adjustment of transmitter loading, received volume and the operating conditions of the reaction suppressor.

Note. — Although the requirements contained in Part 2 of the Recommendations are much less severe than those imposed on international land-line circuits, the ideal remains to attain the same standards of telephone transmission in all cases. In view of this, it is desirable that the telephone systems connected to a radiotelephone circuit should conform to C.C.I.F. recommendations referring to the general conditions to be met by international circuits used for land-line telephony especially in respect of equivalent, distortion, noise, echoes and transient phenomena.

Bearing in mind the recommendations contained in Parts 1 and 2 above, it is desirable that in each particular case, Administrations and private companies concerned should first reach agreement on how far the standards usually employed for international land-line circuits may be attained in the case considered. If the technique of Part 1 of the recommendation can be used, the objective should be to obtain as far as possible the characteristics recommended by the C.C.I.F. for international land-line circuits. Otherwise, the Administrations and private companies concerned should study the best solution from the point of view of both technique and economy.

RECOMMENDATION No. 41 *

NOISE AND SENSITIVITY OF RECEIVERS

(Recommendation No. 2 and Question No. 2)

The C.C.I.R.,

CONSIDERING :

(a) That Question No. 2 asks for noise and sensitivity figures for the various types of apparatus used for the reception of different classes of emission in the different services ;

(b) That receiver noise and sensitivity are closely related ;

(c) That a very wide range of signal-to-noise ratios occurs in practice ;

(d) That it is desirable to define precisely sensitivity and noise figure and their methods of measurement ;

(e) That values for noise figure may, in many cases (see Annex), be of more general utility than sensitivity figures since they are nearly independent ** of receiver selectivity and are more uniform for different types of receivers designed for different classes of emission or traffic,

RECOMMENDS :

1. That " the sensitivity of a receiver is a measure of its ability to receive weak signals and reproduce them with usable intensity and acceptable quality " *** ;

2. That " maximum usable sensitivity is measured by the minimum value of the signal which must be applied to the input of the receiver to obtain, at the output, the signal level with signal-to-noise ratio necessary for normal operation " ***, the input values being those for the e.m.f. in series with the appropriate dummy antenna (see Annex) ;

3. That, within the linear range of the ratio of signal-to-noise in the output circuit to signal in the input circuit of a receiver, the maximum usable sensitivity for any signal-to-noise ratio can be calculated from its " reference sensitivity ". The " reference sensitivity " can be obtained by measuring the maximum usable sensitivity at any point within the linear range of the receiver, and proportioning it to a signal-to-noise ratio of 20 db, under the assumption that the receiver is linear in between ;

---

* This Recommendation replaces Recommendation No. 2.

** Except in the case of very wide band receivers where the noise figures tend to be slightly higher than those for narrow band receivers.

*** Quoted from Recommendation No. 2.

4. That the noise figure shall be defined for linear receivers connected to a dummy antenna, as follows : " The noise figure is the ratio of noise power, measured at the output of the receiver, to the noise power which would be present at this output if the antenna were the only source of noise in the system " ;

5. That reference sensitivity figures and the values of noise figure should be associated with a statement giving the type of aerial used, the overall receiver pass band and the input frequency range to which the figures apply ;

6. That noise figures should not, for the present, be used to determine the reference sensitivity or the maximum usable sensitivity of receivers in which the output signal-to-noise ratio bears a markedly non-linear relationship to the input signal.

ANNEX I

Laboratory measurements on receivers, without self-contained aerials, are made with a dummy aerial and their sensitivity is determined, taking into account only noise arising from the receiver and the dummy aerial.

When the receiver is connected to an actual aerial it usually receives, as a result, additional external noise which adds to the above mentioned noise. If the usable sensitivity of a receiving installation is calculated, such noise must be taken into account (see C.C.I.R. Recommendation No. 10 and Question No. 10).

When the external noise is high, and the receiver noise figure alone is not therefore of prime importance, a looser coupling to the aerial is permissible, thus permitting increased selectivity and the satisfactory operation of a receiver with aerials of different types.

For these reasons some types of receiver (e. g. Broadcast receivers) are not designed to have the lowest possible reference sensitivity or noise figure.

In a good receiver, noise is mainly due to the random voltages (thermal and shot noise) generated in the early stages of the receiver and its aerial circuit. When measuring noise figures. the appropriate dummy aerial must therefore be connected to the receiver input. For receivers where hum is present due to the source of power activating the receiver, this must also be included in the receiver noise.

In C.C.I.R. Recommendation No. 2, the noise figure is stated to be " the ratio of the total internal noise to the unavoidable part of the noise ". It is considered that this " unavoidable part " refers to the noise due to the source (aerial) at normal temperature. This is then in agreement with the definition given in the present Recommendation and also with the more general definition for a linear network, that is, the noise figure is the ratio of the input available signal to the input available noise power divided by the ratio of the output available signal to the output available noise power. Available power is the maximum power which can be extracted from a given source.

The noise figures for good modern receivers which are especially designed to have a low noise figure are as follows :

Frequency Mc/s	Noise Figure	
	Power Ratio	Decibels
up to 50	2.1	3.2
100	2.5	4.0
200	3.2	5.1
500	5.6	7.5
1000	10.4	10.2
2000	40	16
3000	125	21

Sufficient figures of reference sensitivity have not been available to state representative figures for the different classes of receivers. A table is therefore given in Ann. II showing some examples for particular receivers.

The reference sensitivity is expressed as microvolts in series with a dummy aerial. The aerial should in general have an impedence characteristic similar to that of the dummy aerial shown in Fig. 1 or be a 75 ohm resistance. If other aerials are used they must be adequately described. Microvolts per metre would be used for receivers with built-in aerials.

For A3 or A2 (modulation only keyed) the signal should be modulated 30%.

For F3 the signal should be modulated to produce 30% of the peak deviation for which the receiver is designed.

Note *. — When obtaining maximum usable sensitivity figures for receivers having manual predetector gain controls, special precautions are necessary and the following procedure should be followed :

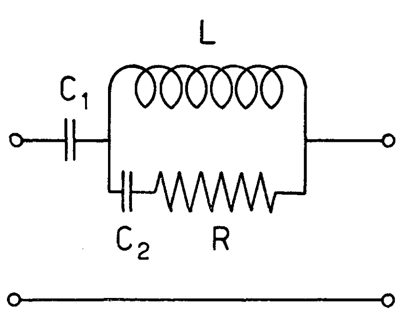
1. Set the radio frequency and the intermediate frequency gain controls to produce maximum gain.

2. Adjust the audio frequency gain and the input to obtain the normal output. If the signal to noise ratio is less than the required ratio the input should be increased and the audio gain reduced until the satisfactory ratio is achieved with normal output. If the ratio is initially higher than the required ratio, the input must be reduced and the audio gain increased.

3. In receivers where the value of input, found as above, would overload the predetector stages at full modulation, the predetector gain must be reduced until the necessary signal-to-noise ratio at normal output is obtained without overloading.

For A3 and A2 (modulation only keyed) receivers, a convenient method of ensuring that overloading is not occurring is to calibrate the detector current against receiver input and note the value I_d of detector current at which saturation first begins.

If the detector current in the above tests 1 and 2 exceeds $I_d/2$, then the gain should be reduced (first by reducing the I.F. gain, and then the R.F. gain, if separate predetector gain controls are fitted) until the value of $I_d/2$ is reached.



Dummy aerial

C_1	=	200 pF
C_2	=	400 pF
L	=	20 μH
R	=	400 Ω
Q_L	>	15 (at 1 Mc/s)

* See Ann. II bis of Doc. No. 170 of Geneva.

ANNEX II

Examples of Sensitivities and Noise Figures of Receivers

Receiver Number	Class of Emission	Frequency Range (Mc/s)	Overall Passband (kc/s)	Output Power (mW)	Dummy Antenna Impedance (ohms)	S/N ratio used during measurement shown in column 8 (db)	Measured Sensitivity (microvolts)	Reference Sensitivity (microvolts)	Noise Figure (db)
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10
1	A3	0.15-0.39 0.5-1.3 1.3-30	13 13 13	50 50 50	75 75 75	20 20 20	10 10 7	10 10 7	*7.6* *7.6* *4.5*
2	A3	0.2-0.4 1.6-10	4	0.5	70	16	5	8	*11.1*
3	A3	0.6-1.6	4	50	Fig. 1	20	12-30	12-30	*17-25*
4	A1	0.6-4	5	6	Fig. 1	20	2-4	2-4	*11.8-17.8*
5	A1	3-24	2.5	50	75	6	1	5	*19.2*
6	A1	4-27	8	6	70	20	2-3.5	2-3.5	*6.5-11.3*
7	A3	100-156	12	50	52	6	2-3.5	10-17.5	*13.2-18*
8	A3	110-160 110-160	6 14	6 6	52 52	10 10	2 3	6.32 9.5	*8.5* *8.4*
9	A3	0.5-1.5	—	—	400	—	—	—	12
10	A3	0.5-1.5	—	—	400	—	—	—	18
11	A3	3-30	—	—	—	—	—	—	4-5.3
12	A3	5-20	2.8	—	—	—	—	—	4.3-5.5
13	A1	5-30	0.25 0.5 1	—	—	—	—	—	3.8-5.7
14	A3	6-20	—	—	100	—	—	—	13
15	A3	6-20	—	—	100	—	—	—	24

Types of receivers

Receiver Number

1. Communications receiver.
2. Ground station for airway use.
3. Broadcast receiver.
4. Marine general service receiver.
5. Special communications diversity receiver.
6. Marine general service receiver.

Receiver Number

7. Airborne VHF crystal controlled receiver.
8. Marine service receiver.
9. Broadcast receiver (with Radio Frequency amplification).
10. Broadcast receiver (without Radio Frequency amplification).
11. Single side band receiver.
12. Communications receiver.
13. Communications receiver.
14. High frequency broadcast receiver (with Radio Frequency amplification).
15. High frequency broadcast receiver (without Radio Frequency amplification).

Remarks

Col. 4 The " Overall Passband " has been taken as the smaller of the two following quantities :

(a) the predetection passband or

(b) twice the postdetection passband.

Col. 8 The values given for A2 and A3 apply to 30% modulation.

Col. 9 The values given for A2 and A3 apply to 30% modulation. The " reference sensitivity " values are given for an output signal/noise ratio of 20 db.

Col. 10 The *italicised* values of noise figures have been calculated from the reference sensitivity, according to the following formula :

$$F = \frac{E^2}{400\,k\,TBR}$$

where E = e.m.f. of signal

k = Boltzmann constant = 1.37×10^{-23} Joule/degree C

T = absolute temperature

B = noise bandwidth (see Doc. No. 3 of Geneva)

R = resistance of dummy aerial

RECOMMENDATION No. 42 *

SELECTIVITY AND BANDWIDTH OF RECEIVERS

(Recommendation No. 4 and Question No. 2)

The C.C.I.R.,

CONSIDERING :

(a) That receivers should not be influenced by transmissions occupying frequency bands other than those which are intended to be received ; **

(b) That the state of technique has evolved to such an extent as to make it possible to approach these ideal conditions ; **

* This Recommendation replaces Recommendation No. 4.

** Quotations from Recommendation No. 4.

(c) That the recommendation No. 83 of the C.C.I.R. (Bucharest) gives the following definition of selectivity :

" The selectivity of a receiver is a measure of its ability to receive a particular signal to the exclusion of emissions made on other frequencies "

and states that in reference to the selectivity of receivers it is necessary also to envisage the case in which an undesired signal is superimposed on a desired signal at the input terminals of the receiver ;

(d) That uniform methods of measuring receiver characteristics are necessary ;

UNANIMOUSLY RECOMMENDS :

1. That in order to carry out uniform measurements and for the purpose of establishing representative figures in the case in which two signals are applied to the input of the receiver :

1.1 The definition of selectivity shall be further precisely specified by introducing the concept of " effective selectivity ", which will be defined as the ability of a receiver to discriminate between a desired signal to which the receiver is tuned, and an undesired signal, having a frequency outside the passband of the receiver, both desired and undesired signals acting simultaneously and one or both being modulated ;

1.2 If the effect of the interfering signal is to introduce new undesired output components, then representative figures should be obtained by establishing the relationship of the frequency difference between the desired and undesired signals to the level of the undesired signal that gives a total interference power output of 20 db less than the desired signal ; the level of the desired signal and the type of modulation of the undesired signal should appear as parameters ;

1.3 If the effect of the interfering signal is to reduce the useful output signal components, the procedure should be to establish the relationship of the frequency difference between the desired and undesired signals to the power of the undesired signal, that gives a reduction of 6 db in the output power of the desired signal, with parameters as before.

2. That for the purpose of the study of receiver bandwidth the following definitions be adopted :

2.1 "Passband" : the band of frequencies limited by the two frequencies for which the attenuation differs from the attenuation of the most favoured frequency by some agreed value. In general this value is 6 db except for high quality radiotelephony receivers where the value is 2 db. For future applications it may be necessary to consider less values *.

2.2 " Attenuation slope " :

2.2.1 On each side of the passband, the ratio :

$$\frac{\text{difference of attenuation obtained for two frequencies beyond the passband}}{\text{difference between these frequencies}}$$

In practice sufficient indication is obtained in considering the difference of frequencies corresponding to the attenuations of 20, 40, 60, and if possible 80 and 100 db, reckoned from the limit frequencies. When the values thus obtained are essentially equal for the two sides of the band, it is sufficient to give mean values.**

2.2.2 The attenuation outside the passband can also be expressed as decibels per octave, defined by the slope of the attenuation curve when plotted against a scale in which the abscissa is the logarithm of the frequency difference between the midband frequency and the frequency in question.

3. That, since the total bandwidth of a receiver is determined by a series of filters, it is necessary to adopt the best compromise to avoid spurious responses and intermodulation products which may arise when subject to intense interfering signals ;

4. That, after having provided at the input stages of the receiver the most appropriate filtering, use shall be made, whenever possible, in the intermediate frequency circuits, of special filters such as crystal filters, which provide a substantial increase of the attenuation slope and better protection against interference ;

* Quotations from Recommendation No. 4.

** Quoted from Recommendation No. 4, except for the addition of figures 80 and 100 db.

5. That the study of receiver characteristics shall continue, and that, for this purpose, the study group should collect all necessary information about receivers in use in different countries.

Note. — For information an annex is attached giving some values of bandwidth and attenuation slopes taken from a few receivers of which details have been supplied in documents submitted to the VIth Plenary Assembly of the C.C.I.R.

ANNEX

Examples of Bandwidths and Attenuation Slopes of Various Radio Receivers

Receiver Designation	Frequency Range (Mc/s) *(See Note a)*	Service	Class of Emission	Pass-band (kc/s) *(See Note b)*	Attenuation slope in db/kc/s *(See Note c)* 26 db + —	46 db + —	66 db + —	86 db + —	106 db + —	Ultimate slope in dbs/octave *(See Note d)* + —
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	1.0	Broadcasting	A3	4.6	5.0	6.2	—	—	—	28
2	1.0	”	A3	4.8	5.9	6.0	—	—	—	32
3	1.0	”	A3	5.8	6.0	6.0	—	—	—	32
4	1.0	”	A3	4.4	6.5	5.2	—	—	—	22
5	1.0	”	A3	6.0	5.0	3.8	—	—	—	19
6	1.0	”	A3	6.8	4.9	4.0	—	—	—	22
7	1.0	”	A3	6.0	6.9	6.6	—	—	—	39
8	1.0	”	A3	7.0	3.3	2.4	—	—	—	19
9	1.0	”	A3	5.8	5.1	4.6	—	—	—	28
10	1.0	”	A3	4.4	7.7	6.6	—	—	—	27
11	1.0	”	A3	8.4	5.0	5.9	—	—	—	46
12	1.0	”	A3	7.4	5.9	5.0	—	—	—	28
13	1.0	”	A3	8.2	5.3	5.0	—	—	—	33
14	1.0	”	A3	5.2	4.3	4.2	—	—	—	29
15	1.0	”	A3	5.0	4.4	4.2	—	—	—	29
16	1.0	”	A3	8.5	4.0 4.5	3.6 4.3	3.2 3.7	—	—	32 33
17	1.0	”	A3	4.5	8.9	7.3 7.8	5.6 6.7	—	—	28 33
18	1.0	”	A3	6.3	2.4 5.6	3.3 5.0	3.3 4.7	—	—	38 43
19	4.0	Gen. Purp. Teleph.	A3	3.7	4.3	4.1	4.1	—	—	41
20	0.625 1.605	Broadcasting	A3	4.6	5.1 4.0	4.4 3.0	3.5	—	—	25
21	0.625 1.605	”	A3	4.9	4.1 4.4	4.5 3.6	3.5 3.1	—	—	27 30
22	0.625 1.605	”	A3	5.9	4.3	4.2 4.5	3.6 4.3	—	—	31 40
23	0.625 1.605	”	A3	4.3	3.4 4.8	2.5 4.2	—	—	—	29 27
24	0.625 1.605	”	A3	7.5	5.3 4.6	4.1 3.3	3.3	—	—	27 23
25	0.625 1.605	”	A3	7.6	3.8 5.7	3.0 4.4	—	—	—	22 25
26	3 24	Fixed	A1	0.1	182	80	32	—	—	11
27	3 24	”	A1	0.85	34	29	21	—	—	24
28	3 24	”	A1 A3	2.5	25	24	20	—	—	37
29	3 24	”	A1 A3	7.2	18	17	15	—	—	56
30	3 24	”	A1 A3	13	13	13	12.4	—	—	75
31	5 30	”	A1 F1	1.6	44 50	40 53	—	—	—	37 67
32	5 30	”	A1 F1	0.5	200 125	129 78	—	—	—	19 23
33	5 30	”	A1 F1	0.25	266	296	—	—	—	24 22
34	6 28	”	A3	9.6	7.1 5.9	6.9 5.1	—	—	—	42 32
35	6 28	”	A1	1.36	105 111	129 133	—	—	—	—
36	6 28	”	A1	0.88	59 62	87 73	107	—	—	116
37	6 28	”	A1	0.16	42 38	55 54	70 68	—	—	78 74
38	1.8 25	”	A1	4.5	6.8	6.6	5.9	—	—	34
39	HF	”	A3	9.8	4.9	4.4	4.3	3.6	—	47
40	HF	”	A3	6.4	10	130	60	27	33	68
41	HF	”	A1	0.5	160	210	230	—	—	83
42	HF	”	A1 A2 A3	12.5	17	21	24	17	—	65
43	{0.4 0.6 / 1.6 10}	Mobile	A3	5.0	6.7	7.0	7.1	—	—	45
44	0.6 4	”	A1 A2 A3	3.5	10	10	10	10	—	60
45	0.6 4	”	A1 A2 A3	9.0	4.5	5 7	6.0	6.5	—	76

Receiver Design-ation	Frequency Range (Mc/s) *(See Note a)*	Service	Class of Emis-sion	Pass-band (kc/s) *(See Note b)*	Attenuation slope in db/kc/s *(See Note c)* 26 db + —	46 db + —	66 db + —	86 db + —	106 db + —	Ultimate slope in dbs/octave *(See Note d)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
46	4 · 27	Mobile	A1 A2 A3	3.5	10	10	10	10	—	60
47	4 27	”	A1 A2 A3	20	5.3	5.3	5.3	5.3	—	70
48	2 3	”	A3	4.8	6.3	6.1	5.8	—	—	34
49	HF	”	A3	5.2	5.6	5.7	5.3	—	—	27
50	2 3	”	A3	4.9	5.3	5.1	4.7	—	—	38
51	0.5 54	”	A1	0.5	80	20	20	—	—	46
52	0.5 54	”	A1 A2 A3	17	14	8.2	6.4	—	—	46
53	HF	”	A3	5 3	4.4	4.2	3.7	—	—	29
54	102 160	”	A3	129	0.3	0.38	0.44	—	—	70
55	100 156	”	A3	135	0.53	0.53	0.45	—	—	43

Receivers Nos.	1-19	Documents of Geneva	Nos. 5	(U.K.)
	20-25		1	(Italy)
	26-30		175	(Czechoslovakia)
	31-33		121	(Netherlands)
	34-37		260	(Allied High Commission)
	38-55		3	(U.S.A.)

Note (a). — When a single figure is given in the frequency range column this refers to the frequency at which the measurement was made. Where two figures are given, these refer to the limiting frequencies at which measurements were made.

Note (b). — The " Passband " figure is that defined in Recommendation No. 4, taken between the 6 db points.

Note (c). — The quoted attenuation slopes in decibels per kc/s refer to the slope of the chord joining the point on the attenuation/frequency curve corresponding to 6 db attenuation to the point corresponding to the attenuation shown in the particular column heading. It is not the differential slope of the curve at the point in question.

Where two figures are shown under + and —, these refer to the slopes on either side of the curve, above and below the centre frequency respectively. A single figure indicates that the curve is symmetrical about the centre frequency in respect to that attenuation figure.

Note (d). — The " ultimate slope " is derived from a plot of the attenuation curve on a logarithmic frequency difference base. The ordinate of the curve is the decibels attenuation corresponding to a particular frequency differing from the frequency of maximum response by Δf, and the abscissa is

$$\log_{10} (\Delta f)$$

The differential slope of this curve is expressed in decibels per octave, which is the increase in attenuation which would result from an increase in frequency difference from Δf to $2\Delta f$, if the slope of this curve were to remain constant.

For many forms of attenuation curve this slope approaches an approximately constant value for values of Δf several times the bandwidth, and is the quantity shown in the last column as " Ultimate Slope ".

Where two figures are shown under + and —, these correspond respectively to the values above and below the frequency of maximum response.

RECOMMENDATION No. 43

CHANNEL SEPARATION

(Recommendation No. 1)

The C.C.I.R.,

CONSIDERING :

That Recommendation No. 1 can be used in future study of frequency separation between channels ;

RECOMMENDS :

1. That attention be drawn to the fact that measurements of the power of the wanted signal and the power of the interference is the primary requirement ;

2. That future study of the problem should be undertaken in connection with Question No. 3.

RECOMMENDATION No. 44

BANDWIDTHS AND SIGNAL TO NOISE RATIOS IN COMPLETE SYSTEMS

(Question No. 3)

The C.C.I.R.,

CONSIDERING :

That it is not yet possible to give a full and accurate answer to Question No. 3, but that in order that such an answer may be given it is desirable to classify the important points with which future study will have to deal,

RECOMMENDS :

1. That in the meanwhile the values given in the table in Ann. I should be adopted as provisional values for the signal-to-noise ratio required for the types of service concerned ;

2. That in the further study relating to the minimum separation between frequencies of stations operating on adjacent channels, the factors detailed in Ann. II should be taken into consideration.

ANNEX I

Signal/Noise Ratios Required

(Stable conditions)

Type of Service	Receiver Audio bandwidth kc/s	Audio S/N db	Receiver bandwidth kc/s	Ratio of Peak R.F.S./Noise in 6 kc/s band *(Note 1)* db
A1 Telegraphy				
8 baud low grade	1.5	−4	3	−7
24 baud	1.5	11	3	8
120 baud recorder	0.6	10	0.6	0
50 baud printer	0.25	16	0.25	2
A2 Telegraphy				
8 baud low grade	1.5	−4	3	−3 *(Note 2)*
24 baud	1.5	11	3	12 *(Note 2)*
F1 Telegraphy				
120 baud recorder	0.25	4	1.5	2
50 baud printer	0.10	10	1.5	−2
Facsimile A4	3	35	6	41
Hellschreiber	1.5	10	3	13
Telephony				
A3 Double side-band low grade	3	3	6	15
A3 Double side-band commercial	3	33	6	35*
A3 SSB :				
1 channel	3	33	3	26*
2 channels	3	33	3	28*
3 channels	3	33	3	29*
4 channels	3	33	3	30*
Broadcasting	5	33	10	47

* Using noise reducers.

Note 1. — Measured as the ratio of RMS signal corresponding to peak output of the transmitter and RMS noise in a 6 kc/s band, assuming stable conditions.

Note 2. — Using beat frequency oscillators.

ANNEX II

Factors to be taken into account for Various Services in determining the Minimum Separation between Frequencies of Stations operating on Adjacent Channels

1. Required signal-to-interference ratios
2. Necessary bandwidth for required intelligence
3. Transmitters :
   (a) Out of band radiations
   (b) Frequency instability
4. Propagation :
   Allowances for fluctuations due to absorption and fading
5. Receivers :
   (a) Necessary bandwidth
   (b) Attenuation Slope
   (c) Frequency instability
6. Effect of :
   (a) Inequalities of received field strength on desired and adjacent channels
   (b) Antenna directivity at transmitter and receiver

RECOMMENDATION No. 45

AVOIDANCE OF INTERFERENCE FROM SHIPS' RADAR TO OTHER RADIO COMMUNICATION APPARATUS ON BOARD

(Question No. 35)

The C.C.I.R.,

CONSIDERING :

(a) That experience has proved that with well designed and properly installed radar the possibility of interference occurring in practice is very remote ;

(b) That the possibility of interference to radio reception and to direction finding on a vessel other than that upon which the radar is located is exceedingly remote and that no instances of such interference have been reported ;

(c) That in the unlikely case where radar interference might result to radio reception aboard a radar equipped vessel, the presence of such interference may be readily detected and identified by listening on the radio receiver or direction finder ;

(d) That where interference has occurred to radio reception aboard ships equipped with well designed radar, in each case the cause of the interference has been faulty initial installation and has been removed by correcting the installation ;

UNANIMOUSLY RECOMMENDS :

1. That Administrations shall see to it that radar equipments placed aboard ships are well designed and properly installed so as not to cause interference to radio reception aboard the radar equipped vessel. In this regard, particular attention shall be paid to shielding, bonding and to fitting line filters, especially in the modulator circuits, for the conductors which are routed between the major components of the installation ;

2. That the absence of interference shall be assured either by test procedures of prototypes or by installation inspection procedures whereby an investigation is made to determine whether or not there exists any noticeable interference to the ship's radio receiver or direction finder under practical conditions of installation and operation.

RECOMMENDATION No. 46

DIRECTIVITY OF ANTENNAS AT LONG DISTANCES

(Recommendation No. 17)

The C.C.I.R.,

CONSIDERING :

(a) That the study of the directivity of antennas at long distances concerns chiefly distant radio communications on frequencies between 3,000 and 30,000 kc/s ;

(b) That in certain cases the phenomena of ionospheric propagation may be such as to modify appreciably both the theoretical directivity diagram and the practical diagram drawn up for measurements at short distances ;

(c) That it would be very useful for operators to have the most accurate idea possible of the directional discrimination that can be expected of the antennas they are using ;

RECOMMENDS :

1. That all Administrations in a position to do so should undertake systematic measurements on frequencies that can be used for long distance circuits ;

2. That the method used for the study of item *(c)* could be either the statistical method described in Doc. No. 23 of Geneva or any other appropriate method ;

3. That members of the C.C.I.R. who are able to provide either transmitting or receiving installations which could take part in the programme of studies proposed above should communicate full details of their installations to the specialized secretariat of the C.C.I.R. as soon as possible, so that the latter may send them on to such other members of the C.C.I.R. as express a wish to receive them.

RECOMMENDATION No. 47

LIMITATION OF THE POWER OF TRANSMITTERS IN THE TROPICAL ZONE TO AVOID INTERFERENCE IN THE BANDS SHARED WITH TROPICAL BROADCASTING

(Question No. 4)

The C.C.I.R.,

CONSIDERING :

(a) That the power of transmitters for radio services in the tropical zone operating within the bands shared with tropical broadcasting (Art. 9, § 244, Radio Regulations, 1947) should be determined so as to ensure full protection to broadcasting in the tropical zone ;

(b) That it is preferable to exploit the possibilities of " time sharing " between broadcasting services in the tropical zone and radiotelegraph services operating within the shared bands ;

(c) That, at sunspot minimum, when certain frequencies become useless for tropical broadcasting, such frequencies could be used by other services ;

(d) That Recommendation No. 84 recommends provisional power limitations for broadcasting stations in the tropical zone ;

(e) That the maximum power of radiotelegraph stations can best be determined in the light of the permissible " repetition distance " (geographical sharing *) ;

(f) That the protection ratio to be considered in the determination of the " repetition distance " will be that set forth in Recommendation No. 50 ;

(g) That the factors governing the limitation of power for A3 emissions by services other than broadcasting within the shared bands are similar to those for radiotelegraphy ;

RECOMMENDS :

1. That, for the particular cases not involving simultaneous operation of broadcasting and other services, no limitations be imposed on the power for radiotelegraph stations operating within the shared bands other than those necessary to comply with the provisions of Section I, Art. 13, Radio Regulations, 1947 ;

2. That, for the general case involving simultaneous operation of broadcasting and radiotelegraph services within the shared bands, the limitation to be imposed on the power of radiotelegraph stations in the tropical zone should be only that required to provide adequate protection for the broadcasting services ;

3. That the limitations for fixed service stations in the tropical zone employing A3 emissions and operating within the shared bands should be similar to those for radiotelegraph stations operating under like conditions.

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* See P.F.B. Doc. No. 712, dated 14th February, 1950.

RECOMMENDATION No. 48

CHOICE OF FREQUENCY TO AVOID INTERFERENCE IN THE BANDS SHARED WITH TROPICAL BROADCASTING

(Question No. 4)

The C.C.I.R.,

CONSIDERING :

(a) That an audible interfering beat note may occur irrespective of the position of the frequencies used by other services between two adjacent broadcasting carriers in the shared bands ;

(b) That the minimum tolerable field strength ratio of the wanted to unwanted signal depends primarily upon the frequency separation between the carrier waves ;

(c) That it is extremely important that all stations operate with the best frequency stability obtainable ;

(d) That transmitters of poor frequency stability may be capable of causing harmful interference to tropical broadcasting when operated in the shared bands ;

(e) That mobile stations, due to their lower frequency stability and variable location, are likely to cause more interference than fixed stations to tropical broadcasting when operated within the shared bands, particularly when using A3 emissions ;

RECOMMENDS :

1. That it is not necessary for frequencies of other services sharing frequency bands with broadcasting in the tropical zone to be assigned only midway between the broadcasting frequencies.

When mid-spaced frequencies are not assigned, however, it is desirable that the same frequencies be assigned for other services as for broadcasting. The use of frequencies midway between broadcasting station carriers would have the advantage that less stringent tolerances would be required to maintain the required degree of protection than would be the case when frequencies of other services are assigned indiscriminately between adjacent broadcasting frequencies ;

2. That Administrations should attempt to improve, as soon as possible, the frequency stability of fixed stations and, more generally, of all stations operating in the shared bands to the values specified in App. 3, Column 3, Radio Regulations, 1947. Administrations should arrange for transmitters which do not meet this requirement to operate only on frequencies outside the shared bands, unless there is little possibility of interference to tropical broadcasting services ;

3. That, wherever possible, Administrations should avoid the operation of mobile stations in the tropical zone within the bands shared with broadcasting, particularly as regards the use of A3 emissions by such mobile stations.

RECOMMENDATION No. 49

CHOICE OF SITE OF STATIONS AND TYPE OF ANTENNA TO AVOID INTERFERENCE IN THE BANDS SHARED WITH TROPICAL BROADCASTING

(Question No. 4)

The C.C.I.R.,

CONSIDERING :

(a) The provisions of Art. 13, § 3, Radio Regulations, 1947 ;

(b) That all possible sources of interference to broadcasting should be minimized ;

RECOMMENDS :

1. That Administrations should make every effort to comply, as soon as possible, with the regulations with regard to the siting of stations and the use of directional antennas when the nature of the service permits ;

2. That Administrations should take steps to ensure that all interference to broadcasting and other radio services in the tropical zone produced by radiation, such as key-clicks, sideband spread, etc., be kept to a minimum ;

3. That the broadcasting services in the tropical zone should, for their part, reciprocally take similar precautions to facilitate the operation of other services working in other zones in the shared bands.

RECOMMENDATION No. 50

MINIMUM PERMISSIBLE PROTECTION RATIO TO AVOID INTERFERENCE IN THE BANDS SHARED WITH TROPICAL BROADCASTING

(Question No. 4)

The C.C.I.R.,

CONSIDERING :

(a) That it is necessary to establish, as soon as possible, a value for minimum permissible protection ratio for broadcasting within the shared bands in the tropical zone ;

(b) That operation of broadcasting transmitters with 10 kc/s separation makes it difficult to measure the protection ratio with a receiver having an audio frequency cut-off in excess of 5 kc/s ;

(c) That, in the absence of sufficient information concerning noise values in various parts of the tropical zone, it is difficult to state a value of minimum field to which the minimum permissible protection ratio should be maintained ; however, this minimum field strength should provide satisfactory reception at the limit of the broadcast station service area as provided by Art. 9, § 243, Radio Regulations, 1947 ;

RECOMMENDS :

1. That, for the present and wherever practicable, the ratio of median wanted broadcasting carrier to median unwanted carrier in the tropical zone shall be 40 db to provide a steady state ratio of not less than 23 db for 90% of the hour and 90% of the days (ref : Mexico City (1948/49) Doc. No. 635, § 13) * ;

2. That the protection ratio thus defined be measured at the output of a receiver having an audio frequency cut-off of 5.0 kc/s ** ;

3. That, for the present, the protection ratio, as defined in § **1** above, should be maintained, throughout the broadcast service area in the tropical zone, to a minimum field strength of 200 microvolts/metre or any lower value consistent with satisfactory reception ;

4. That the conditions of operation required for broadcasting in the tropical zone should be compatible with the protection ratio required for other services outside the tropical zone, in accordance with Art. 3, No. 90, § 5, of the Radio Regulations, 1947 ;

5. That a further study be undertaken in an endeavour to determine finally a value for minimum permissible protection ratio for broadcasting services operating in the shared bands in the tropical zone with due regard to the following factors :

— improvements in transmitter frequency stability which are now possible ;
— the receiver audio frequency cut-off at which the protection ratio should be measured ;
— the minimum field strength to which the protection ratio should be maintained at the limit of the broadcast service area ;
— the nature, the intensity and the distribution of prevailing noise levels in the different parts of the tropical zone ;
— the efficacy in practice of the value of minimum permissible protection ratio recommended in § **1** above.

RECOMMENDATION No. 51

MIXED PATH GROUND-WAVE PROPAGATION

(Question No. 6)

The C.C.I.R.,

CONSIDERING :

(a) That the calculation of ground-wave field strengths over mixed paths such as part land and part sea is a matter of great importance in determining the service areas of medium-wave broadcasting transmitters ;

* Doc. No. 43 of Washington refers, in particular, to the effect of long and short term fading.

** Where measurements are made with a receiver of audio frequency cut-off different from 5.0 kc/s, the appropriate correction should be applied to the figures given in § 1. Practical considerations of the frequency separation of adjacent channels require the use of an audio frequency cut-off of 5 kc/s in preference to the 6.4 kc/s mentioned in section 6 of Question No. 4.

(b) That it is also of importance in connection with the use of medium and low frequencies for navigational aids ;

(c) That the method proposed by Millington (*P.I.E.E.*, Part III, **96**, p. 53) for the calculation of field strengths in propagation over mixed paths has the support of theory and of several experiments designed to test its validity ;

(d) That this method is straightforward for engineering application and makes use of ground-wave curves for propagation over a homogeneous earth,

RECOMMENDS :

That this method should be provisionally adopted for the calculation of ground-wave field strengths where the propagation is over a path consisting of well defined sections of differing conductivities.

RECOMMENDATION No. 52

GROUND WAVE PROPAGATION CURVES BELOW 10 Mc/s

(Question No. 6)

The C.C.I.R.,

CONSIDERING :

(a) That ground wave propagation curves for an extended range of frequencies are of continued importance for all types of radio communication including navigational aids ;

(b) That such curves for a range of land conductivities are needed for the varying conditions along the land paths met with in practice ;

RECOMMENDS :

1. That the curves in the Annex hereto be used for the determination of ground wave field strengths on frequencies below 10 Mc/s under the conditions stated ;

2. That these curves supersede the existing C.C.I.R. (1937) curves for frequencies below 10 Mc/s.

ANNEX

The attached curves apply to propagation on frequencies below 10 Mc/s.

The following points are to be especially noted with regard to them :

(a) They refer to a smooth homogeneous earth, as in the corresponding C.C.I.R. (1937) curves ;

(b) No account is taken of tropospheric effects on these frequencies, i.e. they are calculated for the actual radius of the earth. It is realised that the troposhere exerts some influence below 10 Mc/s, but experimental evidence suggests that on medium frequencies the usually assumed $^4/_3$ earth's radius over-estimates the effect of normal refraction in the troposphere. Moreover, mathematical analysis shows that with decreasing wavelength the concept of an effective earth's radius is no longer strictly valid as the necessary transformation involves not only the frequency used but also the conductivity of the earth. It was therefore decided to retain the use of the actual earth's radius as in the case of the C.C.I.R. (1937) curves, and the consideration of the effect of the troposphere is accordingly made the subject of Study Programme No. 11 ;

(c) The frequency range has been extended down to 10 kc/s in view of the suggested use of very low frequencies for navigational aids ;

(d) In order to cater more adequately for the differences of land conductivity met with in practice the curves for the value 10^{-13} e.m.u. of the conductivity σ have been supplemented by curves for the further values $10^{-12.5}$, $10^{-13.5}$, 10^{-14} e.m.u. The value of the permittivity assumed is $\varepsilon = 4$ as in the C.C.I.R. (1937) curves, but it may be stated that the precise value assumed is not of practical signifiance for the frequency range under consideration. For the sea curves, the values $\sigma = 4 \times 10^{-11}$ e.m.u. and $\varepsilon = 80$ have been retained ;

(e) It should be pointed out that the sea curves and the land curves for $\sigma = 10^{-13}$ e.m.u. differ from the C.C.I.R. (1937) curves only in the extension of the frequency range and in the slightly modified method of presentation, as they are based on the same rigid analysis of the problem given by van der Pol and Bremmer ;

(f) The presentation is given in two forms :

1. With a linear scale of distance out to 2000 km as abscissa and an ordinate scale which is linear in decibels for which the datum is a field strength of 1 μV/m. A subsidiary scale reading directly in μV/m is added on the right hand side. The linear distance scale has been retained to exhibit the linear aspect of the curves in the diffraction region where the field strength is effectively exponentially attenuated with distance. The linear scale in decibels replaces the logarithmic scale for μV/m used in the C.C.I.R. (1937) curves in view of its greater convenience in most engineering applications ;
2. With a logarithmic distance scale for short distances out to 200 km. This has been done to make the curves more useful in the neighbourhood of the transmitter where they are very steep when the linear distance scale is used. It should be noted that at these short distances it is not practicable to include all the curves down to 10 kc/s where they differ very little from one another and from the unattenuated inverse distance curve ; in fact it is not practicable to label all the curves that have actually been included ;

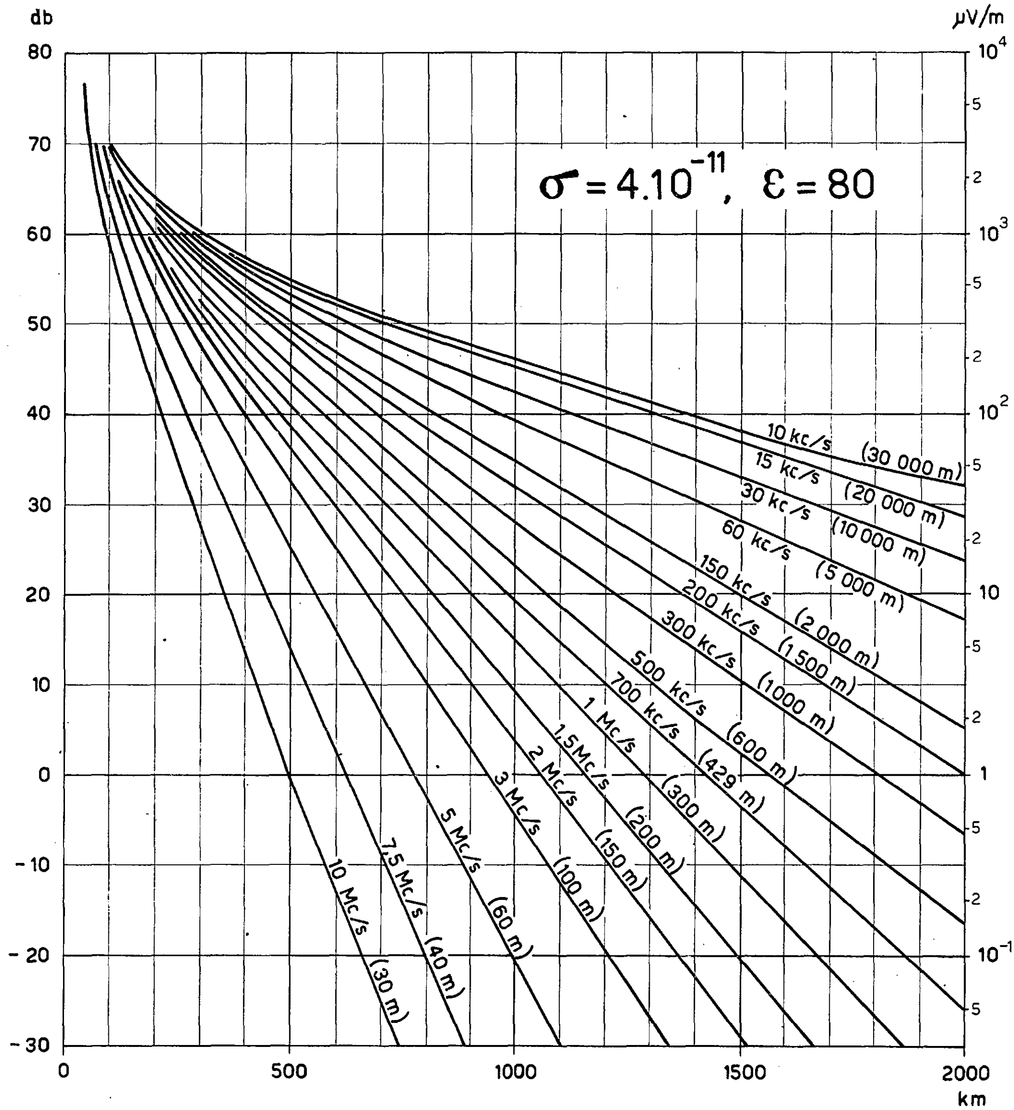
(g) The curves are no longer referred to a radiated power of 1 kW, but to what has been called an unattenuated field strength of $3 \times 10^5/D$ μV/m where D is the distance from the transmitter in kilometres. This field would actually correspond to the case of a vertical antenna, shorter than one quarter wavelength, radiating 1 kW when placed on the surface of a perfectly conducting plane earth. The engineer should regard as an auxiliary problem the determination of the appropriate value of the unattenuated field in a given practical case and the value of the necessary multiplier ;

(h) The transmitter and receiver are both assumed to be on the ground. In most practical cases in the frequency range concerned, the height-gain effects with elevated antennas would not be significant. Although height-gain curves exist which refer to this frequency range, their restriction to the diffraction region makes them of very limited use, and it was decided not to include them ;

(i) The curves should, in general, be used to determine field strength only when it is known that ionosphere reflections of the frequency under consideration, will be negligible in amplitude—for example propagation in daylight between 150 kc/s and 2 Mc/s. However, under conditions where the sky wave is comparable with, or even greater than, the ground-wave, the curves are still applicable when the effect of the ground-wave can be separated from that of the sky-wave by the use of pulse transmissions, as in some forms of direction-finding systems and navigational aids.

PROPAGATION CURVES

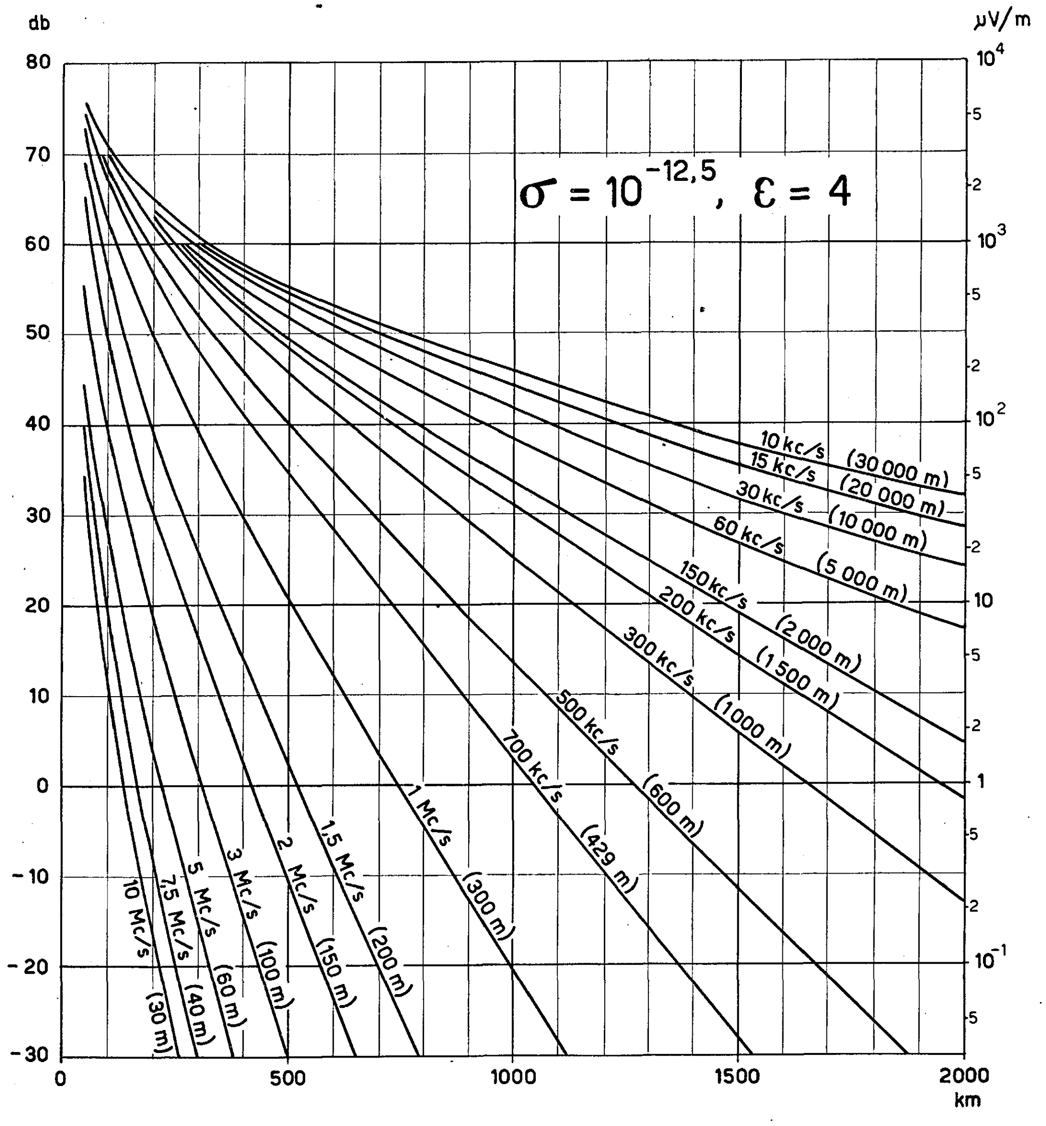
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$



Propagation over sea (conductivity $\sigma = 4 \times 10^{-11}$ e.m.u., dielectric constant $\varepsilon = 80$ e.s.u.)

PROPAGATION CURVES

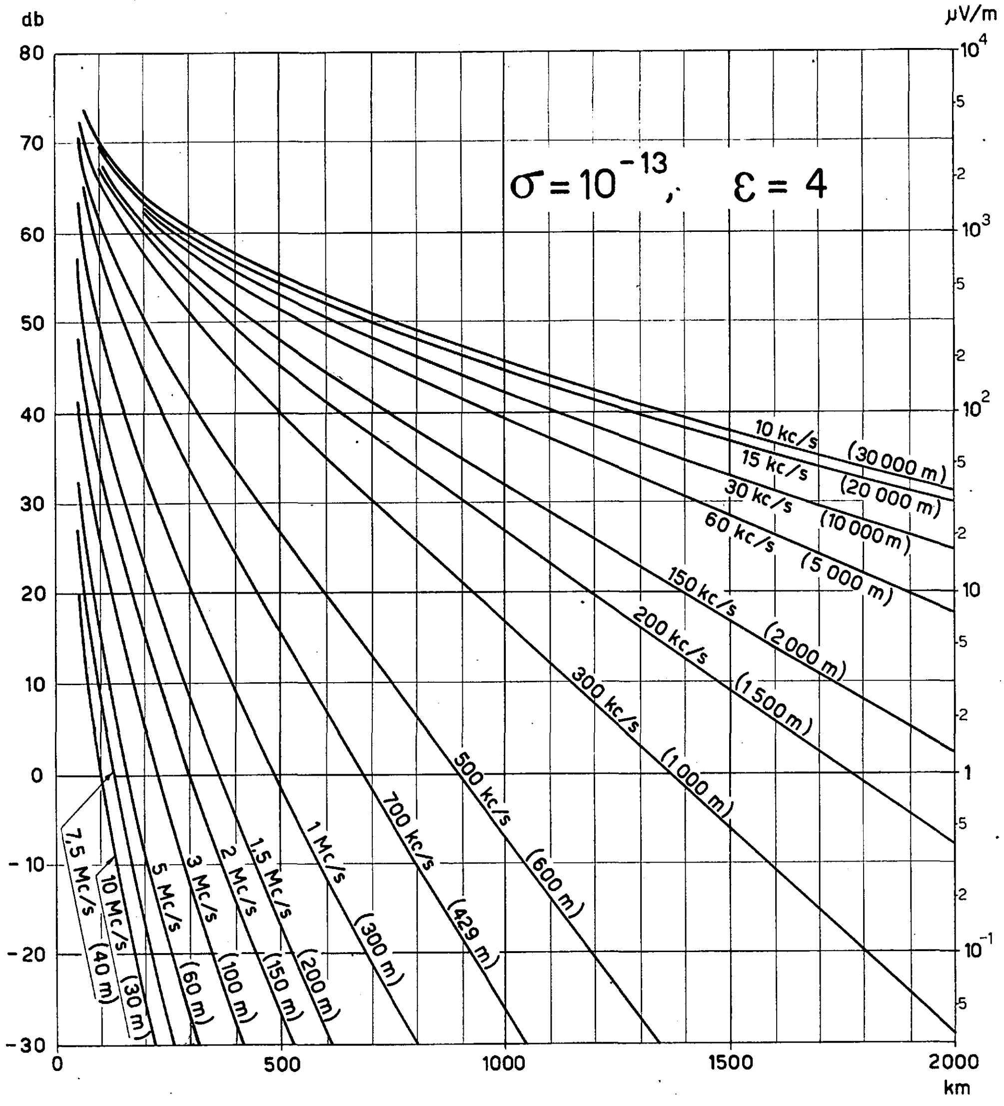
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$



Propagation over land (conductivity $\sigma = 10^{-12.5}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

PROPAGATION CURVES

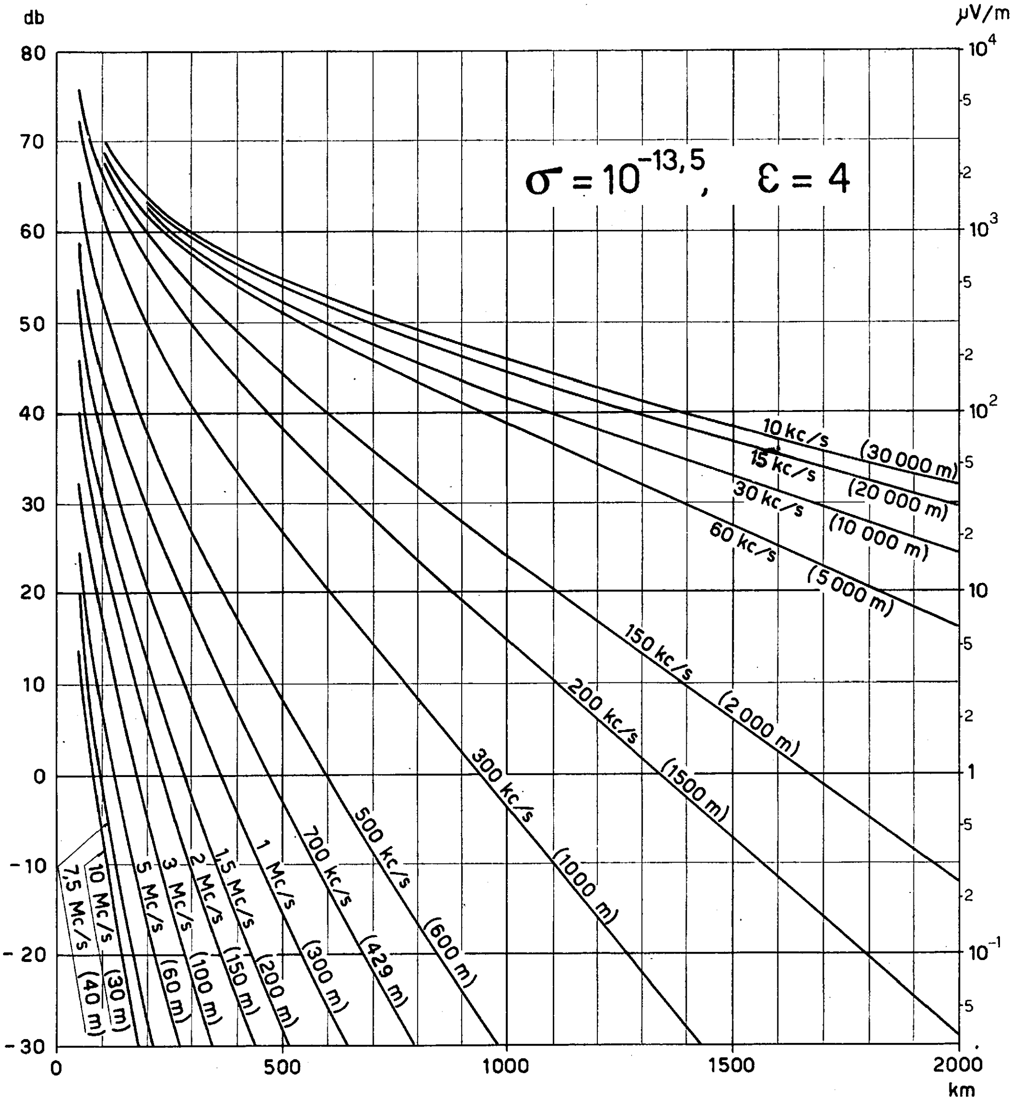
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ $\mu V/m$



Propagation over land (conductivity $\sigma = 10^{-13}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

PROPAGATION CURVES

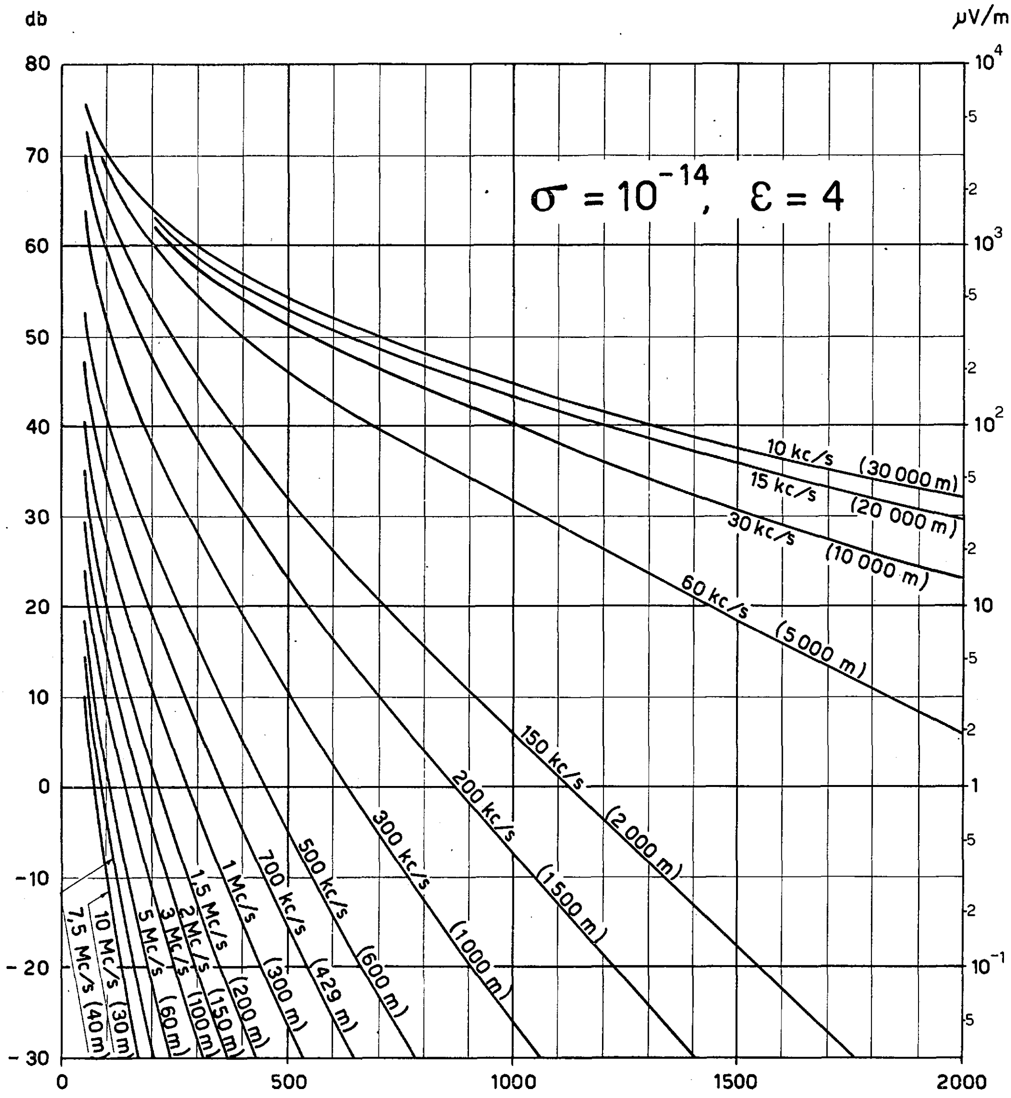
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ μV/m



Propagation over land (conductivity $\sigma = 10^{-13.5}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

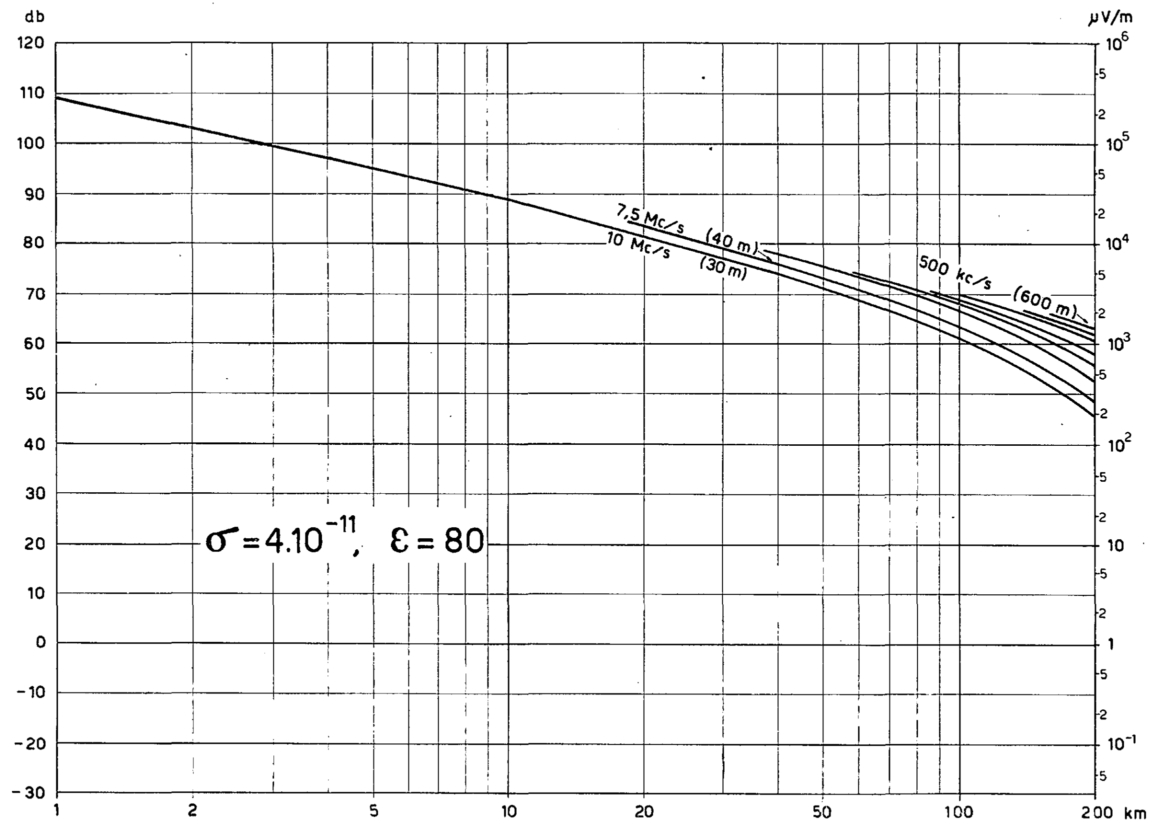
PROPAGATION CURVES

Groundwave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ μV/m



Propagation over land (conductivity $\sigma = 10^{-14}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

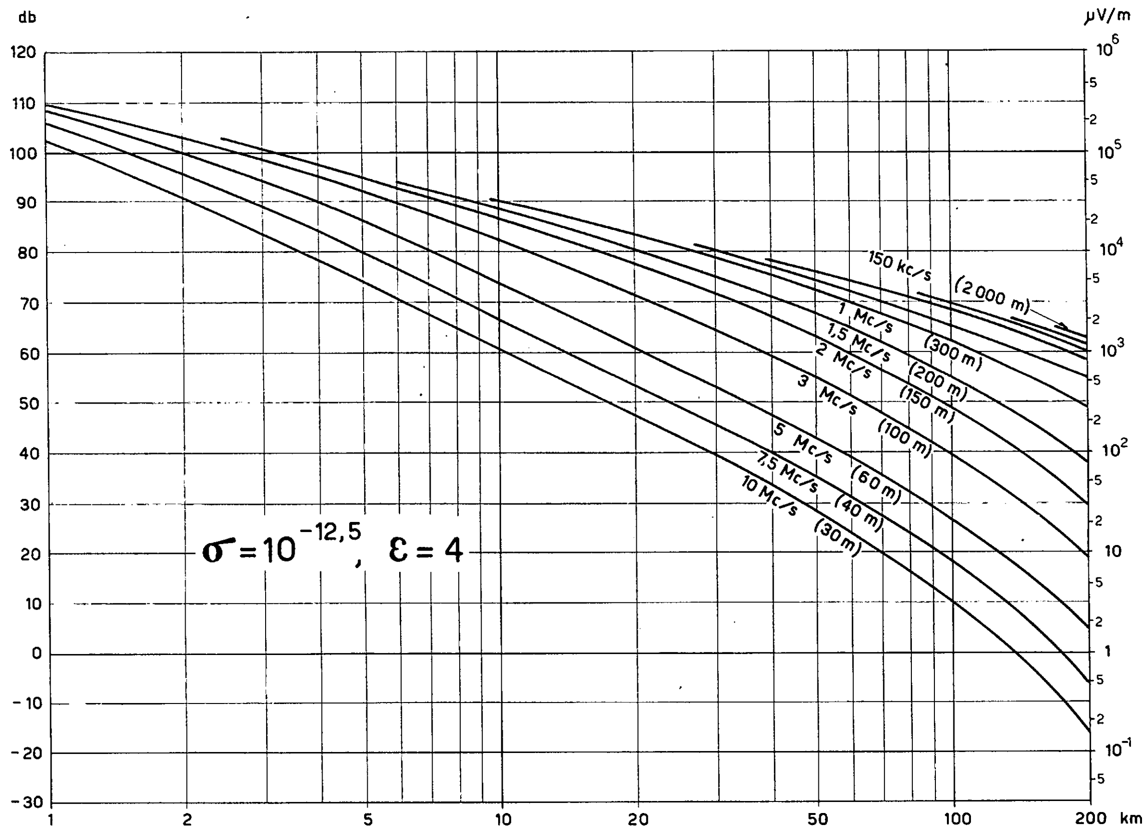
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$



Propagation over sea (conductivity $\sigma = 4 \times 10^{-11}$ e.m.u., dielectric constant $\varepsilon = 80$ e.s.u.)

PROPAGATION CURVES

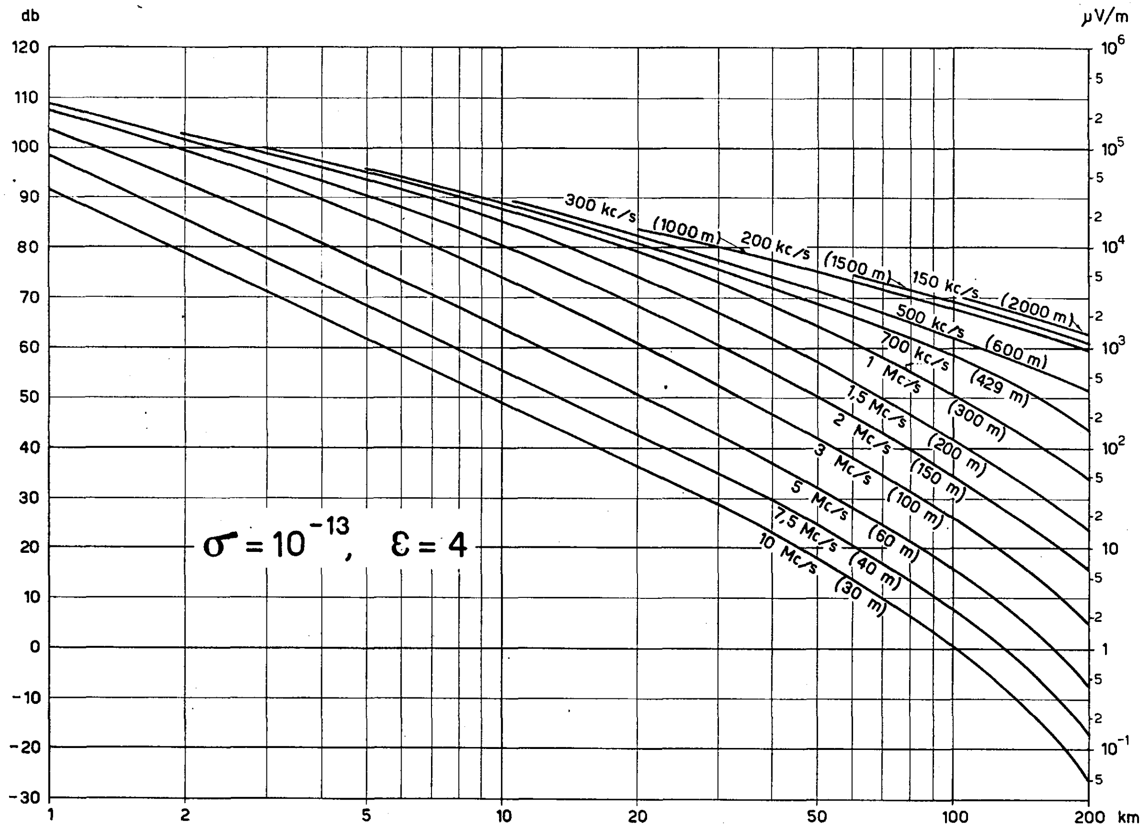
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ μV/m



Propagation over land (conductivity $\sigma = 10^{-12.5}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

PROPAGATION CURVES

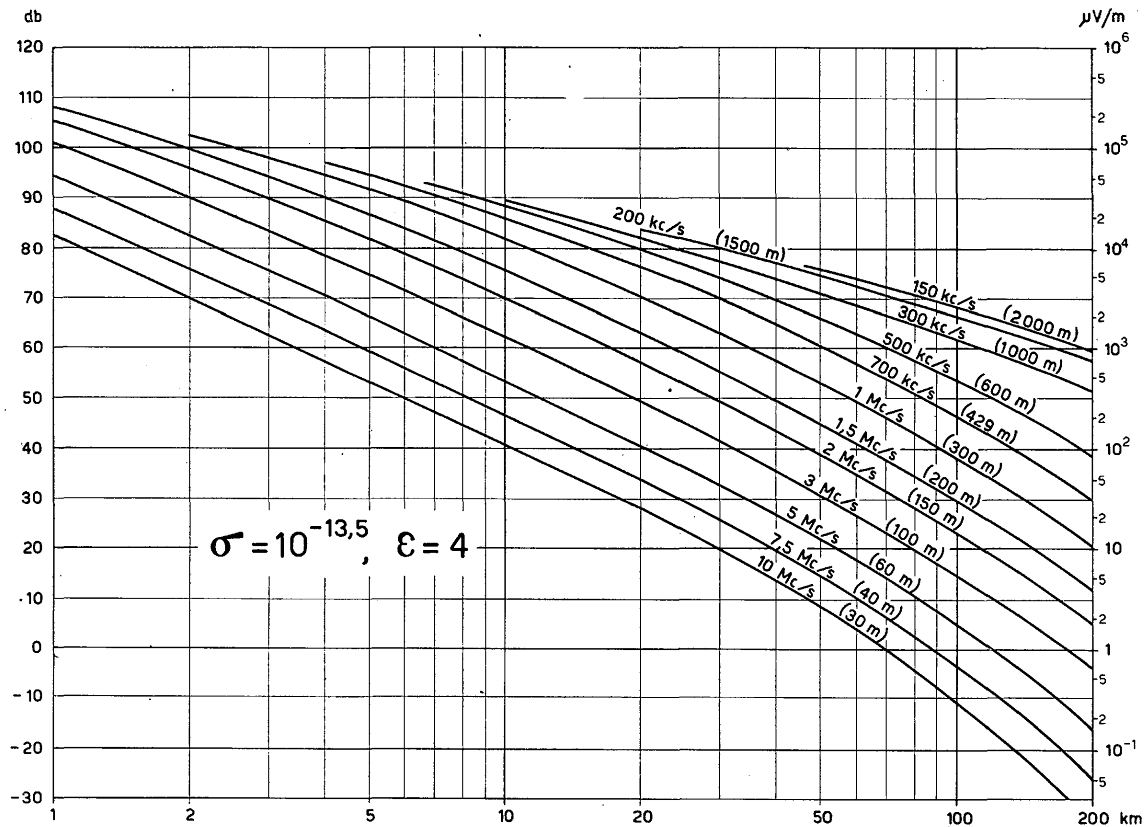
Groundwave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$



Propagation over land (conductivity $\sigma = 10^{-13}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

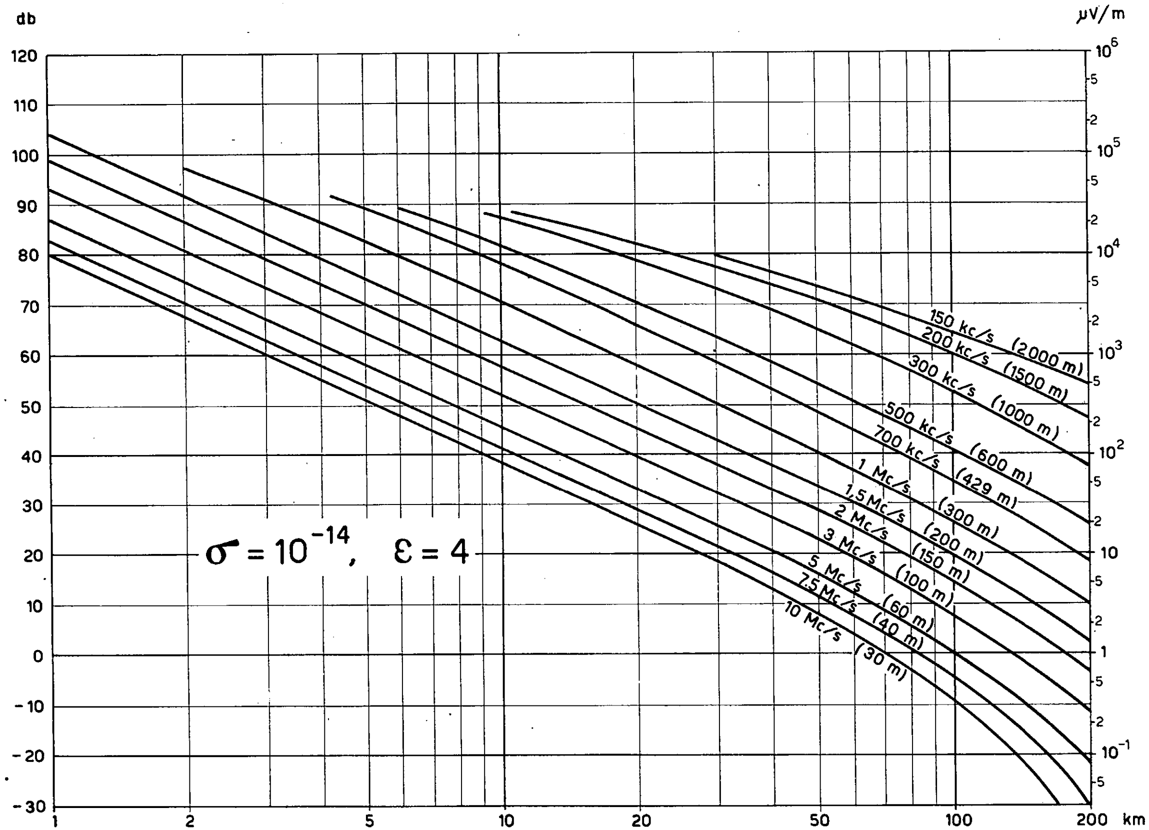
PROPAGATION CURVES

Groundwave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ μV/m



Propagation over land (conductivity $\sigma = 10^{-13.5}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

Groundwave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$



Propagation over land (conductivity $\sigma = 10^{-14}$ e.m.u., dielectric constant $\varepsilon = 4$ e.s.u.)

RECOMMENDATION No. 53

CHARTS FOR PREDICTION OF RADIO FREQUENCIES

(Recommendation No. 12)

The C.C.I.R.,

CONSIDERING :

That the accuracy of the routine frequency predicitions and the charts of ionization density over the world is now limited by the form of presentation of these charts and that it is important that prediction charts should be in a form convenient for practical use.

RECOMMENDS :

1. That each organization making prediction charts should exchange proposals for a better method of presenting the information available ;

2. That the participating organizations and agencies should consider the relative convenience to the organizations using predictions of radio frequencies of such alternative methods of presentation ;

3. That a desirable uniform scale for the present form of charts is one which utilizes a centimeter grid on which one centimeter represents ten degrees of latitude and fifteen degrees of longitude or one hour of time.

RECOMMENDATION No. 54

DEFINITIONS OF TERMS RELATING TO PROPAGATION IN THE TROPOSPHERE

(Recommendation No. 15)

The C.C.I.R.,

CONSIDERING :

That it is well known that the propagation of waves of frequencies greater than 30 Mc/s is greatly influenced by meteorological conditions in the troposphere,

UNANIMOUSLY RECOMMENDS :

That the list of definitions annexed hereto be adopted for incorporation in the vocabulary related to Recommendation No. 34.

Vocabulary of Terms used in Radio Propagation through the Troposphere

	Term	Definition
1.	*Troposphere*	The lower part of the earth's atmosphere extending upwards from the earth's surface, in which temperature decreases with height except in local layers of temperature inversion.
2.	*Tropopause*	The upper boundary of the troposphere, above which the temperature increases slightly with respect to height, or remains constant.
3.	*Temperature Inversion*	In the troposphere : an increase in temperature with height.
4.	*Modified Refractive Index*	For a given height above sea level : the sum of the refractive index of the air at this height and the ratio of this height to the radius of the earth.
5.	*Refractive Modulus*	One million times the amount by which the modified refractive index exceeds unity.
6.	M *Unit*	A unit in terms of which refractive modulus is expressed in accordance with the preceding definition.
7.	M *Curve*	A curve showing the relationship between refractive modulus and height above the earth's surface.
8.	*Standard Refractive Modulus Gradient*	That uniform variation of refractive modulus with height above the earth's surface which is regarded as a standard for comparison. The gradient considered as normal has a value of 0.12 M Units per metre (3.6 M Units per hundred feet).
9.	*Standard Radio Atmosphere*	For tropospheric propagation : an atmosphere having the standard refractive modulus gradient.
10.	*Standard Refraction*	The refraction which would occur in a standard radio atmosphere (See Fig. 1).
11.	*Super-refraction*	Refraction greater than standard refraction (See Fig. 1).
12.	*Sub-refraction*	Refraction less than standard refraction (See Fig. 1).
13.	*Standard Propagation*	The propagation of radio waves over a smooth spherical earth of uniform electrical characteristics under conditions of standard refraction in the atmosphere.
14.	*Tangential Wave Path*	In radio wave propagation over the earth : a path of propagation of a direct wave, which is tangential to the surface of the earth. The tangential wave path is curved by atmospheric refraction.
15.	*Radio Horizon*	The locus of points at which direct rays from the transmitter become tangential to the earth's surface.
16.	*Effective Radius of the Earth*	The radius of a hypothetical earth for which the distance to the radio horizon assuming rectilinear propagation is the same as that for the actual earth with an assumed uniform vertical gradient of refractive index. (For the standard atmosphere, the effective radius is $^4/_3$ that of the actual earth).
17.	*Tropospheric Radio Duct*	A stratum of the troposphere within which an abnormally large proportion of any radiation of sufficiently high frequency is confined and over part or all of which there exists a negative gradient of refractive modulus. The upper bounding surface is determined by a local minimum value of the refractive modulus. The lower bounding surface is either the surface of the earth or a surface parallel to the local stratification of refractive properties at which the refractive modulus has the same value as that at the local minimum value of the refractive modulus (See Figs. 2, 3 and 4).

Term	Definition
18. *Surface Duct* *Ground-based Duct*	A tropospheric radio duct having the earth as its lower boundary, and in which the modified refractive index is everywhere greater than the value at the upper boundary (See Figs. 2 and 3).
19. *Elevated Duct*	A tropospheric radio duct of which the lower boundary is an elevated surface at which the modified refractive index has the same value as at the upper boundary (See Fig. 4).
20. *Duct Thickness* *Duct Width*	The difference in height between the upper and lower boundaries of a tropospheric radio duct.
21. *Duct Height*	The height above the surface of the earth of the lower boundary of an elevated duct (See Fig. 4).
22. *Tropospheric Mode*	Any one of the possible modes of propagation in the troposphere.
23. *Trapped Mode*	A mode of propagation in which the energy is substantially confined within a tropospheric radio duct.

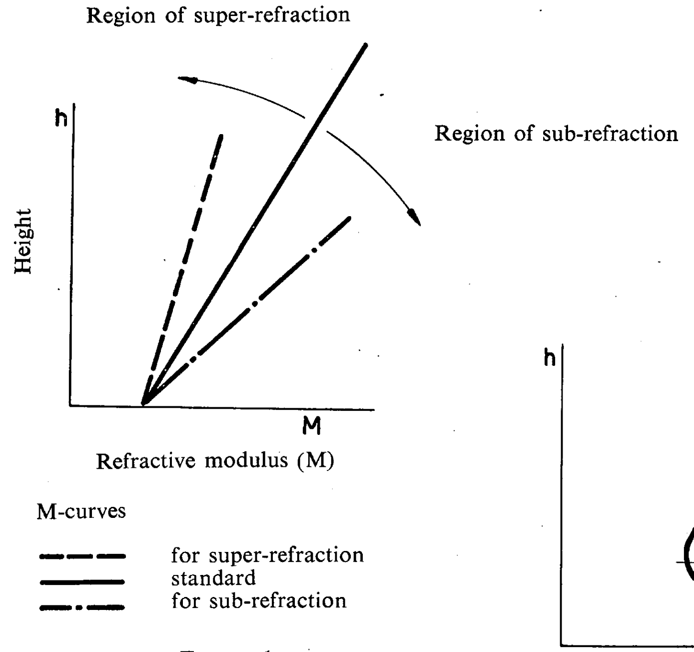
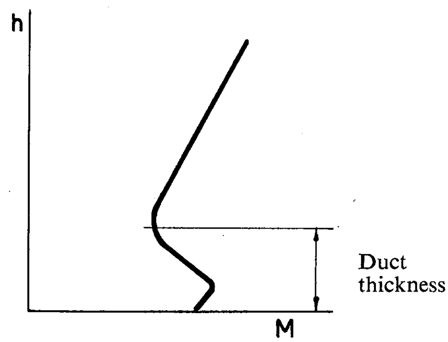
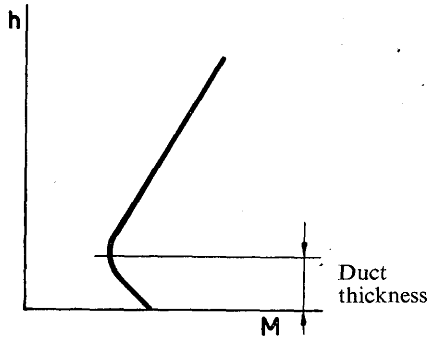


FIGURE 1



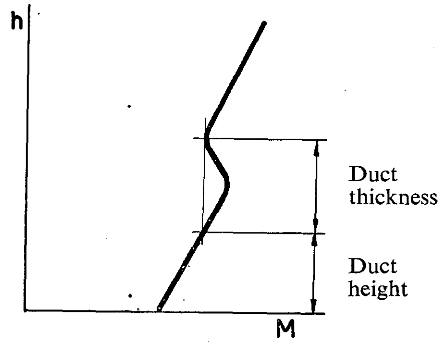
Surface duct

FIGURE 2



Surface duct

FIGURE 3



Elevated duct

FIGURE 4

RECOMMENDATION No. 55

TROPOSPHERIC WAVE PROPAGATION CURVES

(Question No. 7)

The C.C.I.R.,

CONSIDERING :

(a) That there is an urgent need for guidance to be given to engineers in the planning of services in the frequency band 30-300 Mc/s, in particular television and VHF broadcasting ;

(b) That a matter of great importance is the minimum distance of separation of stations working in the same or adjacent frequency channels required to avoid intolerable interference due to long distance tropospheric transmission ;

(c) That the annexed curves are based on the statistical analysis of a considerable amount of experimental data ;

RECOMMENDS :

That these curves be adopted for provisional use under the limited conditions stated in the annex.

ANNEX

The following points with regard to the curves should be noted :

a) As a matter of convenience they were prepared from the existing data of the U.S.A. and apply principally to the North-Eastern States, as this was justified by the satisfactory agreement between these data and the additional data supplied by the United Kingdom ;

(b) They refer only to locations where the average meteorological conditions are similar to those existing in the North-Eastern States of the U.S.A. and in the United Kingdom ;

(c) They give the field-strengths exceeded for 1% and 10% of the time respectively for a long period of continuous observation. Curves for higher percentages are not given as they would scarcely be of interest in the planning of a system based on common channel working. It should be borne in mind that all the data that exist on this subject show that for short periods of time (in general much below 1% of the over-all time) very high peak values of field strength may be attained. There are even occasions when these peak values are comparable with the free-space value.

(d) They should not be used for paths which lie wholly or partly over sea, as present experience suggests that under these conditions the field strengths may be considerably greater on the average than those given by the curves ;

(e) They apply only for distances greater than twice that of the radio horizon from the transmitter where the effects of different antenna heigths are found to be small ;

(f) They are referred to a radiated power of 1 kW from a short dipole several wavelengths above the ground ;

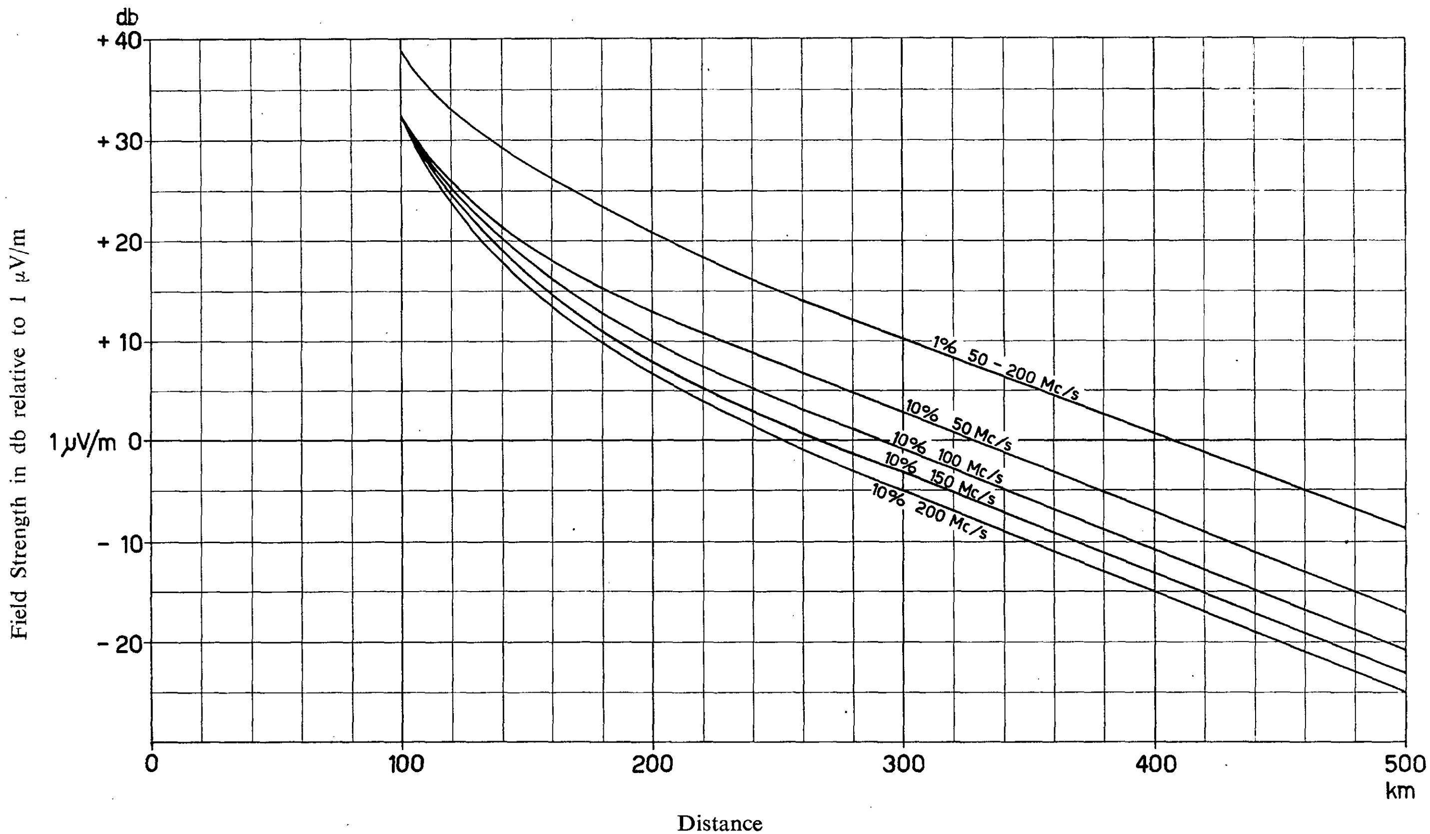
(g) They refer equally to horizontal and vertical polarisation ;

(h) They take into account to some extent the dependences of the field strength upon the irregularity of the terrain, as they include a statistical study of this dependence in only 50% of the locations in the geographical areas in which the data were obtained.

(i) They should be used in the knowledge that there is always a wide scatter about the mean values given, and they should therefore not be interpreted too precisely. In fact, each curve ought rather to be considered as a broad band with the curve as a mean value. On the other hand, the data show that in the case of the 10% curves there is a statistical dependence on frequency as indicated.

ESTIMATED TROPOSPHERIC FIELD-STRENGTH
EXCEEDED FOR 1% AND 10% OF THE TIME

Frequency Range 50-200 Mc/s
1 kW radiated from a half wavelength dipole. Vertical and horizontal polarization



RECOMMENDATION No. 56

THE RESERVATION OF FREQUENCIES FOR THE STUDY OF EXTRATERRESTRIAL RADIO NOISE

(Question No. 9)

The C.C.I.R.,

CONSIDERING :

(a) That study on solar radiation at radio frequencies and on galactic radio noise is being made in various countries throughout the world ;

(b) That this study is often impeded by very bad interference from radio transmitters and is therefore in urgent need of the reservation of a number of clear frequencies ;

(c) That at present different frequencies are used in different countries for the purpose ;

(d) That it is advisable to use the same frequencies throughout the world, from the point of view of economical frequency allocation, and that such frequencies should therefore be internationally reserved ;

(e) That scientific and technical observations made in such study are highly important from the point of view of international radio services ;

(f) That however, the problem of frequency distribution can be dealt with only by the Ordinary Administrative Radio Conference and by taking account of the requirements of all radioelectric services ;

RECOMMENDS :

1. That the attention of the various Administrations should be drawn to the desirability of reserving, where feasible, for the international study of solar radiation and of galactic radio noise, one particular exclusive frequency in each of several parts of the radio spectrum as set out below or, if this is not feasible, to the desirability of seeking regional agreements upon frequencies near these.

These frequencies should be :

	40	80	200	320	640	1280	and	3000 Mc/s	
with guardbands of	±20	25	140	500	1000	3000	and	3000 kc/s	respectively.

2. That, in preparation for the next Ordinary Administrative Radio Conference, the attention of the various Administrations should be drawn to the desirability of reserving one exclusive frequency at, or near, each of those named above, with the guardbands and for the purpose stated, provided that the requirements of all radioelectric services allow this to be done.

RECOMMENDATION No. 57

PRODUCTION AND REDUCTION OF IONOSPHERIC DATA: STANDARDS, SYMBOLS AND CONVENTIONS

(Recommendation No. 6)

The C.C.I.R.,

CONSIDERING :

(a) That experience in the use of the symbols and conventions for their use in the presentation of the results of ionospheric soundings given in the Annexes of Recommendation No. 6 of the Vth meeting of the C.C.I.R., and adopted simultaneously by the VIIIth meeting of the International Scientific Radio Union (U.R.S.I.), has already brought forth a number of revisions, as well as some new recommendation, by the IXth meeting of the U.R.S.I. ;

(b) That still further revisions and clarifications of these Annexes in the light of more recent experience with their use have become necessary (the meeting of the C.C.I.R. International Study Group 6 has already given some thought to revisions in Doc. No. 130 of Washington, as well as recognised in Doc. No. 144 of Washington the ultimate requirement for some new and less subjective way of obtaining pertinent information from ionospheric measurements) ;

(c) That some consolidation of the recommendations of the Vth meeting of the C.C.I.R. and the IXth meeting of the U.R.S.I. is indicated ;

(d) That it is wasteful of effort and productive of confusion for the symbols, conventions, and definitions to be debated and altered at consecutive meetings of the C.C.I.R. and the U.R.S.I. ;

(e) That the interchange of ionospheric data is of concern primarily to research organisations engaged in obtaining ionospheric data, and thus the standarisation of symbols and conventions can best be handled by a body such as the U.R.S.I. ;

(f) That the volume of data now in existence is so large, and is growing so rapidly that machine methods seem to be indicated for its study, processing, and storage ;

RECOMMENDS :

1. That the symbols and conventions for their use together with certain other matters of convention, as detailed in the seven attached Annexes, be adopted in the interchange of ionospheric data ;

2. That every effort be made to improve the quality and accuracy of ionospheric soundings as rapidly as the techniques can be developed or applied, in order to encourage the scientific analysis which is needed ;

3. That equipment for ionospheric soundings should preferably meet the following minimum requirements :

3.1 Peak power : 1 kW.

3.2 Frequency range : 1 Mc/s to 20 Mc/s.

3.3 Height range over which measurements are possible : 50 km to 1000 km.

3.4 Accuracy of calibration : 10 km in height, and 0.1 Mc/s in frequency.

3.5 Length of pulses : 100 microseconds or less.

3.6 Length of time for each observation :

— Automatic equipment : 2 minutes or less

— Manual equipment : 15 minutes or less.

These requirements should not be construed as suggesting that it is sufficient to record layer heights to the nearest 10 km and frequencies to the nearest 0.1 Mc/s, when it is both desirable and possible to be more accurate.

4. That the interchange of ionospheric characteristics should include :

4.1 Either tabulations of hourly observations by days for each month,

4.2 Or monthly median values for each hour, including as much as possible the median count,

4.3 Or both.

This recommendation should not be construed as precluding the interchange of monthly mean values of ionospheric characteristics, and in fact *mean* values (more suited to scientific studies) should be interchanged as well as *medians* (more suited to engineering studies) whenever the quality of the observations permits this ;

5. That ionospheric observations should be made at least once an hour, on the hour, using local mean time corresponding to the nearest or most convenient meridian of longitude from Greenwich which is an integral multiple of 15° ; this meridian is to be clearly specified when reporting the data ;

6. That, at least, data for foE, foF1, foF2, and (M 3000) F2 should be interchanged, and that in addition, when possible, data for fEs, h′E, h′F1, h′F2 and hpF2 should also be interchanged ;

7. That the Director of the C.C.I.R. should refer this subject, as embodied in this recommendation, together with its Annexes, to the President of the U.R.S.I. (with the understanding that the U.R.S.I. will not, in its pursuit of purely scientific parts of the subject, allow itself to lose sight of the engineering objectives of this work which are of concern to practical HF radio communication) in order that the inevitable future modifications and revisions may be undertaken henceforth exclusively by the U.R.S.I. ;

8. That the Director of the C.C.I.R. should draw the attention of the U.R.S.I. to the desirability of studying, and perhaps attempting, standardisation in machine techniques for the study, processing, storing and interchanging of ionospheric data.

ANNEX I

General Symbols

1.	f	frequency ;
2.	fo	ordinary-wave critical frequency ;
3.	fx	extraordinary-wave critical frequency ;
4.	fz	critical frequency corresponding to the lowest frequency branch of an h′f trace (see 13 below) showing triple splitting ;
5.	h′	virtual height (frequently prefixed to the designation of a layer to denote the minimum virtual height, i.e., the virtual height of a point on the trace at which the tangent is horizontal) ;
6.	hp	a height, derived from a parabolic fit to the “ nose ” of the curve of electron density distribution with height and based upon the observed h′f trace for a particular layer, which would represent the height of maximum ionisation if the electron density distribution were truly parabolic, and if there were no lower layers present. It is equal to the virtual height measured on the ordinary-wave branch at a frequency equal to 0.834 fo ;

7.	yp	the semi-thickness deduced from a parabolic fit to the " nose " of the curve of the electron density distribution with height and based on observed h′f trace for a particular layer ;
8.	MUF	maximum usable frequency ;
9.	d-MUF	maximum usable frequency for a path of some specified standard length d ;
10.	FOT	optimum traffic frequency (formerly optimum working frequency—OWF) ;
11.	LUF	lowest useful high frequency ;
12.	Md	maximum usable frequency factor for a path of some specified standard length d ;
13.	h′f	an observation displaying the virtual height h′ as a function of frequency f ;
14.	h′t	an observation displaying the virtual height h′ as a function of time for a specified fixed frequency.

It is now very nearly universal practice to specify quantities in the above list representing frequencies in megacycles per second, and to specify quantities representing height or distance in kilometres. Exceptions should always be clearly indicated, as for example the use of miles in symbols 9 and 12.

In the table above the abbreviations MUF, FOT and LUF should be left unaltered in sequence of letters when translated into various languages in order to preserve them as pronounceable words.

ANNEX II

Characteristics Most Commonly Observed or Derived from h′f Observations

1.	foE	ordinary-wave critical frequency for the E, E2 (see Remark 1), F1 and F2 layers respectively ;
2.	foE2	
3.	foF1	
4.	foF2	
5.	fxE	extraordinary-wave critical frequency for the E, E2, F1 and F2 layers respectively ;
6.	fxE2	
7.	fxF1	
8.	fxF2	
9.	fzE	critical frequency for the lowest frequency branch in the event of triple splitting for the E, E2, F1, and F2 layers respectively ;
10.	fzE2	
11.	fzF1	
12.	fzF2	
13.	fEs	highest frequency on which echoes of the sporadic type are observed from the lower part of the E layer ;
14.	fE2s	highest frequency on which echoes of the sporadic type are observed from the upper part of the E layer ; the distinction between the upper and lower parts of the E layer is purely one of apparent virtual height (apparent range of echo) and should be based on station experience ; 140 km has been chosen by some stations to represent this distinction ;
15.	fbEs	the lowest frequency at which echoes from the F layer are observed when sporadic echoes from any height in the E layer are of the intense or blanketing type ;
16.	fmin	that frequency below which no echoes are observed ;
17.	h′E	minimum virtual height on the ordinary-wave branch for the E, E2, F1 and F2 layers respectively ;
18.	h′E2	
19.	h′F1	
20.	h′F2	
21.	h′Es	minimum virtual height of Es echoes (see 13 above) ;

22.	h′E2s	minimum virtual height of E2s echoes (see 14 above) ;
23.	hpF2	virtual height of the F2 layer measured on the ordinary-wave branch at a frequency equal to 0.834 foF2 ;
24.	ypF2	semi-thickness of the F2 layer deduced from a parabolic fit to the " nose " of the curve of the electron density distribution with height and based on the observed h′f trace ;
25. 26. 27.	E-d-MUF F1-d-MUF F2-d-MUF	maximum usable frequency for a path of some specified standard length d for transmission by the E, F1 and F2 layers respectively ;
28. 29. 30.	(Md) E (Md) F1 (Md) F2	maximum usable frequency factor for a path of some specified standard length d for transmission by the E, F1 and F2 layers respectively.

It is now very nearly universal practice to specify quantities in the above list representing frequencies in megacycles per second, and to specify quantities representing height or distance in kilometres. Exceptions should always be clearly indicated, as for example the use of miles in symbols 25 to 30 inclusively.

It should be remarked that all symbols of the above list should be written, on a straight line, i.e., superscripts and subscripts are no longer to be used.

Remark I. — In the event that clear stratification is evident below the F1 layer and above the regular E layer, care has to be taken to distinguish among stratification in the normal E layer, existence of an E2 layer, and stratification at the bottom of the F1 layer. As a rough guide, in order to classify a layer as E2, it is thought that with equipment having high resolution, the E2 trace will be isolated in height from the traces of the layers above and below, or that generally it should be situated between virtual heights of 140 and 190 km. These latter limits are subject to adjustment according to the experience at each station.

Remark II. — Understanding of the processes which give rise to echoes of the sporadic type from the E layer is still largely lacking. There have been cases reported in which sufficient retardation, and also change in echo intensity, has been observed to suggest the possibility of using such symbols as foEs and fxEs. Cases have also been observed of Es echoes at virtual heights above about 140 km. These have been designated as E2s (see 14 above).

Remark III. — In the region of the h′f trace identified with the critical frequency of the F1 layer, it is noted that the tangent to the trace is seldom vertical. It would appear, therefore, that quantities recorded as critical frequencies of the F1 layer must not be regarded in the same way as the critical frequencies of the F2 layer. As a guide for assigning numerical values for foF1, fxF1 and fzF1, it is probably sufficient to require that a horizontal tangent exist to the trace of the higher layer, if present. In cases where there is, nevertheless, no sharp discontinuity or cusp in the h′f trace, guidance should be sought in the multiple traces, if present.

ANNEX III

Qualifying Symbols

1.	( )	Individual observed values thus enclosed are considered doubtful. The reason for doubt should be specified by an appropriate descriptive symbol (see Ann. IV) or by a footnote.
2.	[ ] or / /	Individual numerical values thus enclosed represent interpolations rather than observations. The reason for the interpolation should be specified by an appropriate descriptive symbol (see Ann. IV) or by a footnote.
3.	> or D	This symbol when it stands before a number means greater than.
4.	< or E	This symbol when it stands before a number means less than.

In 3 and 4 above the letters D and E have been chosen for use with a typewriter. They can be easily remembered because of their resemblance in meaning to the symbols D and E of Ann. IV (the latter always replace a numerical value). High grade observing stations will have relatively little use for these four qualifying symbols. The symbols are nevertheless given in order to encourage the maximum possible salvage of results from imperfect observations.

Note Concerning Interpolation. — In the hourly tabulations of ionospheric characteristics it is considered desirable to replace missing numerical values by interpolated values whenever possible. As a general rule no missing value should be replaced by an interpolated value if the interpolation must be performed between observed values separated by more than two hours in time. The matter of interpolation is given further attention in Ann. IV.

ANNEX IV

Descriptive Symbols

A letter symbol from the following list, when used to qualify a numerical value, always stands after the numerical value.

	Symbol	Definition
1.	A	characteristic not measurable because of blanketing by Es or by E2s ;
2.	B	characteristic not measurable because of absorption either partial or complete, and probably non-deviative in type ;
3.	C	characteristic not observed because of equipment or power failure ;
4.	D	characteristic at a frequency higher than the normal upper frequency limit of the equipment (see item 3, Ann. III) ;
5.	E	characteristic at a frequency lower than the normal lower frequency limit of the equipment (see item 4, Ann. III) ;
6.	F	spread echoes present ;
7.	G	*(a)* F2-layer critical frequency equal to or less than F1-layer critical frequency ;
		(b) no Es (or E2s) echoes observed though regular E (or E2) layer echoes are present (i.e., a symbol for daytime usage) ;
8.	H	stratification observed within the layer ;
9.	J	ordinary-wave characteristic deduced from measured extraordinary-wave characteristic ;
10.	K	ionospheric disturbance in progress (this is always applied to a series of hourly values, never to an isolated value) ;
11.	L	*(a)* F1-layer characteristic omitted or doubtful because no definite or abrupt change in slope of the h′f curve is observed either for the first reflection or any of the multiples (Remark 3 of Ann. II applies) ;
		(b) h′F2 omitted because the F2-layer trace is continuous with the F1-layer trace and without a point of zero slope ;
12.	M	characteristic not observed because of some failure or omission on the part of the operator, rather than owing to any mechanical or electrical fault in the equipment or its power supply ;
13.	N	nature of the record is such that the characteristic cannot readily be interpreted ;

	Symbol	Definition
14.	P	trace extrapolated to critical frequency (it is unnecessary to use this letter for small extrapolations of one or two per cent, but use should be made of symbol 3 of Ann. III if the extrapolation leads to a critical frequency which exceeds the last observed point on the trace by more than five per cent) ;
15.	Q	distinct layer not present (this symbol is intended to apply to daytime layers only and should be used in the hour columns at the beginning and end of the daylight period to fill empty spaces in those columns where one or more numerical values exist—it should not be used in hour columns where no numerical values exist because of darkness—these columns may be left blank) ;
16.	S	characterictic obscured by interference or by atmospherics ;
17.	T	loss or destruction of successful observations ;
18.	U	hp or yp not measurable, for instance, because ordinary-wave trace has horizontal tangent at or above the frequency 0.834 fo ;
19.	V	trace forked near critical frequency ;
20.	W	characteristic at a virtual height greater than the normal upper height limit of the equipment ;
21.	Y	Es (or E2s) trace intermittent in frequency range—very short pieces of trace at the high-frequency end should be ignored since they may be presumed to be due to shortlived echoes ;
22.	Z	third magneto-ionic component of the h′f trace is observed.

For nearly all purposes enough symbols have been provided to make it unnecessary to leave any blank spaces in the monthly tabulations of hourly values. In the event that no symbol should be found to be entirely satisfactory a suitable footnote should be given. Blank spaces in the tabulation sheets will therefore be taken to indicate that no observation was scheduled at the given hour (note the exception contained in 15 above).

It should be noted that many occasions will arise when more than one letter symbol is appropriate to describe the circumstances of a particular observation. In these cases the most important symbol should be placed first. The use of more than one symbol should be held to a minimum.

Notes on the Use of the Descriptive Symbols

1. The following descriptive symbols are used only in place of an observed numerical value :

C D E G M N Q T U and W

2. The following descriptive symbols may be used either in place of, or to qualify an observed numerical value :

A B F L and S

3. The following descriptive symbols may be used only to qualify an observed numerical value :

H J K P V Y and Z

4. Certain of the descriptive symbols when used in place of an observed numerical value have the same force as an actual number when medians are taken, and should therefore be included in the median count in the manner made appropriate by their definitions. It should be noted, however, that if half or more of the observations are represented by these symbols, it may be found that the median can only be indicated as greater than or less than the numerical value of the limitation represented. These symbols are :

D E G and, when it replaces a height characteristic, W

5. When an observed numerical value has been replaced with certain of the descriptive symbols, it is frequently permissible to enter an interpolated value (See discussion of interpolation practice in Ann. III). Such symbols, when they qualify the interpolated value, are :

A B C F L M N S T and U

6. When an observed numerical value is indicated as doubtful by the use of parentheses, the reason for doubt should always be indicated. The following descriptive symbols are often used to provide the explanation :

A B F H J K L P and S

ANNEX V

Median Values, Median Counts, Conventions for Determination of Median Values of Ionospheric Characteristics

1. Definitions

1.1 For a set consisting of an odd number of numerical values, the median value is the middle value of the set when its members are arranged in order of size ;

1.2 For a set consisting of an even number of numerical values, the median value is the arithmetic mean of the two middle values of the set when its members are arranged in order of size ;

1.3 For a set of numerical values, the median count is the number of numerical values in the set ;

2. Conventions

2.1 *Rounding off.* — A median value found according to 1.2 above should contain no more significant places than an individual member of the set. Therefore, rounding off, for example, to the nearest even digit in the last place may at times be necessary ;

2.2 *Use of Certain Descriptive Letter Symbols as Numerical Values for Purposes of Finding a Median Value.* — This matter is discussed in Ann. IV under note 4 on the usage of the descriptive symbols. The letter symbols which have the force of numerical values are : D, E, G and when it replaces a height characteristic, W.

2.3 *Use of Figures indicating a limiting value only.* — Hourly measurements which can be recorded only as greater than or less than some specified limiting value (i.e., involving the use of symbols 3 or 4 of Ann. III) may often have the force of unqualified numerical measurements and should contribute to the determination of the median. Judgement must be exercised, however, when using observations qualified in this manner to insure that the resulting median is not systematically displaced in an unrepresentative manner.

2.4 *Doubtfulness of Monthly Median Values.* — The degree of doubtfulness of a monthly median value is best measured by the number of values on which the median is based. These numbers ought to be published or indicated together with the median values.

ANNEX VI

Standard Transmission Curve

The international standard 3000 km transmission curve used for obtaining (M3000) F2, as adopted in 1944 by the International Radio Propagation Conference at Washington, is defined by the following table, which gives the corrected secant ϕ_0 factors for the standard 3000 km transmission curve.

Height in km	Factor
200	4.55
250	4.05
300	3.65
350	3.33
400	3.08
500	2.69
600	2.40
700	2.20
800	2.04

ANNEX VII

New Descriptive Terms

The following descriptive terms are coming into use :

1. *Ionosonde:* equipment which is employed in making ionospheric measurements.
2. *Ionogram:* the record of an ionospheric sounding.

RECOMMENDATION No. 58

PULSE TRANSMISSION AT OBLIQUE INCIDENCE

(Recommendation No. 9)

The C.C.I.R.,

CONSIDERING

Points 1 and 2 of Recommendation No. 9 ;

RECOMMENDS :

1. That a Working Group, formed of some of the members of the Study Group on ionospheric propagation, serve in the period between this and the next Plenary Assembly of the C.C.I.R. as an interim body in order to start the co-ordination of pulse transmission tests and to set up schedules between organisations who are able to do so at present.

   Supplementing the direct exchange of information among the members of this Working Group and interested organisations, the Chairman of the Working Group shall forward to the Director of the C.C.I.R. all information as it becomes available, in order for him to transmit it promptly to the other members of Study Group on propagation.
   The Director of the C.C.I.R. shall request publication of these results in *Le Journal des Télécommunications,* the *Information Bulletin of the U.R.S.I.,* etc.

2. That this Working Group distribute to its various members and to such other members of the Study Group on ionospheric propagation as are interested, and who request it, the following information on pulse tests :
   — originating organisation and persons to contact for further information,
   — operating frequency,
   — geographical location of transmitting antenna,

— whether a directive antenna is used and if so the approximate direction of the main lobe,
— nominal power,
— pulse repetition rate,
— schedules and probable duration of tests, with time expressed as Greenwich Civil Time (Universal Time).

3. That this Working Group provide for co-ordinating these tests with those pertaining to other recommendations or questions of the C.C.I.R., as far as they may give results of value for the study of these recommendations and questions ;

4. That in practice the following kinds of transmitters be made available for these tests ;
— transmitters operated by research organisations or installed at ionospheric sounding stations ;
— fixed-service transmitters ;
— broadcast transmitters.

RECOMMENDATION No. 59

EXCHANGE OF INFORMATION FOR THE PREPARATION OF SHORT-TERM FORECASTS AND THE TRANSMISSION OF IONOSPHERIC DISTURBANCE WARNINGS

(Recommendations Nos. 11, 13 and 16)

The C.C.I.R.,

CONSIDERING :

(a) That it is important to give Administrations and operating services (navigation and other services) using ionosphere-propagated waves the earliest possible warning of the onset of disturbances to ionospheric propagation conditions, so that they may arrange their traffic schedules accordingly ;

(b) That it is desirable to find an easier method of drawing up a plan for the rational use of frequencies in place of the system based on long-term mean values, when the latter is temporarily unsatisfactory on account of ionospheric disturbances ;

(c) That it would therefore be advisable for all organizations publishing ionospheric forecasts to study the technique of forecasting disturbances ;

(d) That it is of great importance to take steps to secure the greatest possible accuracy of such forecasts and the maximum of speed in their dissemination ;

(e) That, for the exchange and dissemination of propagation information, there are three categories of users : those who make forecasts, those who make operational use of propagation information, and those who require the information for scientific research or other purposes ; and that, to meet these different requirements, it is desirable to use the most appropriate methods of exchange in each case ;

(f) That collaboration is desirable between Administrations or operating services and the organizations studying the characteristics of the ionosphere and deducing forecasts therefrom, with a view to checking the accuracy of the forecasts periodically ;

(g) That provisional codes, prepared by the International Radio Scientific Union (U.R.S.I.) such as the code used in French ursigrams, or due to organizations such as the Central Radio Propagation Laboratory (C.R.P.L.), the Arbeitsgemeinschaft Ionosphäre, the Japanese Central Propagation Laboratory and others, have proved their usefulness in the dissemination of information for the preparation of short-term forecasts ;

RECOMMENDS :

1. That each country participating in radio propagation research should designate an official agency for the reception, coordination and exchange of such data and for liaison with corresponding agencies in other countries ;

2. That the information required for the preparation of short-term forecasts should be centralized by the agencies mentioned in § **1**, as far as possible by the most direct electrical means of communication between the centralizing agency and the various scientific institutes for solar, magnetic and other observations ;

3. That, of the data thus assembled, those which are of use for forecasting within 48 hours should be disseminated in accordance with the U.R.S.I. decisions by suitable available communication channels ;

4. That the other data, of use for the improvement of forecasting technique in general and for other purposes, should be disseminated by ordinary post or airmail ; if they deem it of use for the organization of regional forecasts or for scientific research, interested Administrations may organize alone or preferably collectively after centralization of information, the dissemination of detailed information by radio ;

5. That certain short, but regular, transmissions, giving short-term warnings of ionospheric disturbances, should be effected by long range radio stations ;

6. That the attention of the U.R.S.I. should be drawn to the advantages of the fullest possible standardization of the codes to be used either for the short warnings mentioned in § **5**, or for the exchange of the limited information mentioned in § 3 or the general information mentioned in § **4** ;

7. That Administrations should be invited to conform to the resulting codes and to make them known to their operating services ;

8. That the Administrations should invite these services, together with operating agencies to study the accuracy of the forecasts, to submit records and to make any suggestions which might assist the studies undertaken to improve the methods used ;

9. That special attention should be paid to the comparison between the forecasts and the actual behaviour of radio circuits ; it is particularly desirable that Administrations should adopt identical methods of assessing the quality of the circuits by using a suitable classification ;

10. That it is also desirable that a common method should be adopted to describe ionospheric perturbations, taking account of such factors as : starting time, zone affected, duration and importance of the perturbation.

RECOMMENDATION No. 60

BEST METHODS FOR EXPRESSING THE FIELD STRENGTH OF UNMODULATED CONTINUOUS WAVE TRANSMISSIONS

(Question No. 8, § A.1a)

The C.C.I.R.,

CONSIDERING :

(a) That the field strength which is most easily measured is that of a stable plane wave of linear polarization and constant amplitude ;

(b) That fields to be measured are in practice usually composed of several waves ;

(c) That field strengths to be measured generally vary as a function of time ;

(d) That a single component of the resultant field is generally used but that one or several other components may also be present ;

UNANIMOUSLY RECOMMENDS :

1. That a field at a given point due to a stable plane wave of linear polarization and constant amplitude be expressed :

1.1 In respect to intensity,

1.1.1 For frequencies below 300 Mc/s by the RMS value of the electric vector in volts (or submultiples) per metre,

1.1.2 For frequencies higher than 3000 Mc/s by the power flux of the Poynting vector in watts (or submultiples) per square metre,

1.1.3 For frequencies between 300 and 3000 Mc/s by either of these two quantities ;

1.2 In respect to direction, by the direction of the electric vector ;

2. That a complex field of constant strength be represented by the component or components to be studied. The variation of the apparent field strength as a function of the orientation of the antenna constitutes a first element of practical information on the complexity of the field ;

3. That a complex field, the strength of which varies in time, be represented by recordings of the component or components to be studied. These recordings should be made with a time constant adapted to each case, with a view to ascertaining, according to practical requirements, the average strength of the field and the percentages of time during which it exceeds certain values.

RECOMMENDATION No. 61

BEST METHODS FOR EXPRESSING THE FIELD STRENGTH OF MODULATED CONTINUOUS WAVE TRANSMISSIONS

(Question No. 8, § A.1b)

The C.C.I.R.,

CONSIDERING :

(a) That this question should be confined to classical amplitude modulation, since for purposes of field strength measurement a frequency-modulated wave can be considered as an unmodulated continuous wave, and telegraph modulation can be regarded as a particular case of pulse transmission ;

(b) That satisfactory processes and apparatus for field strength measurement have been evolved and are well known for this type of transmission ;

(c) That in the large majority of field strength measurement processes use is made of the observation of a rectified current ;

UNANIMOUSLY RECOMMENDS :

1. That the field produced by a modulated continuous wave transmission can normally be satisfactorily measured by a field strength measuring apparatus provided that the linearity of the apparatus is adequate ;

2. That to allow for certain special cases such as overmodulation of the transmitter or carrier amplitude variation with modulation, it is desirable to make the measurement during the absence of modulation in order to measure the normal field strength of the carrier.

Note. — The case of overmodulation or of carrier amplitude variation with modulation is of importance from the point of view of monitoring and control, and should be the object of further studies.

RECOMMENDATION No. 62

BEST METHODS FOR EXPRESSING FIELD STRENGTH FOR PULSE TRANSMISSIONS

(Question No. 8, § A.1c)

The C.C.I.R.,

CONSIDERING :

(a) That the characteristics of the field of a pulse-modulated transmission include the peak amplitude, the repetition rate, the shape of the pulse and the type of transmission ;

(b) That the relative importance of these various quantities depends on the objectives of the measurement, but that the most characteristic quantity is nevertheless the peak amplitude ;

(c) That the pulse shape may be altered by propagation phenomena ;

(d) That the measurement of pulse field strengths will in principle involve the use of all the equipment required for the measurement of fields produced by continuous wave transmissions, with certain parts of the equipment modified or other equipment added in view of the special operating conditions necessitated by pulse modulation ;

(e) That corrections may be necessary because of limited bandwidth and detector characteristics of the measuring equipment ;

UNANIMOUSLY RECOMMENDS :

1. That the field strength produced by pulse transmissions be represented by the value of the peak amplitude, normally disregarding transient peaks (spikes). If necessary, these should be considered separately ;

2. That in the special case of amplitude-modulated pulses the field strength should be represented by the average of the peak amplitudes taken over an interval long compared with the periodicity of the modulation ;

3. That the measurements should include determination of the shape, the repetition rate, and other characteristics of the pulses ;

4. That apparatus for measuring and determining pulse charactistics be developed ;

5. That a cathode-ray oscilloscope be included as a part of any pulse field strength measuring equipment ;

6. That the bandwidth of the receiving equipment be large enough to reproduce the general form of the pulse.

RECOMMENDATION No. 63

BEST METHODS FOR EXPRESSING FIELD STRENGTH FOR REDUCED CARRIER TRANSMISSIONS

(Question No. 8, § A.1d)

The C.C.I.R.,

CONSIDERING :

(a) That the field strength of a reduced carrier transmission in a given place depends among other factors on :

1. the type of transmission,
2. the magnitude of the independent side bands, relative to the carrier ;

(b) That in current practice the maximum nominal power and distortion of a channel may at times be exceeded during a transmission ;

(c) That the power of the carrier is the only constant element during transmission but that there is nothing to prevent the carrier from being adjusted to a level different from normal nor is there anything to prevent the channels from having different maximum nominal powers ;

(d) That consequently the field strength of such a transmission cannot be satisfactorily represented by the field strength of its carrier nor can it represented by the field strength of any one of the channels without a detailed description of the condition of operation of the channel ;

(e) That for a reduced carrier transmission there exists for each channel a peak field produced when the transmitter is delivering to this channel its maximum nominal power ;

(f) That the peak field strength so defined represents the field strength of this transmission for the channel under consideration and that complete representation of the transmission necessitates knowledge of the peak field strength for each channel ;

UNANIMOUSLY RECOMMENDS :

That the field strength produced by a reduced carrier transmission be represented by the maximum peak field strength, and also by the average of the peak field strengths, taken over an interval long enough to include a sufficient number of peaks of maximum modulation, for

1. each channel operating separately ;
2. all channels simultaneously in normal operation.

Notes. — The measurement of the field strength for reduced carrier transmission needs in principle the cooperation of the station being measured. It is desirable but not indispensable that during the measurement the station should transmit in the channel being measured a single modulating frequency selected near the centre of the band allotted for the channel.

RECOMMENDATION No. 64

FIELD STRENGTH MEASUREMENT (Types of Wave Collector and Equipment for Use in Each Frequency Band)

(Question No. 8, § A.3)

The C.C.I.R.,

CONSIDERING :

(a) That the effective length of a loop antenna whose dimensions are small compared with the received wavelength is easily calculable ;

(b) That the effective length of a doublet, sufficiently far from the ground, or of a stub-antenna *, is calculable ;

(c) That the effective length of the more complex directional antenna arrays cannot be calculated accurately ;

(d) That the field strength measurement apparatus commonly in use is composed essentially of a wave collector and a radio-frequency voltmeter ;

UNANIMOUSLY RECOMMENDS :

1. That the following wave collectors be used for the measurement of field strengths stronger than a few microvolts per meter :

- between 10 kc/s and 30 Mc/s, loop or stub-antennas * (it is possible to use loops up to about 100 Mc/s) ;
- above about 30 Mc/s, doublets, or stub-antennas *, or loop antennas up to about 100 Mc/s ;
- above about 1000 Mc/s, more complex directional wave collectors ;

2. That for the measurement of field strengths below a few microvolts per meter the more complex directional antenna arrays be suitably calibrated and used, with due care in orientation of the wave collector for the component of the field being measured ;

3. That in some cases, if so desired, the receiving equipment in use or available may be transformed into field strength measurement equipment by the addition of reference standards of voltage and indicators, and the use of suitable calibration methods.

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* The term stub-antenna is used to denote a single-conductor antenna of a length considerably shorter than a quarter of a wavelength. It is to be noted that longer single-conductor antennas may be used effectively to measure weak field strengths.

RECOMMENDATION No. 65

FIELD STRENGTH MEASUREMENT
(Desirable and attainable Accuracy of Field Strength Measurement for each Frequency Band)

(Question No. 8, § A.4)

The C.C.I.R.,

CONSIDERING :

(a) That the attainable accuracy of measurement of field strength depends on the design of equipment, carefulness of installation and use, location of measuring sites, conditions under which the measurements are made, and the skill of the operator ;

(b) That the principles of field strength measurement have remained unchanged since the Vth Plenary Assembly of the C.C.I.R., but that equipment is gradually being improved in range, accuracy and convenience of operation ;

(c) That the principal instrument error is caused by inaccuracy in voltage measurement over a wide range of voltage ;

(d) That portable field strength measuring equipment covers a smaller voltage range and is less stable than that at fixed installations ;

(e) That the degree of accuracy needed at present can be obtained, but only by the use of costly, complex and non-portable equipment ;

UNANIMOUSLY RECOMMENDS :

1. That more stable and less complex portable field strength measuring equipment should be developed, in order to increase the attainable accuracy of such measurement in each frequency band ;

2. That the accuracy of measurements on unmodulated continuous wave transmissions now attainable in normal operation using present-day portable equipment is probably somewhat better than shown in Table I, taken from the proposals submitted to the Vth Plenary Assembly of the C.C.I.R., Stockholm, 1948, as published by the General Secretariat of the I.T.U., Geneva, 1949, page 263 ;

Table I

Frequency-band	Accuracy of measurement (db)	Minimum field strength at which this accuracy is obtained (μV/m)
10-30 kc/s	± 2	10
30-300 kc/s	± 2	5
300-3000 kc/s	± 2	2
3-30 Mc/s	± 2	2
30-300 Mc/s	± 3	5
300-3000 Mc/s	± 5	50
3000-30000 Mc/s	± 5	10*

* 10 μV/m corresponds approximately to 2.7×10^{-13} watts/sq. m.

3. That a study be made to discover the accuracy requirements for field strength measurements for various purposes such as communications, control, and scientific and industrial applications. A number of these require accuracies greater than those shown in Table I. ;

4. That field strength measuring equipment should be so designed and operated that the accuracy of measurement will be limited principally by the accuracy of the voltage measuring device ;

5. That in reporting the results of field strength measurements, the estimated accuracy of the measurements should always be given.

RECOMMENDATION No. 66

FIELD STRENGTH MEASUREMENT
(Influence of Local Conditions on Interpretation and Accuracy of Measurements of Field Strength)

(Question No. 8, § A.5)

The C.C.I.R.,

CONSIDERING :

(a) That the influence of local conditions on the measurement of field strengths is a variable factor ;

(b) That the most satisfactory site for field strength measurements is one clear of buildings, flat and homogeneous over a wide area and to a sufficient depth, without trees, wire lines, antennas or buried conductors ;

(c) That the field strength in a place which does not fulfil the above conditions may vary greatly from one point to another ;

(d) That the nature of the soil in the neighbourhood of the measuring place will affect the measurements ; its influence depends also on the angle of arrival of the waves ;

UNANIMOUSLY RECOMMENDS :

1. That sites for field strength measurements should, whenever possible, be clear of obstructions and non-uniformity of ground ;

2. That measurements should be accompanied by :

2.1 A description of the equipment and method used, with an assessment of the accuracy obtained ;

2.2 A description of the measurement site, with details of any obstructions in the vicinity regardless of direction (buildings, overhead wires, cables, trees, cliffs, railways, roads, stretches of water, waterways, etc.) and details of any buried conductors or non-uniformity of the ground ;

2.3 Values of the conductivity and dielectric constant of the soil, or, failing this, information on the nature of the ground and its moisture ;

3. That, whenever possible, the variations of the field strength around the measurement site be investigated by means of numerous measurements at different locations on the site ;

4. That organizations engaged in field strength measurements conduct systematic experiments to determine under what conditions reliable field strength measurements can be made at various locations.

RECOMMENDATION No. 67

ATMOSPHERIC NOISE DATA

(Question No. 10)

The C.C.I.R.,

CONSIDERING :

(a) That Report No. 5 of the U.S. Army Signal Corps Radio Propagation Unit is considered to be the most useful document at the present time giving information on atmospheric noise levels throughout the world, although more reliable information exists for specific locations ;

(b) That the predicted noise levels given in this report may be in error by amounts ranging from 5 to 20 db under certain conditions ;

(c) That this Report is based on several kinds of observations taken at points not uniformly distributed over the world ;

RECOMMENDS :

1. That continued but cautious use should be made of the data in this publication and in the other publications mentioned in C.C.I.R. Report No. 8 ;

2. That in order to derive greater use from publications on atmospheric noise in the future, the necessary steps should be taken to verify and amplify them with any data that may become available.

RECOMMENDATION No. 68

ALLOWANCES FOR FADING

(Question No. 15)

The C.C.I.R.,

CONSIDERING :

(a) That sufficient results have not yet been obtained from independent sources, in pursuance of the study programme proposed in Question No. 14, for a definite answer to be given to the various questions set in the text of Question No. 15, but that certain figures have nevertheless been proposed ;

(b) That figures are urgently needed in reply to Question No. 15, for instance concerning the simultaneous use of one frequency by more than one transmitter ;

RECOMMENDS :

That the numerical results of Question No. 15 contained in Doc. Nos. 79 and 215 of Geneva, and in Doc. Nos. 43, 47 and 138 of Washington, should provisionally be adopted as a guide, pending the results of subsequent study.

RECOMMENDATION No. 69

PREDICTION OF SOLAR INDEX

(Question No. 45)

The C.C.I.R.,

CONSIDERING :

(a) That it is desirable to have an internationally agreed prediction of smoothed relative sunspot numbers for about six months in advance, as reflected by Question No. 45, proposed by the International High Frequency Broadcasting Conference, Florence-Rapallo ;

(b) That it is impracticable at present to obtain complete agreement on methods of prediction ;

(c) That it is generally felt that prediction methods involving harmonic analysis are inappropriate, and that methods which can be classified under the heading of cycle matching, while very useful, are in principle somewhat arbitrary, and not always sufficiently objective ;

(d) The appeal of newer statistical techniques involving autocorrelation, which for prediction purposes appear to be the most objective and least controversial in matters of detailed application ;

RECOMMENDS :

1. That the Director of the C.C.I.R. should draw the attention of the International Astronomical Union (I.A.U.) and the International Scientific Radio Union (U.R.S.I.), as well as of other international organizations concerned, to the importance of predicting solar activity and to the desirability of studying prediction methods ;

2. That the Director of the C.C.I.R. should undertake to prepare six months in advance predictions of the smoothed relative sunspot number, utilizing autocorrelation techniques and based upon :

   — the Zurich relative sunspot numbers, final whenever available, but provisional when final are not available ;
   — the following commonly used formula for smoothed averages :

$$\bar{R}_0 = \frac{\frac{1}{2}\left(R_{-6} + R_{+6}\right) + \sum_{-5}^{+5} R_k}{12}$$

   where R_k is the Zurich relative sunspot number for month k, and where the subscript " o " corresponds to the month for which the smoothed number is being obtained ;

3. That these predictions should be published currently in the *Journal des Télécommunications* for the benefit of members of the I.T.U. ;

4. That these predictions should be made available to all interested parties as soon as available each month by an inexpensive postcard subscription service utilizing air-mail ;

5. That prior to the next Plenary Assembly of the C.C.I.R., the Director of the C.C.I.R. and the various Administrations should supply their comments on these predictions, making particular reference to :

   — the suitability of the use of 12-month running means ;
   — the suitability of a prediction six months in advance ;
   — the applicability of the predictions to their communications problems.

APPENDIX

METHODS OF PREDICTING SOLAR INDEX

(a) *Harmonic Analysis*

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RECOMMENDATION No. 70

STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Recommendation No. 18)

The C.C.I.R.,

CONSIDERING :

(a) That Recommendation No. 18 called for the study of the provision and operation of a world-wide standard frequency and time service ;

(b) That experimental standard frequency stations were operated and that a considerable amount of data on their performance was collected (see Ann. I) ;

(c) That the usefulness of the standard frequency transmissions will be improved appreciably when the proposed exclusive bands for the service become available ;

(d) That the present standard frequency services are experiencing interference from stations other than standard frequency stations ;

RECOMMENDS :

1. That frequencies as transmitted should be maintained within ± 2 parts in 10^8 ;

2. That the standards used for control should have a drift of less than 1 part in 10^8 per week ;

3. That time intervals as transmitted should be maintained within ± 2 parts in $10^8 \pm 10$ microseconds ;

4. That notice of any adjustments to the standard frequencies and time signals should be sent regularly, in the uniform manner suggested in form A of Ann. II, by each Administration to the Secretariat of the C.C.I.R. for association and distribution ;

5. That the measured values of the frequencies and time signals should be sent regularly, in the uniform manner suggested in form A of Ann. II, by each Administration to the Secretariat of the C.C.I.R. for association and distribution ;

6. That the International Time Bureau should continue the publication of corrections to the transmitted signals ;

7. That any experimental station within the framework of Study Programme No. 25 found to be causing harmful interference to established services of permanent stations shall take steps to eliminate such interference ;

8. That no new permanent standard frequency station operating in the standard frequency bands shall be notified to the I.T.U. until the experimental investigations have provided sufficient material ;

9. That steps shall be taken at the earliest possible time for the clearance of the proposed bands.

ANNEX I

MAIN CHARACTERISTICS OF STANDARD FREQUENCE STATIONS (1)

1	*Station*		HAWAII	RUGBY	TOKYO	TURIN	WASHINGTON
2	*Call sign*		WWVH	MSF	JJY		WWV
3	*Service*		Experimental	Experimental	Experimental	Experimental	Working
4	*Carrier Power* (2) (kW)		0.4	10.0	2.0	0.3	10.0
5	*Type of antenna*		Vertical dipole	Vertical dipole	Vertical dipole	Horizontal (7) dipole	Vertical dipole
6	*Number of simultaneous transmissions*		3	1	2	1	6
7	*Number of frequencies used*		3	2	2	1	6
8	*Transmissions*	*Days per week*	7	7	7	1 (8)	7
9		*Hours per day*	22	1	24	6	24
10	*Standard Frequencies used*	*Carrier* (Mc/s)	5 10 15	5 10	4 8	5	ALL
11		*Modulation* (c/s)	1 440 600	1 1000	1 (6) 1000	1 440 1000	1 440 600
12	*Duration of tone modulation in minutes*		4 of each 5 (3)	5 of each 15	9 of each 10	5 of each 10 (9)	4 of each 5 (3)
13	*Accuracy of frequencies in parts in* 10^8		± 2	± 2	± 2	± 2	± 2
14	*Oscillator drift in parts in* 10^8 *per month 1950*		+ 2.0	+ 0.5	+ 3.0	—	+ 1.0
15	*Steps of frequency adjustment parts in* 10^8		$\leqslant 1$	$\leqslant 2$	$\leqslant 2$	$\leqslant 2$	$\leqslant 1$
16	*Duration of time signals minutes*		continuous	5 of each 15	continuous	5 of each 10	continuous

	Stations	Hawaii	Rugby	Tokio	Turin	Washington
17	*Accuracy of time intervals*	$\pm 2 \times 10^{-8}$ $\pm$ 1 micro-second	$\pm 2 \times 10^{-8}$ $\pm$ 1 micro-second	$\pm 2 \times 10^{-8}$ $\pm$ 1 micro-second	$\pm 2 \times 10^{-8}$ $\pm$ 10 micro-second	$\pm 2 \times 10^{-8}$ $\pm$ 1 micro-second
18	*System of adjustment of time signals*	Steering (4)	50 m secs (5)	Adjusted to mean of time signals	Adjusted to mean of time signals	Steering (4)
19	*Remarks*		Service to be extended to 22 hours per day on each of two transmitters	Service to change to 2500 and 5000 kc/s in near future	Service to be extended to 12 hours daily and to other frequencies	

(1) For details see Doc. Nos 144, 257 and 322 of Geneva.
(2) These are maximum values, on certain frequencies and on certain days reduced power is used.
(3) 440 and 600 c/s tones alternately.
(4) No phase adjustments made to time signals.
(5) Adjustments made on first day of month in steps of 50 m sec., when necessary.
(6) Interruption of complete signal.
(7) Maximum radiation in NW and SE directions.
(8) Tuesdays.
(9) 440 and 1000 c/s tones alternately.

ANNEX II

FORM A

Deviations and adjustments of Standard Frequencies and Time Signals as broadcast by

....

.... for the quarter ending .... 195......

1. Deviations of frequencies broadcast are with reference to ....

....

2. Deviations of time signals broadcast are with reference to ....

....

3. Method of reporting :

   (a) Frequency : + indicates that the frequency broadcast was high ; deviations are given as parts in 10^9 ; adjustments were made on the days indicated by * at the times stated.

   (b) Time : the time deviations are expressed as the decimal part of the second, e.g. 010 indicates that the pulses were 0.010 second late while a figure of 990 indicates that the pulses were 0.010 second early ; adjustments were made on the days indicated by * at the times stated.

Date	Frequency, parts in 10^9	Time, milliseconds

Date of compilation :

RECOMMENDATION No. 71

ALARM SIGNAL FOR USE ON THE MARITIME RADIOTELEPHONY DISTRESS FREQUENCY 2182 kc/s

(Recommendation No. 24)

The C.C.I.R.,

CONSIDERING :

(a) That it is desirable and practicable to establish an internationally agreed alarm signal for use on the maritime radio telephony distress frequency of 2182 kc/s * ;

(b) That the alarm signal should be such as to

b. 1 Provide reliable operation of automatic alarm equipment ;

b. 2 Provide a distinctive signal which is readily recognized aurally when received on a loud-speaker or headphones ;

b. 3 Be capable of being received through interference from speech transmissions, through other kinds of interference, and through noise ;

b. 4 Avoid false response, both aurally and by automatic means ;

b. 5 Be capable of being produced by a simple manual device, as well as by automatic means ;

(c) That the alarm signal should be such as to permit the construction of alarm signal equipment which is rugged, dependable, stable in performance, of low cost, of easy production, of long life with a minimum of maintenance, and which can be used with existing maritime radiotelephone equipment ;

---

* The use of 2182 kc/s for the radiotelephony distress and calling frequency depends upon the implementation of the appropriate parts of the Atlantic City Table of Frequency Allocations.

(d) That to aid in clearing the distress frequency of other emissions, the alarm signal and detecting device should be effective beyond the range at which speech transmission is satisfactory ;

(e) That the automatic alarm equipment should be capable of operating in as short a time as possible, consistent with the avoidance of false responses ;

(f) That considerable work has been done on this subject by various administrations since the Vth C.C.I.R., Stockholm, 1948, which has resulted in a substantial body of knowledge on alarm signals and on the performance of automatic alarm equipment ;

(g) That at the VIth C.C.I.R., Geneva, 1951, the alarm signal proposed by the U.S.A. and the signal proposed jointly by France and the U.K. have been shown to contain features of considerable merit ;

(h) That consideration of the above two signals leads to the choice of signal elements which appear to meet all requirements ;

(i) That the experience gained during tests of the alarm signals proposed by the U.S.A. and by France and the U.K. have shown the desirability of establishing internationally agreed standards of performance of the transmitting and receiving automatic alarm equipment ;

(j) That equipment performance standards should be such as to ensure, on the one hand, the desired operational performance, and to avoid on the other hand undue difficulties in manufacture and maintenance ;

(k) That the establishment of equipment performance standards will necessitate some further laboratory and field tests, and that such tests should be completed before the international adoption of an alarm signal ;

RECOMMENDS :

1. That the alarm signal described below should be provisionally adopted internationally for use on the maritime radiotelephony distress frequency ;

1.1 The alarm signal shall be composed of two sinusoidal audio frequency tones, transmitted alternately. One tone shall have a frequency of 2200 c/s and the other tone shall have a frequency of 1300 c/s. The duration of each tone shall be 250 milliseconds ;

1.2 When generated by automatic means, the tolerance of the tone frequencies shall be $\pm 2\%$; the tolerance on the duration of each tone shall be ± 50 milliseconds and the interval between successive tones should not exceed 20 milliseconds ;

1.3 When generated by automatic means, the alarm signal shall be sent continuously for a period of 30 seconds ; when it is sent by manual means, the signal shall be generated as continuously as practicable over a period of one minute ;

2. That, in the absence of noise and interference, the automatic receiving equipment be capable, provisionally, of operating from the alarm signal defined in **1** in a period of not more than 4 seconds ;

3. That Study Programme No. 29 should be carried out and that at the earliest date justified by the results of this study the C.C.I.R. should recommend the characteristics and tolerances of the alarm signal and the equipment performance standards which should be finally adopted internationally.

RECOMMENDATION No. 72

USE OF 8364 kc/s FOR RADIO DIRECTION FINDING

(Question No. 21)

The C.C.I.R.,

CONSIDERING :

(a) That the International Radio Conference of Atlantic City (1947) in Item 780 of the Radio Regulations states that

> " The frequency 8364 kc/s must be used by lifeboats, liferafts and other survival craft, if they are equipped to transmit on frequencies between 4000 and 23 000 kc/s, and if they desire to establish with stations of the maritime mobile service communications relating to search and rescue operations see (600) " *.

(b) That land stations will, when the appropriate portions of Art. 33 of the Atlantic City Radio Regulations become effective, keep watch during their service hours on the band 8356 to 8372 kc/s ; of which 8364 kc/s is the centre ;

(c) That Regulations 13 and 14 of Chapter IV of the Safety of Life at Sea Convention (1948) indicate minimum specifications for automatic distress transmitters ;

(d) That tests and operational experience have shown that high frequency radio direction-finding on 8364 kc/s may be a valuable aid, (in conjunction with direction-finding on 500 kc/s), in finding the position of both aircraft and ships in distress and survival craft ;

(e) That complete coverage cannot be obtained with direction-finding on only one high frequency because of the limitations caused by radio propagation conditions ;

(f) That high frequency radio direction-finding requires apparatus as free as possible from local site error and polarization error ;

(g) That the accuracy of the bearing will depend upon the field strength of the signal and the signal/noise ratio ;

(h) That in view of the rapid variation of the apparent azimuth of the bearing which is frequently observed in high frequency radio direction-finding, measurements should be made over several minutes to obtain a more accurate mean bearing ; and that the bearing and fix may be improved subsequently by a further series of measurements ;

(i) That standardized distress transmissions are desirable ;

(j) That it is essential to have a means of rapid communication between the watch-keeping station and the direction-finding stations ;

RECOMMENDS :

1. That the site of the high frequency radio direction-finding station should be, as far as possible :

1.1 Flat and horizontal for a radius preferably of at least 200 meters with the surrounding neighbourhood flat and free from obstruction ;

1.2 Of high and uniform ground conductivity ;

1.3 Free from large metallic masses and objects likely to resonate at frequencies near to 8364 kc/s ;

* The use of 8364 kc/s for these purposes depends upon the implementation of the appropriate portion of the Atlantic City Table of Frequency Allocations.

2. That the aerial system should be as free as possible from wave polarization error (e.g. Adcock systems and spaced loop systems) ;

3. That the DF receiver bandwidth used when bearings are taken should be as narrow as possible, compatible with the modulation and frequency stability of the signal on 8364 kc/s, and that a broader bandwidth position should also be incorporated in the receiver for watch-keeping purposes ;

4. That the sensitivity of the direction-finding equipment should be such that it operates satisfactorily with a field strength as low as 5 μV/m ;

5. That the bearing should be determined by an aural-null method or by any other method of comparable or better accuracy ;

6. That the direction-finding equipment should be adjusted, balanced and calibrated at frequent intervals on the frequency of 8364 kc/s ;

7. That the signal radiated by survival craft should be as strong as possible and stable in frequency to ensure the greatest accuracy in determining the bearings ;

8. That the signals transmitted by survival craft should preferably include long dashes sent over a period of not less than four minutes for direction-finding purposes. The attention of Administrations should be drawn to the precise form and content of such signals proposed by France, U.S.A. and U.K., given in Doc. Nos. 39 (France), 43 and 99 (U.S.A.) and 44 (U.K.) of Geneva, and to the question of whether it would be desirable to use a common form of signal for both 500 and 8364 kc/s ;

9. That, in order to give as great an accuracy of fix as possible, several widely-spaced and interconnected direction-finding stations should be employed (see Annex) ;

10. That the classification of accuracy of bearings or of fix, as the case may be, as given in App. 15, § 5 and 6 of the Atlantic City Radio Regulations should be used when exchanging direction-finding information ;

11. That the attention of Administrations concerned should be drawn to the advantage of their studying further :

11.1 The most suitable type of network for providing rapid communication between direction-finding stations and plotting centres ;

11.2 The most suitable way in which information should be exchanged between different stations or networks (e.g. use of " Q " code) ;

11.3 The best way to evaluate the most probable fix (position) from bearings supplied by the direction-finding stations ;

12. That the attention of Administrations should also be drawn to the fact that world-wide direction-finding coverage cannot be obtained with only one high frequency.

ANNEX

Accuracy of Bearings on 8364 kc/s

At distances greater than about 1200 km the root-mean-square (RMS) bearing error to be expected with a modern HF-DF system is of the order of 3 to 5 degrees.

At distances less than 1200 km the error progressively increases with decrease of distance to values of the order of 5 to 10 degrees ; at small distances, less than about 100 km, the error may be even greater than 10 degrees.

The above figures refer to the arithmetic mean of bearings spread over an interval of not more than about 10 minutes.

RECOMMENDATION No. 73

STUDY OF RELATIONSHIPS BETWEEN PEAK POWER AND MEAN POWER

(Question No. 22)

The C.C.I.R.,

CONSIDERING :

(a) That the Radio Regulations, Atlantic City, 1947, Art. 1, Section IV, items 60 to 64, call for the use of " peak power " in specifying the power of a radio transmitter, but allow the additional use of " mean power " in cases where the peak power specification is not satisfactory or adequate ;

(b) That in many cases it will be possible to measure the peak power directly and in others it will be possible to derive the peak power from measurements made under suitably arranged test conditions ;

(c) That a specification of radiated power is advantageous for use in calculations of radio propagation, channel spacing, signal-to-interference ratios and signal-to-noise ratios involved in radio communications ;

(d) That for administrative purposes or for the calculations in *(c)*, the specification of peak power as defined in the Radio Regulations, Atlantic City, 1947, is not sufficient to evaluate adequately the interference-producing capabilities of a signal ;

(e) That in monitoring or field-intensity recording of the strength of radio signals the use of automatic recorders frequently involves measurements of average rather than peak field strength ; for some types of modulated signal, the mean field intensity is not affected by the modulation ;

(f) That consequently it is necessary for the field strength as measured by use of monitoring equipment to be interpreted consistently in terms of the rated power of the transmitter ;

(g) That information on transmitter power expressed in terms of peak or mean power alone, as defined in the Radio Regulations, Atlantic City, 1947, is adequate only for certain types of emission and for certain uses of the information ; in many cases it is desirable to use power ratings expressed otherwise ;

RECOMMENDS :

That the table attached in the Annex, which presents, for each type of emission specified in the Radio Regulations, Atlantic City, 1947, the relationships between peak power and mean power, and also the power under conditions of no modulation, should wherever practicable, supersede the Annex to Question No. 22.

ANNEX

CONVERSION TABLE FOR RELATIONSHIPS BETWEEN PEAK POWER AND MEAN POWER

1. In the following table the symbols Pp and Pm indicate peak power and mean power, respectively, as defined in Art. 1 of the Radio Regulations, Atlantic City, 1947, which states that :

   1.1 The peak power of a radio transmitter is the mean power supplied to the antenna during one radio frequency cycle at the highest crest of the modulation envelope, taken under conditions of normal operation, and

1.2 The mean power of a radio transmitter is the power supplied to the antenna during normal operation, averaged over a time sufficiently long compared to the period corresponding to the lowest frequency encountered in actual modulation—in general a time of 1/10 second, during which the mean power is a maximum, will be selected ;

2. In the following table the average power which a transmitter supplies to its antenna during one radio frequency cycle under conditions of no modulation is considered to have a value of unity. Conditions of no modulation are specified in the table. With these conditions as a reference, relative values of Pm and Pp for various modulated emissions are indicated by conversion factors under the columns Pm and Pp, where applicable.

3. Specification of modulating wave form is essential for conversions between peak power ratings and power ratings of other types. Accordingly, one or more " characteristic modulations " are assumed and described for each class of emission evaluated in the following table. To permit proper evaluation of potential geographical interference ranges, these " characteristic modulations " are chosen, as far as possible, to give maximum ratios of Pp to Pm.

Type of Modulated Emission	Characteristic Modulation	Condition of No Modulation	Conversion Factors (See 2 above)	
			Pm	Pp
Amplitude Modulation				
A1 (On-off telegraphy)	Series of rectangular dots ; equal marks and spaces ; zero space amplitude	Key down	0.5 (Note 1)	1
A2 (Telegraphy with keying of audio frequency modulating tone, or of modulated emission)	Series of rectangular dots ; equal marks and spaces ; single sine-wave audio frequency modulating tone ; 100% modulation			
	a) Modulating tone keyed	*a)* Key up (tone removed)	*a)* 1.25	*a)* 4
	b) Modulated emission keyed	*b)* Key down (tone removed)	*b)* 0.75	*b)* 4
A3 (Double-sideband telephony full carrier)	*a)* Single sine-wave audio frequency modulating tone ; 100% modulation	*a)* Carrier only (Note 2)	*a)* 1.5	*a)* 4
	b) Smoothly read text	*b* Carrier only (Note 2)	*b)* 1 to 1.08	*b)* 4
A3a (Single side-band reduced carrier)	See Supplementary Table I and Note 3			
A3b (Two independent side-bands reduced carrier)	See Supplementary Table II and Note 3			
A4 (Facsimile)	Black and white checkerboard picture giving square modulating wave ; 100% modulation	Full carrier amplitude	0.5 (Note 6)	1 (Note 6)
A5 (Television)	(See Note 4)			

Type of Modulated Emission	Characteristic Modulation	Condition of No Modulation	Conversion Factors (See 2 above)	
			Pm	Pp
Frequency or phase modulation				
F1	(For all types of frequency or phase modulated transmissions the modulation changes the distribution of power in the frequency band of the emissions while leaving the total power of the emissions unchanged)		1	1
F2			1	1
F3			1	1
F4			1	1
F5			1	1
F9			1	1
Pulse P1 (Simple telegraphy)	Pulse train keyed on and off ; mark and space equal ; rectangular pulses, constant amplitude and duty cycle	Key down (Note 5)	0.5 (Note 5)	1/duty cycle
	Audio frequency tone-modulated telegraphy. Series of equal rectangular marks and spaces ; single sine-wave audio frequency modulating tone ; 100% modulation.			
P2d (Pulses amplitude modulated ; constant duty cycle)	*a)* Modulating tone keyed	*a)* Key up (tone removed) (Note 5)	*a)* 1.25	*a)* 4/duty cycle
	b) Modulated emission keyed	*b)* Key down (tone removed) (Note 5)	*b)* 0.75	*b)* 4/duty cycle
P2e (Pulses, width or duration modulated ; constant amplitude)	*a)* Modulating tone keyed	*a)* Key up (tone removed) (Note 5)	*a)* 1	*a)* 1/average duty cycle
	b) Modulated emission keyed	*b)* Key down (tone removed) (Note 5)	*b)* 0.5	*b)* 1/average duty cycle
P2f (Pulses, position or phase modulated ; constant amplitude)	*a)* Modulating tone keyed	*a)* Key up (tone removed) (Note 5)	*a)* 1	*a)* 1/average duty cycle
	b) Modulated emission keyed	*b)* Key down (tone removed) (Note 5)	*b)* 0.5	*b)* 1/average duty cycle
	Telephony			
P3d (Pulses, amplitude modulated ; constant duty cycle)	*a)* Single sine-wave audio frequency modulating tone ; 100% modulation	*a)* Pulse carrier only (Note 5)	*a)* 1.5	*a)* 4/duty cycle
	b) Smoothly read text	*b)* Pulse carrier only (Note 5)	*b)* 1 to 1.08	*b)* 4/duty cycle
P3e (Pulses, width or duration modulated ; constant amplitude)	Single sine-wave audio frequency modulating tone ; 100% modulation ; rectangular pulses	Pulse carrier only (Note 5)	1	1/average duty cycle
P3f (Pulses, position or phase modulated ; constant amplitude)		Pulse carrier only (Note 5)	1	1/average duty cycle

Note 1. — For Morse Pm = 0.49 Pp.

For International Alphabet No. 2 : Pm = 0.58 Pp.

Note 2. — The peak power of double sideband transmitters is nominally four times the power of the unmodulated carrier. To determine the proper level for applying speech two tones are employed, as in the single sideband case described in Note 3. In a well-constructed transmitter, this should result in reasonably high percentages of modulation. It has been found in connection with smoothly-read text that a reading of 2 (VU * meter readings) corresponds to a mean power of zero dbm ** measured in the audio frequency band, nominally up to 3000 or 4000 cycles/second.

Note 3. — The two-tone method of rating the power of single sideband radio telephone transmitters consists of setting the level of each of two equal tones applied to the audio frequency input so that the resulting cross-modulation term $(2f_1 - f_2)$ is 25 db below the level of either tone, measured in the r.f. output of the transmitter; the peak power rating of the transmitter is taken as four times the r.f. power output, after removal of one of the two tones. Single channel speech is applied at the audio frequency input at a VU level equal numerically to the mean dbm level of one of the two aforementioned tones. For multichannel single sideband transmission, the level of each channel is reduced 0.5 (N − 1) db, where N is the number of channels, up to a total of about four.

Note 4. — Depending on the standards used, the condition of no modulation may not apply. For any particular case, the ratio of mean power to peak power can be calculated, for the extreme conditions of all-black and all-white pictures, by taking into account the relative amplitudes and durations of blanking signals, synchronizing pulses and picture signals. As examples, in the 525-line, 60-field system used at present in the United States, this results in a ratio of Pm to Pp of 0.164 for an all-white picture and 0.608 for an all-black picture ; in the 405-line, 50-field system now used in the United Kingdom, the ratios are 0.800 for an all-white picture and 0.080 for an all-black picture.

Note 5. — The average power which a pulse transmitter supplies to its antenna during one pulse period of an unmodulated pulse train (PO conditions) is considered to have a value of unity.

Note 6. — The values listed here are based upon direct facsimile scanner modulation of the main radio frequency carrier. When the output of the facsimile scanner modulates a sub-carrier and this sub-carrier is then applied as amplitude or frequency modulation of the main carrier, the resultant emission has A3, A3a, A3b, or F3 characteristics and the appropriate power relationships, therefore, must be sought in the corresponding section of the table.

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* This refers to readings of a VU meter, which is a volume indicating device having certain specific dynamic characteristics, and which is described in *Proc. I.R.E.*, 28,1 (January 1940) Such a device reads zero for a 1000-cycle tone delivering 1 milliwatt to a load impedance of 600 ohms. When speech volume is measured by it according to I.R.E. standards, a reading of zero corresponds to zero VU.

** dbm defined as " power in decibels referred to one milliwatt ".

Supplementary Table I

RATIO OF P_m TO P_p FOR A3a EMISSION

Condition of No Modulation	Characteristic Modulation		
Carrier Level, Referred to Peak Power of Sideband	* Single Sine-wave Audio Frequency Modulating Tone : Transmitter Fully Loaded	** Smoothly Read-Text : Transmitter Fully Loaded	*** " Other " Programme Material ; Transmitter Fully Loaded
−10 db	0.636 (−1.97 db)	0.149 (−8.27 db)	0.115 (−9.39 db)
−20 db	0.835 (−0.78 db)	0.139 (−8.57 db)	0.091 (−10.4 db)
−30 db	0.940 (−0.27 db)	0.150 (−8.24 db)	0.095 (−10.2 db)
−∞ (fully suppressed)	1.000 (0 db)	0.158 (−8.00 db)	0.100 (−10.0 db)

Supplementary Table II

RATIO OF P_m TO P_p FOR A3b EMISSION

Condition of No Modulation	Characteristic Modulation			
Carrier Level, Referred to Peak Power of Either Sideband	* Single Sine-wave Audio Frequency Modulating Tone on Each Channel : Transmitter Fully Loaded	** Each Channel Fully Loaded by Smoothly-Read Text : Transmitter Fully Loaded	*** Each Channel Fully Loaded by "Other" Programme Material: Transmitter Fully Loaded	Channel 1 Smoothly-read Text and Channel 2 " Other " ProgrammeMaterial
−10 db	0.392 (−4.07 db)	0.078 (−11.1 db)	0.056 (−12.5 db)	0.067 (−11.8 db)
−20 db	0.456 (−3.41 db)	0.074 (−11.3 db)	0.048 (−13.2 db)	0.061 (−12.1 db)
−30 db	0.485 (−3.14 db)	0.077 (−11.1 db)	0.049 (−13.1 db)	0.063 (−12.0 db)
−∞ (fully suppressed)	0.5 (−3.01 db)	0.079 (−11.0 db)	0.050 (−13.0 db)	0.065 (−11.9 db)

* For a single sine-wave Audio-Frequency modulating tone, the mean Radio-Frequency Power of each sideband channel is equal to its peak Radio-Frequency Power (Atlantic City definition), but is 3 db below its maximum instantaneous Radio-Frequency Power : this 3 db difference corresponds to the 3 db difference between the mean and the instantaneous peak Audio-Frequency Power levels of the impressed modulation.

** For smoothly-read text, it is assumed that the mean Radio-Frequency Power of each sideband channel is 8 db below its peak Radio-Frequency Power (Atlantic City definition), or 11 db below its maximum instantaneous Radio-Frequency Power ; the corresponding underlying assumption of an 11 db difference between the mean and equivalent instantaneous peak Audio-Frequency Power levels of the impressed modulation is made in accordance with the most recent information available.

*** For conversational speech and certain programme material other than smootlhy-read text, it is assumed that the mean Radio-Frequency Power of each sideband channel is 10 db below its peak Radio-Frequency Power (Atlantic City definition), or 13 db below its maximum instantaneous Radio-Frequency Power : the corresponding underlying assumption of a 13 db difference between the mean and equivalent peak Audio-Frequency Power levels of the impressed modulation is made in accordance with the most recent information available.

RECOMMENDATION No. 74

PRINCIPLES OF THE DEVICES USED FOR ACHIEVING PRIVACY OF RADIOTELEPHONE CONVERSATIONS

(Question No. 30)

The C.C.I.R.,

CONSIDERING :

(a) That the devices referred to are intended for achieving *privacy* rather than *secrecy* of radiotelephone conversations ;

(b) That in the interests of maximum privacy, the details of the systems employed and of their performance, should be agreed upon between the Administrations and Private Enterprises concerned ;

UNANIMOUSLY RECOMMENDS :

1. That the following statement of principles and characteristics of the devices concludes the study of Question No. 30 for radio circuits operating on frequencies less than about 30 Mc/s *.

1.1 *Principles of the Devices*

Two general types of systems are used for achieving " privacy " or " relative secrecy " of radiotelephone circuits operating on frequencies less than about 30 Mc/s as follows :

1.1.1 *For Double-Sideband Systems*

Inverter systems with or without wobbling of the carrier (i.e. rapid cyclic variation of the carrier frequency over a few hundred c/s), the speech band being inverted about a fixed frequency ;

1.1.2 *For Single-Sideband Systems*

Band-splitting systems in which the speech band is sub-divided into equal frequency bands, the speech components in the sub-bands being interchanged, with or without frequency inversion, and according to a prearranged repetitive sequence, to give " scrambled " speech. The process is reversed at the receiving terminal to reform the speech signals. Accurate synchronisation of the switching processes at the two terminals is required ;

1.2 *Characteristics of the Devices.*

1.2.1 The band-splitting system provides superior privacy to that obtained with the inverter system, but for satisfactory operation it can tolerate less radio distortion such, for example, as is caused by selective fading on the radio link ;

1.2.2 The apparatus is designed to reduce to a minimum attenuation distortion and the levels of unwanted products of modulation and of carrier signals. The extent of the permissible distortion due to the presence of the privacy devices is, in general, dependent on the type of privacy and is usually agreed between the Administrations or Private Enterprises concerned ;

* Information regarding this matter may be found in Doc. Nos. 47 and 48 of Geneva.

1.3 *Location of the Devices.*

To facilitate control and maintenance, and on the grounds of economy, the privacy apparatus is normally located at the point where the transmitting and receiving channels of a radio-telephone circuit are combined ;

2. That for frequencies above about 30 Mc/s the details of the systems to be employed and of their performance should be agreed upon between the Administrations or Private Enterprises concerned.

RECOMMENDATION No. 75

CLASSIFICATION AND ESSENTIAL CHARACTERISTICS OF FEED-BACK SUPPRESSORS

(Question No. 31)

The C.C.I.R.,

CONSIDERING :

That the feed-back suppressors now generally used are of the type whose operation is sufficiently independent of the characteristics of those at the opposite end of the circuit ;

UNANIMOUSLY RECOMMENDS :

That no classification of types nor terminology be adopted.

Essential characteristics

(§ *(b)* of Question No. 31)

The essential characteristics of the feed-back suppressors used on radiotelephone circuits in the United Kingdom and in the United States of America for Fixed Services are described respectively in Doc. Nos 49 and 51 of Geneva. These are in substantial accord with the characteristics described in C.C.I.F., 1950-1951, Vth Study Group, Doc. No. 7, Question No. 2.

RECOMMENDATION No. 76

VOICE OPERATED DEVICES FOR SHIP STATIONS AND CARRIER OPERATED DEVICES FOR SHORE STATIONS

(Question No. 32)

The C.C.I.R.,

CONSIDERING :

(a) That the essential characteristics of the devices controlled by voice currents and acting on the carrier wave in radio-telephone stations on board ships and of the carrier-operated devices in receivers of coast stations are their " operate " and " release " times ;

(b) That the operate times of the devices should be short to minimize clipping, and their release times should be sufficiently long to enable the devices to remain operated in the intervals between words in normal speech ;

UNANIMOUSLY RECOMMENDS :

1. That the operate and release times of the voice-operated carrier switching unit on the ship should be as follows :

Input Level *(Note a)*	Net Operate Time *(Note b)*	Net Release Time *(Note c)*
– 30 db	less than 25 ms	between 75 and 170 ms
– 20 db	less than 15 ms	between 75 and 170 ms

2. That the operate time *(Note d)* of the carrier-operated device in the coast station receiver should be as short as practicable to allow somewhat longer operate times in the ship's apparatus and should not exceed 5 milliseconds when the carrier level at the input to the receiver is more than 1 db above the level just necessary to operate the device. The required value of release time *(Note e)* is dependent on several factors, including the time constants of the automatic gain control of the radio receiver and a value between 10 and 50 milliseconds is generally suitable.

Note (a). — *Input level* refers to the level of a test sinusoidal signal of frequency corresponding to the middle of the voice-frequency range relative to that producing 100% modulation.

Note (b). — *Net operate time* is the time which elapses between the instant the test signal is applied to the input to the modulator of the transmitter, and the instant when the carrier reaches 50% of its maximum amplitude.

Note (c). — *Net release time* is the time which elapses between the instant when the test signal is disconnected and the instant the carrier is reduced to within 5 db of the maximum carrier suppression achieved.

Note (d). — *Operate time* of the carrier-operated device is the time which elapses between the sudden application of a test signal simulating the carrier wave from the ship and the instant of opening of the receiving channel (the instant when the attenuation of the receiving channel is within 5 db of the final value of attenuation for the receiving condition).

Note (e). — *Release time* of the carrier-operated device is the time which elapses between the cessation of a test signal simulating the carrier wave from the ship and the instant of blocking of the receiving channel (the instant when the attenuation of the receiving channel is within 5 db of the final value of attenuation in the blocked condition).

RECOMMENDATION No. 77

CONDITIONS NECESSARY FOR INTERCONNECTION OF MOBILE RADIOTELEPHONE STATIONS (FOR INSTANCE AUTOMOBILES, AIRCRAFT AND SHIPS) AND INTERNATIONAL TELEPHONE LINES

(Question No. 33)

The C.C.I.R.,

CONSIDERING :

(a) That the conditions concerning which international agreement is necessary appear to be few in number ;

(b) That these conditions, if met, would permit suitable interconnection between mobile radiotelephone stations and international telephone lines ;

RECOMMENDS :

1. That mobile radiotelephone circuits, intended for connection to international telephone systems, should terminate (on a 2-wire basis, for the present at least) in such a way that they may be connected to international lines in the same manner as other land-line connections ;

2. That the mobile radiotelephone circuits should accept from and deliver to the land-line system, speech volumes conforming, as far as possible, to the C.C.I.R. and C.C.I.F. standards for connections to international circuits ;

3. That the attenuation-frequency characteristics of the radio system (including the land-lines to the radio receiver and radio transmitter) should be such that the grade of transmission is not unduly affected ; and in particular, the effectively transmitted band should be not less than 300 to 2600 c/s ;

4. That the noise from a radio circuit connected to an international circuit should not be unduly great and should be insufficient to operate frequently echo suppressors or other devices on domestic or international circuits ;

5. That in the case of mobile radiotelephone stations which may have to communicate with land stations in more than one country, consideration be given to the necessity for agreement as to a method of signalling for use between the land and mobile stations.

RECOMMENDATION No. 78

PREVENTION OF INTERFERENCE TO RADIO RECEPTION ON SHIPS *

(Question No. 34)

The C.C.I.R.,

CONSIDERING :

(a) That the Maritime Regional Radio Conference, Copenhagen (1948), recommended to the C.C.I.R. to study the question of interference to radio reception caused by electrical installations on board ship ;

(b) That the Safety of Life at Sea Conference, London (1948), requested that all steps be taken to eliminate as far as possible the causes of radio interference from electrical and other apparatus on board ship ;

(c) That electrical interference is caused by the unwanted excitation of the radio receiving equipment, including the aerial, by fluctuating electromagnetic fields set up by other electrical installations ;

(d) That the fluctuation of electromagnetic fields which gives rise to interference is caused by abrupt changes in current in the source of interference, and by abrupt changes in the resistance of conductors situated in electromagnetic fields ;

(e) That electrical interference may be transmitted by direct radiation and induction from the source of interference itself, and also by re-radiation and induction from conductors which carry interfering currents ;

UNANIMOUSLY RECOMMENDS :

1. That the design, construction and installation of electrical equipment in ships should be such that interference is minimized at its source ;

2. That electrical equipment installed in ships should be efficiently maintained to prevent any increase in the level of interference which it causes ;

3. That aerials used for transmission or reception should be erected as far above and as far away as possible from electrical machinery and from parts of the ship's structure such as funnels, stays and shrouds ;

4. That the down-leads of aerials which are used exclusively for reception should be screened ; that the screen should extend continuously from the receiver to a point which is as high as practicable above the ship's structure, and that the screen should be effectively connected to the ground terminal of the receiver ;

5. That frame or loop aerials used for direction finding should be effectively screened against electrostatic interference ;

6. That the radio receiving room should be effectively screened and situated as high as practicable in the ship ;

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* Interference from radar and other electronic equipment has not been specifically considered in framing this Recommendation. The prevention of radar interference is covered by Recommendation No. 45.

7. That power converting plant within the radio receiving room should be housed in a separate screened enclosure, unless the plant is self-screened ;

8. That the radio receiving equipment should be designed so that it is effectively screened ;

9. That suppressor filters to prevent the propagation of interference should be fitted at the sources of interference, preferably built into the interference-producing equipment, and that in particular :

(a) The electrical ignition systems of internal-combustion engines, including those which may be installed in life-boats, should be fitted with suppressors ;

(b) The navigational instruments and associated equipment which are installed in the neighbourhood of the receiving aerials or the radio receiving room should, if necessary, be fitted with suppressors, be screened, and the screen effectively grounded ;

10. That cables in the vicinity of the receiving aerials or the radio receiving room, and cables within the radio room, should be screened by enclosing them in metal conduits, unless the cables themselves are effectively screened ;

11. That twin cables should be used wherever possible : if single-core cable is necessary, the " lead " and " return " conductors should be fixed as close to one another as possible to avoid the formation of loops ;

12. That suppressors should be fitted to cables at their point of entry into the radio receiving room, unless they terminate close to the point of entry in equipment which itself provides adequate screening and suppression ;

13. That cables, ducts and pipes which do not terminate in the radio receiving room, should preferably not be installed in the radio receiving room ; if it is essential for them to pass through the radio receiving room, the ducts and pipes and the screening of the cables should be effectively grounded ;

14. That a copper earth-busbar should be fixed along the bulkheads and bonded at several points to the ship's structure and to the metal structure or screening of the radio receiving room ; the screens of cables within and near to the radio receiving room, as well as the screens of apparatus in the radio-receiving room, should be effectively connected to the busbar ;

15. That rigging should be either insulated from or bonded to the ship's structure (stays that are subject to considerable tension can more conveniently be bonded) ;

16. That in the case of smaller vessels and those constructed of wood the principles recommended should be applied as far as is practicable ;

17. That particular care should be taken to minimize interference on the frequency bands used for distress and direction finding in the maritime service ;

18. That Administrations should bring the above recommendations to the attention of naval architects, shipbuilders and those responsible for the manufacture, installation and maintenance of electrical equipment.

RECOMMENDATION No. 79

IDENTIFICATION OF RADIO STATIONS

(Question No. 17)

The C.C.I.R.,

CONSIDERING :

(a) That in order to carry out an efficient monitoring service of radio stations it is necessary for these stations to be identified as regularly as possible during their transmissions * ;

(b) That in many categories of radio services the identification procedure used at present is satisfactory to both the operating Agencies and the regulating Administrations, as is the case for single channel low speed telegraphy * ;

(c) That the Atlantic City Radio Regulations (Art. 13, Section V, § 10) set forth requirements for transmissions of radio call signs *, and state that each radio station provided with a call sign from the international series should send this as frequently as is practicable and reasonable ;

(d) That certain types of radio stations are exempted from the necessity of having an international call sign * ;

(e) That the problem of accomplishing identification of multichannel telephone and telegraph transmission is particularly difficult without the use of costly special apparatus * ;

(f) That the requirement of frequently transmitting a call sign may impose a difficult and costly hardship on the operating Agencies, particularly where heavily loaded multichannel or high speed machine operation is employed * ;

RECOMMENDS :

1.1 That each radio station required to have an identifying signal under the provisions of the Atlantic City Radio Regulations, Art. 19 should send its call sign at the beginning and the end of, and as often as possible during a transmission ;

1.2 That the identifying signal should be in International Morse Code, Five-Unit Code (International Telegraph Alphabet No. 2) or in speech modulation ;

1.3 That the call signs of all stations in a system including one or more relay stations should be included in the identification signal as far as possible and, in any case, the call sign of the station of the organization controlling the chain of stations should be transmitted.

2. That the mechanics of identification should include :

2.1 A call signal employing International Morse Code using A1, A2 or F1 emission, and transmitted whenever possible at hand speed ;

2.2 A call signal employing Five-Unit code (International Telegraph Alphabet No. 2) using A1, A2 or F1 emission ;

2.3 A call signal employing speech in clear ;

2.4 The superimposition of the call signal in Morse Code by amplitude modulation on a channel using F1 emission ;

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* Quotations from Question No. 17.

2.5 In the case of single-sideband transmissions, by amplitude keying of the reduced carrier ;

2.6 In the case of radiophoto transmissions, by Morse during the intervals of traffic or, alternatively, simultaneously with traffic by modulation at a frequency below the lowest used for the picture modulation. Where single sideband transmission is used for the picture, amplitude keying of the reduced carrier as in 2.5 above may be used ;

2.7 In the case of the transmission of the call signal simultaneously with traffic, as covered in 2.4, 2.5 and 2.6 above or in other ways, the transmission before the call sign itself of a signal indicating that the call sign which is to follow is superimposed on another emission ;

3. That, in order to avoid additional complexity in the equipping and operating of transmitting stations, every effort should be made to provide monitoring stations with equipment suitable for the reception of call signals of all stations, regardless of the service or class of emission;

4. That, if it is not convenient to transmit the call signal continuously, it is an advantage to the monitoring stations that the call signal shall be transmitted in the period from 10 minutes before to 10 minutes after the hour (G.M.T.).

RECOMMENDATION No. 80

HIGH FREQUENCY BROADCASTING DIRECTIVE ANTENNAS

(Question No. 23)

The C.C.I.R.,

CONSIDERING :

(a) Question No. 23 ;

(b) That the formation of strong subsidiary lobes of radiation can be avoided by the multiple feeding of, and appropriate current distribution in, appropriately spaced radiation elements ;

(c) That, by this means, it is theoretically possible to reduce the subsidiary lobes to a small value for a limited angle of slew of the main beam, provided the working frequency does not materially differ from the frequency for which an array is designed ;

(d) That the realization of these conditions is, however, not considered to be practicable on grounds of complexity of installation, difficulty of operation and maintenance of designed performances ;

RECOMMENDS :

That in practical operating conditions, for purposes of calculating interference, the field strength in directions other than that of the main lobe cannot be assumed to be less than 222 mV/m at a distance of one kilometre for one kilowatt of power supplied to the antenna *.

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* Refer to Statement of Specialized Secretariat of the C.C.I.R. on the subject *The Gain, Directivity and Protection Ratio of a Directional Antenna or Antenna Array*, Doc. No. 24 of Washington as reproduced in Geneva, 1951.

RECOMMENDATION No. 81

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Question No. 42)

The C.C.I.R.,

CONSIDERING :

(a) That a preferred method or methods of sound recording should be adopted to facilitate the international exchange of programmes between broadcasting organizations ;

(b) That technical standards relating to the preferred method or methods should be established ;

RECOMMENDS :

1. That the international exchange of sound recorded programmes shall be by means of lateral cut disks or single track magnetic tape ;

2. That lateral cut disks shall be in accordance with the following standards :

2.1 Speed of rotation : 78 rpm $\pm 0.7\%$
$33^1/_3$ rpm $\pm 0.5\%$ * ;

2.2 Direction of rotation of disk : clockwise ;

2.3 Direction of cut : outside to inside ;

2.4 Type of disk : lacquer coated or processed ;

2.5 Nominal maximum diameter of disks :
for $33^1/_3$ rpm : 16″ (406 mm)
for 78 rpm : 12″ (305 mm) ;

2.6 Maximum number of grooves per unit length :
128 per inch (50 per cm) for both 78 and $33\,^1/_3$ rpm ;

2.7 Centre hole diameter :

$$0.285'' \begin{cases} -0 \\ +0.002'' \end{cases} \left[7.24 \text{ mm} \begin{cases} -0 \\ +0.05 \end{cases} \right];$$

2.8 Minimum diameter of recorded surface :
for 78 rpm** : 3.74″ (95 mm)
for $33^1/_3$ rpm : 7.5″ (190 mm) ;

2.9 Plain grooves at start : minimum 2, maximum 4
Plain grooves at finish : minimum 2, maximum 4 ;

2.10 Groove profile :

— Maximum bottom radius : 0.0015″ (0.038 mm) (a smaller radius is preferable) ;
— Width of the groove : not less than 0.004″ (0.1 mm) ;
— Included angle : 80° to 90° ;

* Information given by the delegates of some countries indicates that $33\,^1/_3$ rpm is in more general use.

** Provisional minimum 3.54″ 90 mm).

2.11 Label content :

- — Broadcasting organization ;
- — Programme title ;
- — Side number ;
- — Total number of sides ;
- — Reference number ;
- — Total playing time ;
- — Speed of rotation in rpm.

3. That single track magnetic tape shall be in accordance with the following standards :

3.1 Speed of tape :

Primary speeds *:	30"/s ±0.5%	(76.2 cm/s ±0.5%)
	15"/s ±0.5%	(38.1 cm/s ±0.5%)
Secondary speed ** :	7.5"/s ±0.5%	(19.05 cm/s ±0.5%)

3.2 Direction of winding :

Although there is no recommendation as to the manner in which tape is placed on the hub, it is nevertheless recommended that manufacturers of magnetic tape mark along the entire length of the back of a coated tape and of one side of homogeneous tape. A blank strip should be placed at the beginning of the tape giving at least the number of the spool and the reference number of the programme on the recorded side.

The tape should be wound in such a way that it may be unwound in an anticlockwise direction during playing.

3.3 Width of tape :

$$0.250'' \left\{ \begin{array}{l} +0 \\ -0.006'' \end{array} \right. \left[6.35 \text{ mm} \left\{ \begin{array}{l} +0 \\ -0.15 \end{array} \right. \right]$$

3.4 Permissible stress exerted by the machine on the tape :
Maximum 2.2 pounds (1 kg) ;

3.5 Spool hub : Two types of hubs are acceptable for international exchange. Figs. 1 and 2 give dimensions of the hub principally used in Europe. Fig. 3 gives dimensions of the hub principally used in the United States. Fig. 4 gives dimensions of the flange used with the hub described in Fig. 3.

Maximum outside diameter of the reel of tape : 290 mm.

3.6 Programme identification :

A label giving the following information shall accompany each recording :

- — Broadcasting organization ;
- — Programme title ;
- — Reference number ;
- — Total number of spools ;
- — Number of spool ;
- — Total playing time ;
- — Tape speed.

At least the reference and spool numbers must always be repeated on the blank strip (see 3.2 above) and if possible also on the boxes containing the spools.

4. Level and frequency characteristics :

Pending an agreement among broadcasting organizations on the standardization of these characteristics, these organizations will endeavour to keep to the characteristics they are at present using both for disks and magnetic tape.

---

* The primary speeds are recognized for international exchange of programmes, but it is probable that in the future 30"/s (76.2 cm/s) will be gradually superseded by 15"/s (38.1 cm/s).

** The secondary speed cannot be used except by prior agreement between the organisations exchanging programmes.

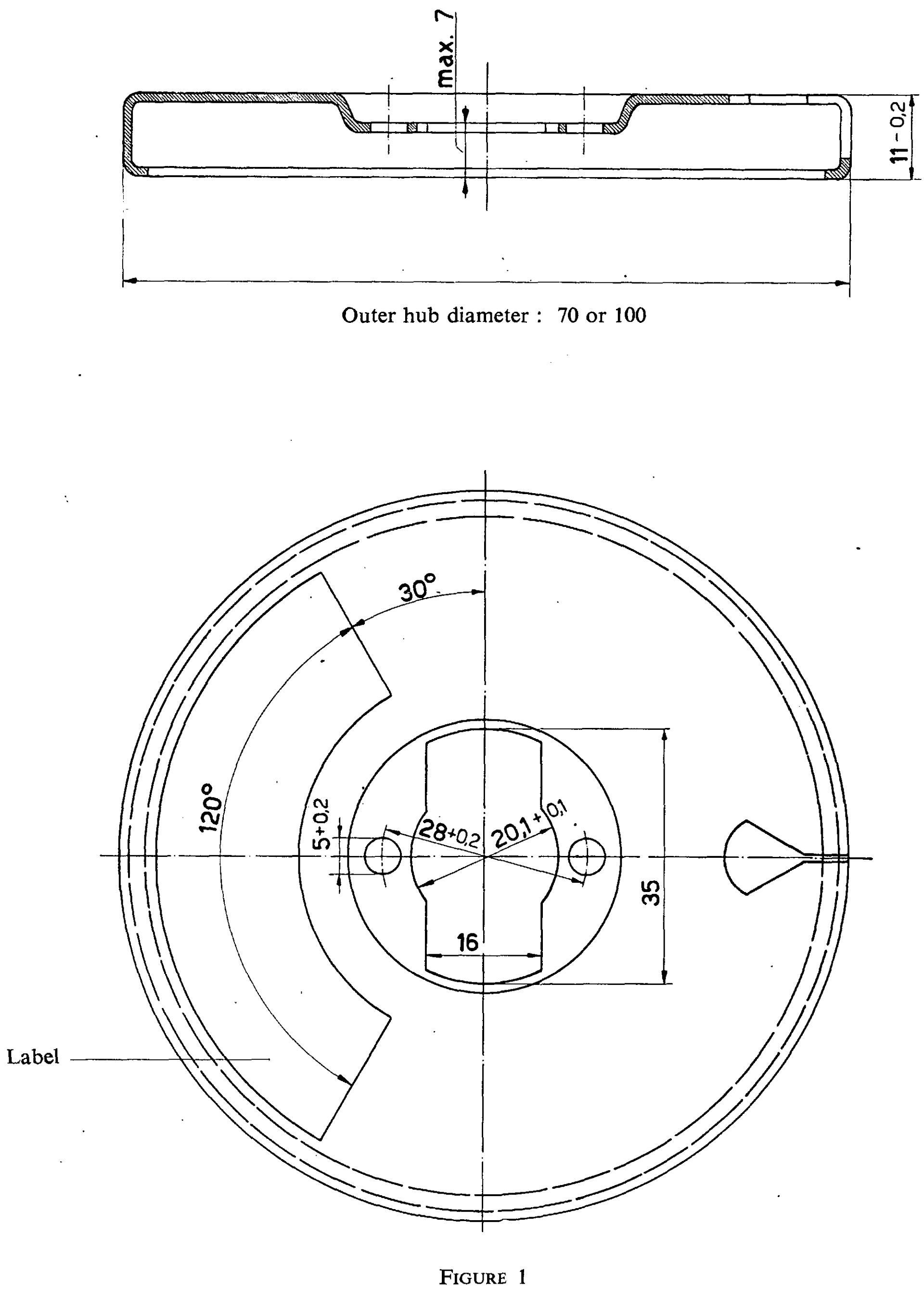


FIGURE 1

EUROPEAN STANDARDS

Spool hub for magnetic tape recording

Note. — The dimensions indicated are given in millimetres

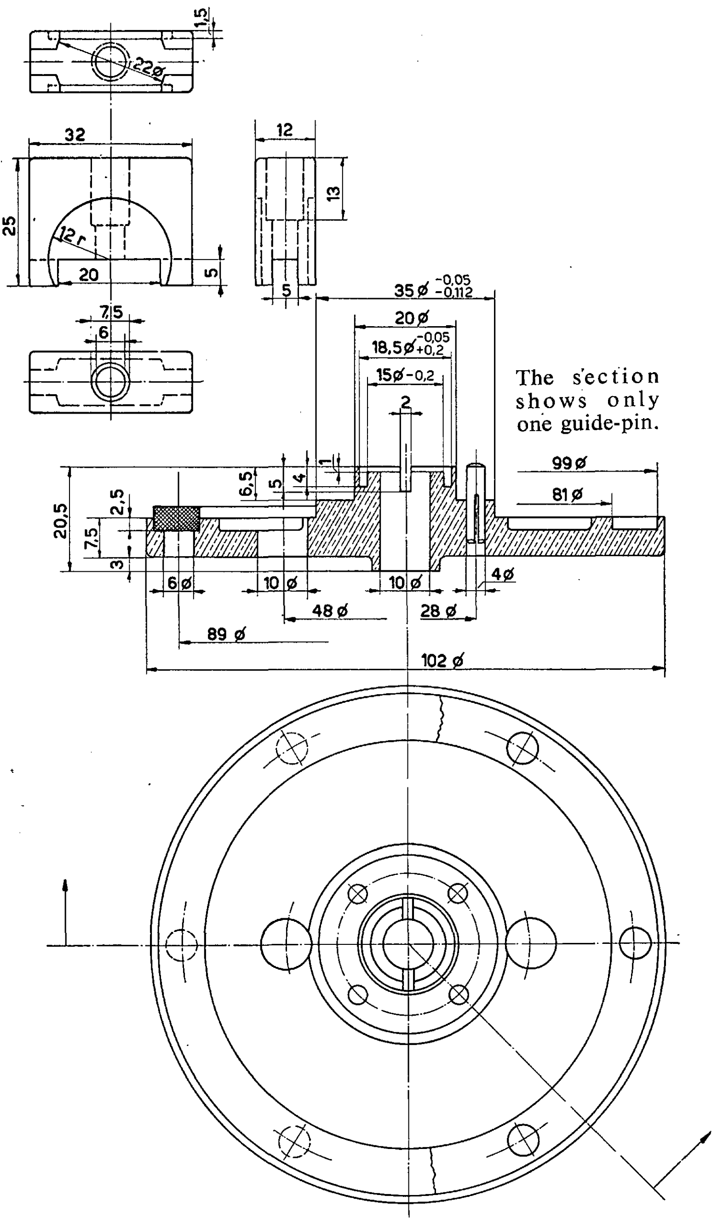
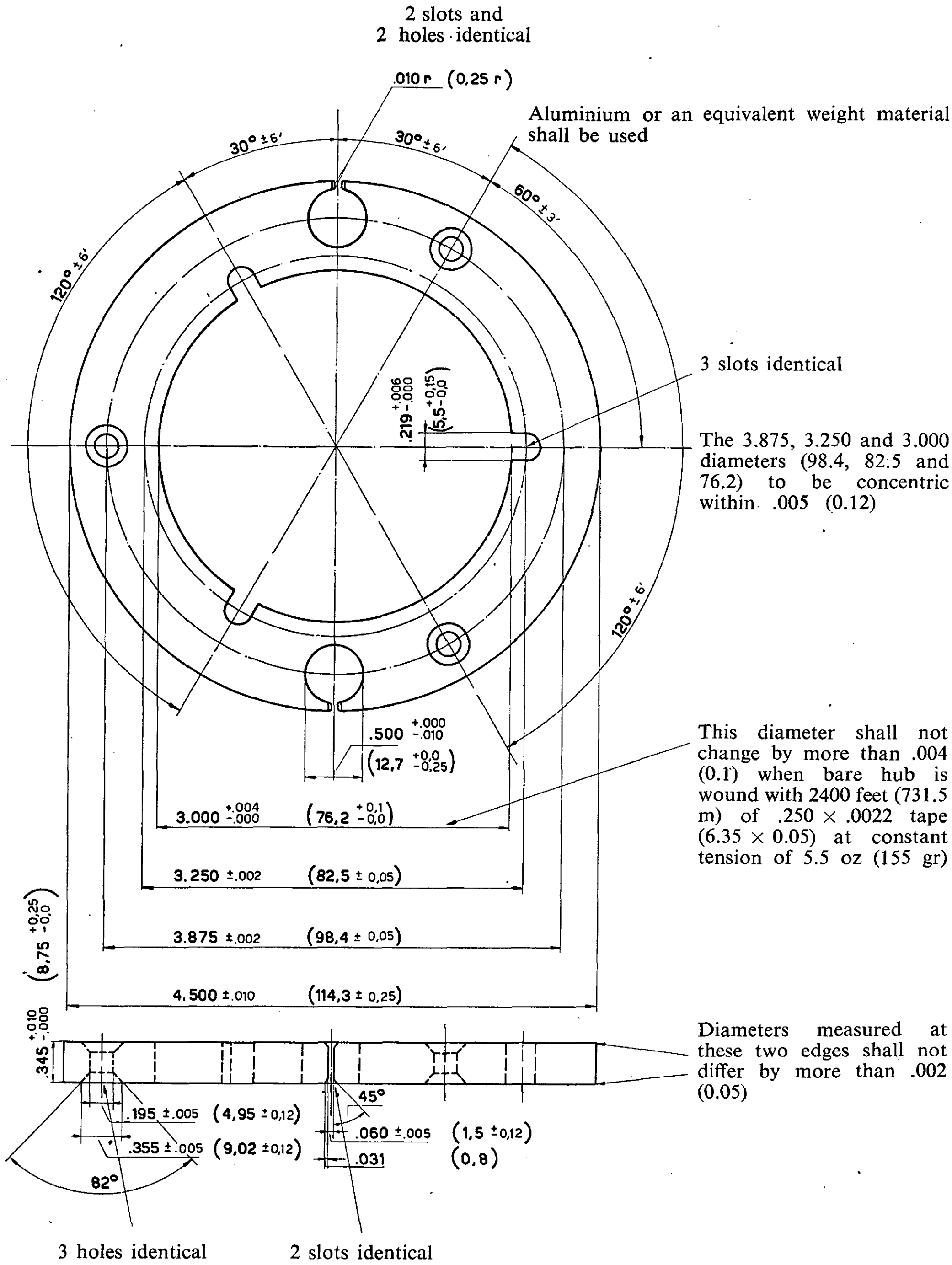


FIGURE 2

EUROPEAN STANDARDS

Guide spool and attachment for magnetic tape recording

Note. — The dimensions indicated are given in millimetres.



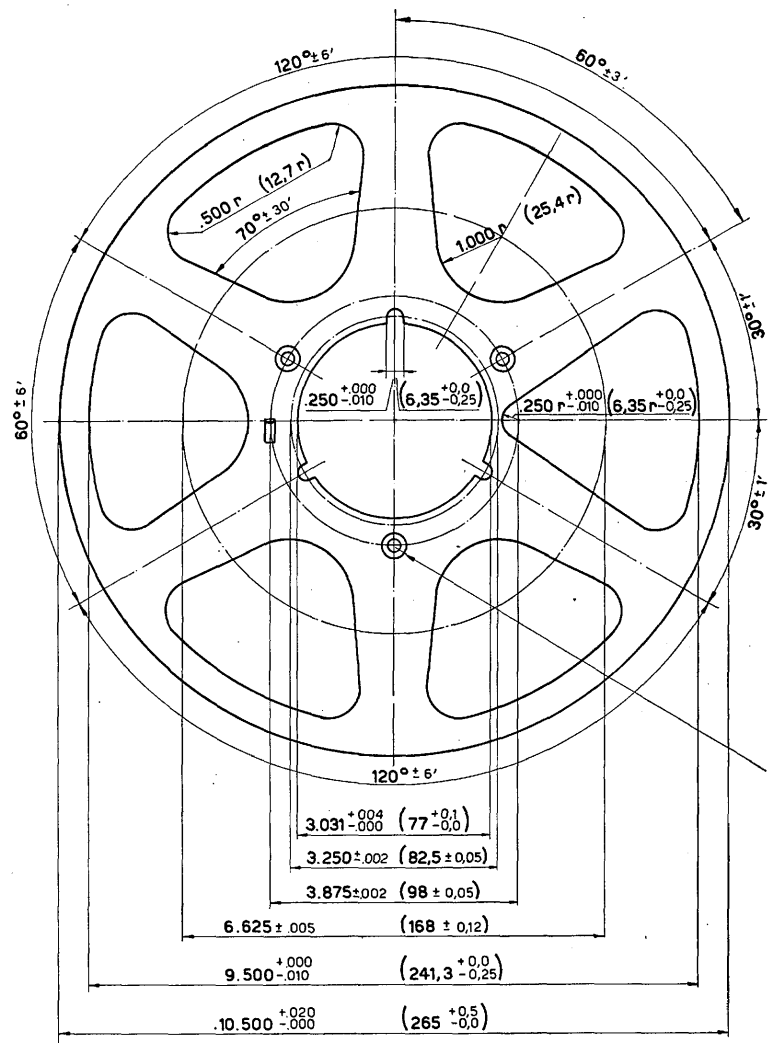
Unless indicated otherwise, break sharp edges to .004 r (0.01 r)

FIGURE 3

U.S.A. STANDARDS

Hub for magnetic tape reel

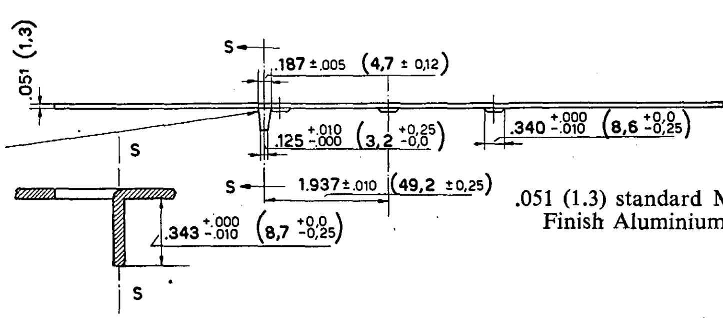
Note. — Unless otherwise indicated, all dimensions are in inches, with corresponding figures in millimetres in parenthesis.



The 10.500, 3.875, 3.250 and 3.031 diameters (265, 98, 82.5 and 77) to be concentric within ±.005 (±0.12). Departure of any point on flange from average plane of flange not to exceed ± .010 (± 0.25)

Punch .190 (4.8) hole and dimple for No. 6-32 flat head serew (dimensions given in other view) — 3 holes

Tape attachment tab : to be smoothed to eliminate all sharp edges



.051 (1.3) standard Mill Finish Aluminium

Section SS enlarged

FIGURE 4

U.S.A. STANDARDS

Flange for magnetic tape reel

Note. — Unless otherwise indicated, all dimensions are in inches, with corresponding figures in millimetres in parenthesis.

RECOMMENDATION No. 82

TELEVISION STANDARDS

(Recommendation No. 29)

The C.C.I.R.,

CONSIDERING :

That a study of television standards was recommended by the C.C.I.R. at its Fifth Plenary Assembly, to facilitate the interchange of programmes and to coordinate the design of receivers ;

RECOMMENDS :

1. That television systems should be capable of operating independently of the frequency of the power supply ;

2. That the aspect ratio of the picture should be 4/3 ;

3. That line interlacing should be used in the ratio 2/1 ;

4. That the scanning of the picture viewed during active periods should be from left to right and top to bottom ;

5. That the vision carrier should be modulated in amplitude ;

6. That receivers should be designed for the reception of vestigial side band transmissions and that the vision carrier should be attenuated in the receiver ;

7. That transmitters should be designed to attenuate the lower or the upper side band without attenuating the carrier ;

8. That the vision and sound carriers should be located within the channel, the vision carrier being 1.25 Mc/s from one edge and the sound carrier being 0.25 Mc/s from the other edge ;

9. That the unwanted side band should be attenuated so that the radiated field is reduced by at least 20 db at that edge of the channel which is 1.25 Mc/s away from the vision carrier ;

10. That the black level should be a definite carrier level independent of the picture content ;

11. That there is no necessity to standardize the polarization of the transmitted wave.

Note. — In those countries where transmitters are already operating on a regular basis Administrations are free to use their discretion as to the extent to which the provisions of § 6, 7, 8 and 9 of this recommendation may be implemented in the case of these transmitters, taking into account the modifications to existing receivers that might be necessary.

RECOMMENDATION No. 83

DISTURBANCES IN TELEVISION RECEIVERS RESULTING FROM HARMONICS AND OTHER NON-ESSENTIAL RADIATIONS FROM RADIO TRANSMITTERS

(Question No. 26)

The C.C.I.R.,

CONSIDERING :

(a) That the Study Programme No. 2 relating to Question 1.*b*, covers the general problem of harmonic radiation from transmitters ;

(b) That the general study of the interference to other services by those harmonic radiations will include that caused to television reception ;

RECOMMENDS :

That the Administrations should collect all possible data relating to such interference with broadcasting (television) in order to assist the Study Group concerned with transmitter questions.

Note. — This recommendation concludes the study of Question No. 26.

RECOMMENDATION No. 84

MAXIMUM POWER FOR SHORT DISTANCE HIGH FREQUENCY BROADCASTING IN THE TROPICAL ZONE *

(Question No. 27)

The C.C.I.R.,

CONSIDERING :

That, until further experimental and theoretical data become available to enable a final limit to be determined, it is desirable to establish at this time a provisional limit for the power of short distance high frequency broadcasting stations employing double sideband transmission and operating in the tropical zone ;

RECOMMENDS :

1. That, until further notice, the upper power limit for the unmodulated carrier wave for short distance high frequency broadcasting in the tropical zone on frequencies up to and including 5060 kc/s should be 10 kW for day-time operation and 5 kW for night-time operation ;

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* As this service is defined in the considerations of Question No. 27.

2. That, until further notice, the upper power limit of the unmodulated carrier wave for short distance high frequency broadcasting in the tropical zone on frequencies above 5060 kc/s should be 5 kW for day-time operation and 1 kW for night-time operation ;

3. That, within the above limits, Administrations should use as far as possible lower power if this will assure satisfactory service throughout the reception area ;

4. That the frequency used should always be as near as possible to the optimum working frequency (provided that the frequency employed is within one of the permissible broadcasting frequency bands), in order to provide as good a received signal to noise ratio as possible.

Note. — Question No. 27 is maintained on the agenda of the C.C.I.R. (See Study Programme No. 38 and Questions Nos. 69, 70 and 71).

RECOMMENDATION No. 85

ADDITION TO APPENDIX 9 OF THE RADIO REGULATIONS

(Question No. 28)

The C.C.I.R.,

CONSIDERING :

(a) That a code should not be inserted in the Radio Regulations unless it provides a sufficiently accurate assessment of the quality of transmissions ;

(b) That it would be advisable for all the Administrations to use the same codes, and that the number of officially recognized codes must consequently be as restricted as possible ;

(c) That the abbreviations in the Q code are in general inadequate for obtaining a clear idea of the quality of a transmission ;

(d) That the SINPO code has been used for several years by some Administrations ;

(e) That the FRAME and RAFISBENQO codes have been used for a long time but :
- the SINPO code gives a more accurate description of the transmission quality than the FRAME code and is easier to use ;
- the SINPFEMO code is derived from the SINPO code by adding three letters relating to special features of telephone transmissions and is easier to use than the RAFISBENQO or RISAFMONE code ;

(f) That the information which is not included in the SINPO or SINPFEMO code may be transmitted satisfactorily by service message ;

UNANIMOUSLY RECOMMENDS :

1. That the SINPO and SINPFEMO codes described in the Annex should be included in the Radio Regulations ;

2. That, in the meantime, these signal codes may be placed in service by interested Operating Agencies or Administrations at the earliest time that may be mutually arranged between them. In this respect, the Secretary General is asked to circularize all Administrations to know if they are prepared to apply these codes by 1st January, 1952.

ANNEX

SINPO Signal Reporting Code

Rating Scale	S	I	N	P	O
	Signal Strength	Degrading Effect of			Overall Readability (QRK)
		Interference (QRM)	Noise (QRN)	Propagation Disturbance	
5	Excellent	Nil	Nil	Nil	Excellent
4	Good	Slight	Slight	Slight	Good
3	Fair	Moderate	Moderate	Moderate	Fair
2	Poor	Severe	Severe	Severe	Poor
1	Barely Audible	Extreme	Extreme	Extreme	Unusable

SINPFEMO Signal Reporting Code

Rating Scale	S	I	N	P	F	E	M	O
	Signal Strength	Degrading Effect of			Frequency of Fading	Modulation		Overall Rating
		Interference (QRM)	Noise (QRN)	Propagation Disturbance		Quality	Depth	
5	Excellent	Nil	Nil	Nil	Nil	Excellent	Maximum	Excellent
4	Good	Slight	Slight	Slight	Slow	Good	Good	Good
3	Fair	Moderate	Moderate	Moderate	Moderate	Fair	Fair	Fair
2	Poor	Severe	Severe	Severe	Fast	Poor	Poor or Nil	Poor
1	Barely audible	Extreme	Extreme	Extreme	Very Fast	Very poor	Continuously overmodulated	Unusable

Special remarks

(a) A signal report shall consist of the code word SINPO or SINPFEMO followed by a five or eight figure group respectively rating the five or eight characteristics of the signal code.

(b) The letter X shall be used instead of a numeral for characteristics not rated.

(c) Although the code word SINPFEMO is intended for telephony, either code word may be used for telegraphy or telephony as may be desired.

(d) The overall rating for telegraphy shall be interpreted as follows :

	MECHANIZED OPERATION	MORSE OPERATION
5 Excellent	4-channel Time Division Multiplex	High Speed Morse
4 Good	2-channel Time Division Multiplex Single channel Start-stop Printer .	100 wpm Morse
3 Fair	Marginal. Single Start-stop Printer	50 wpm Morse
2 Poor	Equivalent to 25 wpm Morse	25 wpm Morse
1 Unusable	Possible BK's XQ's, call letters distinguishable	Possible BK's, XQ's, call letters distinguishable

QUESTIONS

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QUESTIONS Nos. 1, 2* AND 3

REVISION OF ATLANTIC CITY RECOMMENDATION No. 4

The C.C.I.R.,

CONSIDERING :

That to give maximum effectiveness to the studies requested by the International Radio Conference of Atlantic City (1947) in its recommendation No. 4 to the C.C.I.R. it is expedient to rearrange this recommendation and incorporate the relevant Bucharest questions ;

UNANIMOUSLY DECIDES :

A. That the text of Atlantic City Recommendation No. 4 can be rearranged and extended as follows :

Question No. 1

(Study Group No. I)

In respect of the various classes of emission in use, determination of :

(a) The bandwidth strictly necessary to ensure a service of the appropriate quality, practical methods of measuring the bandwidth actually occupied by each emission ;

(b) the level of radio-frequency harmonics radiated by the stations of the different services,
the level to which it is practicable to reduce such harmonics,
the methods of achieving this result,
the corresponding methods of measurement ;

(c) Study of improved methods of obtaining frequency stability in transmitters.

Question No. 2

(This question no longer remains for study)

Question No. 3

(Study Group No. III)

(a) Consideration of the desirable conditions to be fulfilled by the complete systems employed by the different services in order to determine the required technical performance of the equipment (including the station terminal apparatus and the antennas) and of the measuring apparatus used to ascertain whether the equipment satisfies the recommendations of the C.C.I.R. ;

(b) Consideration of the field strength intensity necessary for the reception of different classes of emission in the different services ;

(c) Consideration of the effect of frequency stability of transmitters on the minimum practicable spacing between stations ;

(d) Consideration of the minimum practicable spacing between the frequencies of stations operating in adjacent channels for different classes of emission in the different services.

* Question No. 2 no longer remains for study.

B. That the above questions be studied simultaneously and with the same urgency ;

C. That Questions Nos. 1, 4, 11, 14, 16 and 17 of the C.C.I.R. of Bucharest be removed from the list of questions to be studied by the C.C.I.R.

AND UNANIMOUSLY DECIDES :

To carry on permanently the study of the above-mentioned questions and to publish its recommendations and possible revisions as soon as practicable.

QUESTION No. 4

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

(Study Group No. XII)

*(The reasons which justify this question are given in an annex *)*

The C.C.I.R.,

CONSIDERING :

Recommendation No. 8 of the International Radio Conference (Atlantic City, 1947) and the studies pursued at the Vth Meeting of the C.C.I.R. (Stockholm, 1948) ;

UNANIMOUSLY DECIDES that the following question be studied :

1. What power limitations is it appropriate to impose on radiotelegraph stations in the tropical zone, in the shared bands ?
Will it be appropriate to impose on A3 emissions limitations similar to those that might be imposed on broadcasting stations as a result of studies in connection with question No. 27 ?

2. (This paragraph no longer remains for study.)

3. Is it necessary that the Administrations attempt to improve as soon as possible the frequency stability of fixed stations within the shared bands to the values specified in Column 3 in App. 3 of the Atlantic City Radio Regulations ?
Is it necessary that they operate transmitters which do not meet this requirement only on frequencies outside the shared bands ?

4. (This paragraph no longer. remains for study.)

5. (This paragraph no longer remains for study.)

6. What is the minimum permissible protection ratio of a broadcasting station, when measured at the output of a receiver having an audio frequency cut-off of 6.4 kc/s and to what minimum value of the wanted field should this ratio be maintained ?

7. (This paragraph no longer remains for study.)

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* The annex will be found in the Stockholm book of C.C.I.R. Questions, etc.

QUESTION No. 6

GROUND WAVE PROPAGATION

(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

The continuing importance of the effect of the characteristics of the earth on the propagation of waves used for all types of radio communication and location, including directional transmission and direction finding ;

UNANIMOUSLY DECIDES that the following question be studied :

Ground Wave Propagation

and for this study RECOMMENDS :

That the 1938 C.C.I.R. curves of ground wave propagation be revised and extended to cover the whole of the radio frequency spectrum now in practical use, giving particular attention to :

1. Transmission over mixed paths, e.g. partly over land and partly over sea ;
2. The effect of hills and other obstacles in diffracting the waves in either the horizontal or vertical plane ;
3. The siting of aerials for very high frequency ;
4. The relative effects obtained with horizontal and vertical polarization ;
5. The variations in phase of radio waves in transmission over ground between two points.

QUESTION No. 11

PRESENTATION OF THE RESULTS OF ATMOSPHERIC RADIO NOISE MEASUREMENTS FOR THE REQUIREMENTS OF OPERATIONAL SERVICES

(Study Group No. III)

The results of measurements of atmospheric radio noise show the intensity of noise in given experimental equipment. It is necessary to transform these results in order to ascertain to what extent the noise affects various services and various types of receiving equipment used.

A preliminary answer to these questions is given by certain documents (RPU Report No. 5 and PFB Doc. No. 271). It is, however, most important for these subjects to be systematically and thoroughly examined. Our present knowledge in this field does not seem to justify the recommendation of standardised measuring methods, and further progress in this direction seems, for the present, to be within the province of scientific research. However. while awaiting further results, it seems advisable to promote activity on a more empirical basis with a view to revising and improving the above-mentioned documents.

In order to facilitate and to coordinate these studies, the C.C.I.R. is of the opinion that the problems arising from the requirements of radio operation should be clearly stated :

(a) By drawing up a list of the services the operation of which should be considered ;

(b) By enumerating the characteristics of the receiving equipment, the use of which is envisaged, with a view to preparing correction tables and graphs enabling particular cases to be considered.

Consequently, the C.C.I.R.

RECOMMENDS :

1. That the studies by the large Scientific Research Organizations be encouraged on the influence of atmospheric radio noise on the general operation of radiocommunication and in particular receiving equipment ;

2. That more empirical work be carried out with regard to the revision of existing documents relating to these questions ;

3. That the programme of these two categories of research be particularly concerned with the following services :

   A. Aural Services :

   (a) A1 Telegraphy (24 bauds) with aural reception ;

   (b) A2 Telegraphy modulated at 1000 c/s (24 bauds) with aural reception ;

   (c) A3 Double sideband commercial telephony ;

   (d) A3 High fidelity double sideband commercial telephony ;

   (e) A3 Commercial telephony with reduced carrier, including 1 to 4 independent sidebands ;

   (f) A3 Broadcasting ;

   B. Telegraph Services with Automatic Recording :

   (a) A1 Telegraphy (120 to 480 bauds) ;

   (b) A2 Telegraphy, modulated at 1000 c/s (120 bauds) ;

   (c) F1 Frequency Shift Telegraphy (120 to 480 bauds) ;

   C. Other Services :

   (a) A4 Facsimile ;

   (b) Hell ;

   (c) Baudot-Verdan ;

   (d) Multitone Telegraphy (S.S.B. reduced carrier) ;

4. That the research programme be likewise concerned with the following characteristics of receiving equipment and that the results be submitted in the form of correction tables or nomograms making it possible for each particular case to be considered, viz :

   (a) Antenna ;

   (b) Bandwidth of RF, IF and AF Stages ;

   (c) Time constant of automatic volume control ;

   (d) Method of detection.

QUESTION No. 17

IDENTIFICATION OF RADIO STATIONS

(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That in order to carry out an efficient monitoring service of radio stations it is necessary for these stations to be identified as regularly as possible during their transmissions ;

(b) That in many categories of radio services the identification procedure used at present is satisfactory to both the operating Agencies and the regulating Administrations, as is the case for single channel low speed telegraphy ;

(c) That the Atlantic City Radio Regulations (Art. 13, Section V, § 10) set forth requirements for transmission of radio call signs ;

(d) That certain types of radio stations are exempted from the necessity of having an international call sign ;

(e) That the problem of accomplishing identification of multichannel telephone and telegraph transmissions is particularly difficult without the use of costly special apparatus ;

(f) That the requirement of frequently transmitting a call sign may impose a difficult and costly hardship on the operating Agencies, particularly where heavily loaded multichannel or high speed machine operation is employed ;

UNANIMOUSLY DECIDES that the following question be urgently studied :

The possibilities of ensuring the convenient identification of stations utilizing multiple channel, synchronized systems, high speed machine systems, the Hell system and systems for the transmission of radiophotography, or other special systems of transmission, in the most effective manner without the necessity of interrupting the transmissions of such stations, or of increasing the bandwidth of the emissions.

The increased costs which would be incurred by the recommended solutions to the monitoring and transmitting stations should be borne in mind.

QUESTION No. 18

TELEGRAPHIC DISTORTION

(Study Group No. I)

The C.C.I.R.

UNANIMOUSLY DECIDES :

That it is advantageous that a joint study should be made by the C.C.I.T. and the C.C.I.R. of the following question :

Establishment of a general definition of telegraphic distortion, capable of being usefully applied to the case of radiotelegraphy.

QUESTION No. 19

5-UNIT RADIO TELEPRINTER

(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That the C.C.I.T. has recommended the use on international telegraph circuits, subject to certain reservations, of 5-unit apparatus employing the international telegraph alphabet No. 2 (C.C.I.T. 6th Meeting, Doc. No. 145) ;

(b) That radiotelegraph circuits are required to operate under varying conditions of radio propagation, atmospheric noise and interference which introduce varying degrees of distortion ;

(c) That the use of the 5-unit code is susceptible to errors which are not immediately detectable ;

UNANIMOUSLY DECIDES that the following question be studied :

1. The effects of varying conditions of propagation, atmospheric noise and interference on radiotelegraph circuits employing the 5-unit code in

(a) synchronous systems,

(b) start-stop systems ;

2. The signal distortion that may be expected having regard to signal/noise ratio, propagation effects, type of transmission, etc. ;

3. The use of special types of transmission and the possible adoption of another code on the radio circuit ;

4. If another code or special type of transmission is recommended, what equipment should be used at the terminals of radio circuits to permit their interconnection with wire circuits using the 5-unit international alphabet No. 2 ?

QUESTION No. 20

FREQUENCY SHIFT KEYING

(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

(a) That frequency shift keying is employed in radio-telegraphy on fixed services and its use may be extended to the mobile services ;

(b) That it is desirable to standardize the main operating characteristics of systems employing frequency shift keying ;

(c) That various technical factors influence the choice of operating characteristics in such systems, in particular :

1. The overlap of marking and spacing signals due to multipath propagation (in this respect a small deviation is preferable) ;
2. The possible advantage of frequency diversity for reception (an advantage which increases with deviation) ;
3. The economy of bandwidth and the consequent necessity for controlling the shape of the transmitted signals ;
4. Instability of frequency, which is one reason for the relatively large deviation employed in many existing equipments ;
5. The choice of receiving systems, whether with separate filters or with frequency discriminator ;

UNANIMOUSLY DECIDES that the following question be studied :

1. Fixation of one or more standard values of deviation for the fixed and mobile services in the various frequency bands, having regard to the various factors, in particular :
   (a) the frequency spectrum resulting from the keying operation,
   (b) the degree of frequency diversity desired,
   (c) economy of bandwidth,
   (d) instability of frequencies ;
2. Standardization of the relative position of the marking frequency and the spacing frequency (is it desirable to utilize the upper frequency for mark and the lower frequency for space or vice versa ?) ;
3. Compilation of a standard terminology regarding the characteristics of systems employing frequency shift keying.

QUESTION No. 23

HIGH FREQUENCY BROADCASTING DIRECTIVE ANTENNA SYSTEMS

(Study Group No. X)

*The reasons which justify the following question are given in the annex *.*

It will be appropriate to organise the compilation of statistical measured results from antennas of different types in various parts of the world, in respect of the signal laid down by the main beam and subsidiary lobes, and the amount of scattering in unwanted directions.

The C.C.I.R.

UNANIMOUSLY DECIDES that the following question be studied :

What are the methods by which the formation of strong subsidiary lobes can be avoided, particularly when the directional antenna systems are fed asymmetrically to produce a slew of the main beam ?

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* The annex will be found in the Stockholm book of C.C.I.R. questions, etc.

QUESTION No. 27

MAXIMUM POWER FOR SHORT DISTANCE HIGH FREQUENCY BROADCASTING IN THE TROPICAL ZONE

(Study Group No. XII)

*The considerations in formulating this question are given in the annex *.*

The C.C.I.R.,

CONSIDERING :

(a) That a short distance high frequency broadcasting service is an indirect ray service in which the incident ray meets the reflecting layer at a considerable angle to the horizontal and there is no appreciable skip distance between the transmitter and the service area ;

(b) That the outer limit of a short distance service is considered here as being 800 km ;

UNANIMOUSLY DECIDES that the following question be studied :

1. What is the upper power limit for short distance high frequency broadcasting on frequencies up to and including 6.2 Mc/s ?

2. For those occasions when the use of a frequency higher than 6.2 Mc/s in the H.F. band is appropriate, what is the upper limit of power ?

3. Where the service area to be covered, the propagation conditions, noise and other pertinent factors permit, should a power lower than those specified in § 1 and 2 be used ?

4. For a short distance high frequency broadcasting service, what attention should be paid to the antenna system to increase its radiation within the angle comprised between the vertical and the limit direction desired, corresponding to the service area, and to reduce radiation outside the service area ?

QUESTION No. 37

HIGH FREQUENCY BROADCASTING, JUSTIFICATION FOR USE OF MORE THAN ONE FREQUENCY PER PROGRAMME

(Study Group No. X)

The International High Frequency Broadcasting Conference, Mexico City,

CONSIDERING :

That it has not been possible to make a complete study of a number of questions mentioned in the Report of the Committee on Technical Principles and Standards (Doc. No. 635 **) ;

DRAWS THE ATTENTION of the C.C.I.R. to the technical data contained therein and REQUESTS the C.C.I.R. to undertake the further study of the following questions :

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* The annex will be found in the Stockholm book of C.C.I.R. questions, etc.

** Of Mexico.

The technical conditions under which, because of the urgent need for economy in the use of frequencies for broadcasting, it would be possible to justify the use of more than one frequency for the transmission of one programme to one reception area. This study should be linked with a study of the question of an appropriate definition of "geometric reception area".

QUESTION No. 39

HIGH FREQUENCY BROADCASTING, CONDITIONS FOR SATISFACTORY RECEPTION

(Study Group No. X)

The International High Frequency Broadcasting Conference, Mexico City,

CONSIDERING :

That it has not been possible to make a complete study of a number of questions mentioned in the Report of the Committee on Technical Principles and Standards (Doc. No. 635 *);

DRAWS THE ATTENTION of the C.C.I.R. to the technical data contained therein and REQUESTS the C.C.I.R. to undertake the further study of the following questions :

The technical and practical questions, such as the desirable modulation bandwidth, fading, and the various forms of distortion, related to the subjective aspects of quality of reception.

In making this study, particular attention should be given to the question of the corrections that should be made to take account of long and short term fading in determining :

(a) the average level of the signal necessary to ensure satisfactory reception in the presence of noise or other interference having a fixed level ;

(b) the average level of the signal necessary to ensure satisfactory reception in the presence of atmospheric noise ;

(c) the ratio required between the average levels of wanted and unwanted signals.

QUESTION No. 43

VOICE FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(Study Group No. III)

The VIth Plenary Assembly of the C.C.I.T., Brussels (May, 1948) put the following question for study by the C.C.I.R. :

"What are the conditions which should be imposed on V.F. telegraph plant employing double current technique used on modulated radio transmission channels ? "

Note. — To be studied in collaboration with the International Telegraph Consultative Committee (C.C.I.T. Study Group No. 2).

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* Of Mexico.

QUESTION No. 44

THEORY OF COMMUNICATION

(Study Group No. III)

At its Vth Session (Geneva, September 1950) the Administrative Council of the I.T.U. put the following question for study by the C.C.I.R. :

"What technical methods may be adopted to transmit a given volume of information over a given telecommunication circuit :

(a) in a given time, using a minimum bandwidth ;

(b) with a given bandwidth, in a minimum time ? "

QUESTION No. 46

ARRANGEMENT OF CHANNELS IN MULTI-CHANNEL TRANSMITTERS FOR LONG-RANGE CIRCUITS

(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

That the lack of uniformity in the arrangement and designation of the channels in multi-channel transmitters for long-range circuits may give rise to certain difficulties when one transmitting station has to work with several receiving stations ;

DECIDES that the following question shall be studied :

What is the best way of arranging and designating the channels in multi-channel transmitters for long-range circuits ?

Note. — Members of the C.C.I.R. should exchange information on this subject so that standards may be set up which are acceptable to all Administrations.

QUESTION No. 47

SENSITIVITY AND NOISE FIGURE

(Recommendation No. 2 and Question No. 2)
(Study Group No. II)

The C.C.I.R.,

CONSIDERING :

(a) That Recommendation No. 41 of the C.C.I.R. gives only limited data on receiver sensitivity and noise figure ;

(b) That receiver noise is of greater importance at higher frequencies than at lower frequencies ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. The representative values for reference sensitivity and noise figure for the various types of apparatus used for the reception of different classes of emission in the different services. (See Recommendation No. 41 of the C.C.I.R.)
Figures should be obtained especially for frequencies greater than 10 Mc/s.

2. The appropriate methods of defining the sensitivity of receivers, including the influence of receiver noise, for types of receiver which cannot be adequately defined by the methods given in Recommendation No. 41 of the C.C.I.R. (e.g. Television or Pulse Code Modulation Systems). Appropriate figures defining the sensitivity of such receivers and the corresponding measuring methods should be given.

QUESTION No. 48

DIRECTIVITY OF ANTENNAS AT GREAT DISTANCES

(Former Recommendation No. 17)
(Study Group No. III)

The C.C.I.R.

UNANIMOUSLY RECOMMENDS :

That administrations and organizations suitably equipped carry out experiments on the directivity of antennas at great distances, by the use of directive antennas which can be rotated, or by other appropriate methods.

QUESTION No. 49

PRESENTATION OF ANTENNA RADIATION DATA

(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That a system of radiation presentation known as the " Cymomotive Force Method " is an attempt to tackle this question in a new manner as compared with the other methods used in connection with propagation diagrams ;

(b) That the cymomotive force of an antenna in a given direction may be defined as the product of the R.M.S. value of the electrical radiation field intensity of the antenna in this direction (in vacuo) and the distance from the centre of the antenna ; *

(c) That the available information relating to this method is contained in Document No. 392 of Geneva ;

DECIDES that the following Question should be studied :

Is the cymomotive force method the most suitable means of presentation of radiation data, either calculated or determined experimentally ?

QUESTION No. 50

PRACTICAL USES OF RADIO PROPAGATION DATA

(Recommendation No. 14)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

That it is desirable to have a clear indication of the extent to which the propagation data, calculations and graphs are being used by Administrations and of the extent to which these data are justified by operational data,

DECIDES that the following questions shall be studied :

1. What practical uses are made of radio propagation data by radio operating services and Administrations, e.g. the actual employment of graphs, tables of predicted M.U.F., ionospheric storm warnings, etc. ?

It is desirable that specific examples be given of the nature, extent, and value of such uses based on current practice and that suggestions be made for desirable future practice ;

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* The distance at which the measurement is made shall be such that the field follows the inverse distance law.

2. What is the relative value of the various methods of applying the data and of the tables, graphs, etc., used in past international radio conferences ?

2.1 What are the best methods of drawing up such tables, graphs, etc. ?

2.2 Which tables, graphs, etc. already in existence are most suitable for general application ?

2.3 What improvements can be suggested ?

3. To what extent are these predicted data in accordance with actual propagation conditions in the various parts of the world and during different periods of solar activity ?

QUESTION No. 51

SEVERITY OF FLUCTUATIONS IN FIELD AT RECEPTION

(Questions Nos. 14 and 15)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

(a) That attempts to characterize, by a single distribution function (Rayleigh's law), the fluctuations of the field received from the ionosphere have been successful only for long distance transmissions at high frequencies ;

(b) That there are exceptions, even in such cases ;

UNANIMOUSLY DECIDES that the following question should be studied :

Is it possible to characterize the majority of cases of fluctuation by an approximate distribution function containing one or more parameters in such a way that the parameter(s) provide an indication of the severity of the phenomenon for the different services ?

QUESTION No. 52 *

ALLOWANCES FOR FADING

(Question No. 15)
(Study Group No. VI)

The C.C.I.R.,

UNANIMOUSLY DECIDES that the following question be studied :

What are suitable numerical values or formulae for three types of fading which may broadly be classified as :

— rapid variations,
— hourly variations,
— daily variations ?

* This Question replaces Question No. 15.

Rapid variations are intended to refer to those whose duration is roughly between 10^{-4} second and several seconds.

" Hourly " and " daily " are intended to define variations superimposed on the regular daily variation.

1. For rapid fading, the Rayleigh distribution of amplitudes is often assumed. Does this assumption appear to be a reasonable one ?

2. Is 6 db as an allowance for hourly variation a reasonable value ?

3. Is an additional allowance needed to account for daily variations ?

4. To what extent are these values dependent upon geographical location ?

5. To what extent are these values mutually dependent, that is, to what extent can these variations be used independently in determining acceptable signal-to-interference ratios ?

QUESTION No. 53.

CHOICE OF A BASIC INDEX FOR IONOSPHERIC PROPAGATION

(Question No. 45)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

(a) That it is indisputable that events and processes on the sun are the largest factor controlling the variations in the characteristics of the ionosphere, over both long and short periods ;

(b) That the relative sunspot numbers of Zurich have thus far been the principal basis for the prediction of ionospheric propagation characteristics because of the long period of time for which they have been available ;

(c) That Zurich sunspot numbers provide, when suitably smoothed, an index having fairly good correlation with similary smoothed ionospheric propagation data, but are less satisfactory when :

— considered in relation to detailed ionospheric behaviour involving trends or events of duration short compared with the smoothing period generally used, and

— the level of solar activity is high ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. What are the desirable characteristics of a solar index which render it most applicable to ionospheric propagation ?

2. What solar phenomena, which can be observed in a sufficiently objective manner, will provide a more useful index of activity for application to ionospheric propagation than relative sunspot numbers ?

3. What ionospheric characteristics, which can be determined in a sufficiently objective manner wherever observed, may be usefully employed as a basic index for ionospheric propagation ?

QUESTION No. 54

STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Former Recommendation No. 18)
(Study Group No. VII)

The C.C.I.R.,

CONSIDERING :

(a) That the International Administrative Radio Conference, Atlantic City 1947, allocated frequency bands 2.5 Mc/s $\pm$5 kc/s (2.5 Mc/s $\pm$2 kc/s in Region 1), 5 Mc/s $\pm$5 kc/s, 10 Mc/s $\pm$5 kc/s, 15 Mc/s $\pm$10 kc/s, 20 Mc/s $\pm$10 kc/s, and 25 Mc/s $\pm$10 kc/s, and that the Conference requested the C.C.I.R. to study the question of the provision and operation of a world-wide standard frequency and time service ;

(b) That this service should permit measurement with the maximum accuracy and certainty, while using simple receiving equipment ;

(c) That it is desirable that these services should comprise carrier and modulation frequencies with identical values for all transmissions, as well as time signals of uniform type ;

(d) That the relative merits of several possible programmes of modulation can only be determined by experiment ;

(e) That a number of stations will be necessary to provide a world-wide service, and that their simultaneous operation may cause harmful interference, the extent of which can only be determined, and solutions found, by experiment ;

(f) That the use of more stations than are technically necessary to provide world-wide coverage would, by producing harmful interference, diminish the utility of the service ;

(g) That any experiments that may be made should be so designed and controlled as to minimize disturbance of the existing service ;

(h) That the standardization of time is the responsibility of the International Committee of Time ;

(i) That emissions from standard frequency stations are valuable in studies of radio propagation ;

(j) That the periodical broadcasting of information regarding propagation conditions is useful to operators of radiocommunications services ;

(k) That it is desirable to improve the facilities for radio noise measurement ;

(l) That there is an urgent need to put into operation additional standard frequency and time stations, perhaps in the United Kingdom and in Australia, to serve the now inadequately served areas of the world ;

(m) That conclusions should be reached as to the form of the service and the optimum number of stations before the next C.C.I.R. Meeting ;

RECOMMENDS :

1. That experimental emissions on 2.5, 5, 10, 15, 20 and 25 Mc/s be arranged, particularly to serve the now inadequately served areas of the world, (perhaps from additional stations in the United Kingdom and in Australia, and such other stations as the Study Group No. VII may find practical and available), to determine the effective service areas and the zones of interference with the existing emissions from WWV ;

2. That the Study Group No. VII organise and control the experiments, arrange such further experiments as may seem desirable, and report through the Director of the C.C.I.R. to the Administrations concerned ;

3. That the Study Group No. VII give the maximum possible consideration, within practicable limits, to the proposals of the Administrations which wish to cooperate in the establishment of this service ;

4. That the initial experiments be with emissions on 2.5 and 5 Mc/s, to be followed by experiments on 20 and 25 Mc/s ;

5. That when sufficient information has been gained on 2.5, 5, 20 and 25 Mc/s the experiments be extended to 10 and 15 Mc/s, one frequency at a time ;

6. That in arranging the experiments the maximum practical advantage be taken of the properties of directional antennas, and of transmitter power adjustments, to assure good service with a minimum of interference ;

7. That the Administrations consider, as in the general interest, that no new permanent stations in the standard frequency bands be notified to the I.F.R.B. pending the report of the Study Group No. VII, and that no new experimental station be notified to the I.F.R.B. without the agreement of the Study Group No. VII ;

8. That the Study Group No. VII arrange for trials of various desirable modulation frequencies, including 440, 600 and 1000 c/s, and should work out an optimum modulation programme, including time markers ;

9. That the Study Group No. VII consider the possibilities of single sideband operation, with full carrier ;

10. That the carrier and modulation frequencies as transmitted be maintained within $\pm$ 2 parts in 10^{-8} of their nominal value ;

11. That the standard time intervals and time signals preferably take the form of pulses of 5 cycles of 1000 c/s tone repeated at intervals of one mean solar second, synchronised as nearly as possible with reference to Universal Time, with the 59th pulse in each minute suppressed ;

12. That the Study Group No. VII seek the cooperation of the International Committee of Time in the provision of the time service ;

13. That all standard frequency stations periodically and simultaneously interrupt their transmissions to permit measurement of natural radio noise, and that a programme be worked out in cooperation with appropriate committees of the C.C.I.R. and the U.R.S.I. ;

14. That a code signal giving information on radio propagation disturbances be broadcast at regular intervals ;

15. That the attention of appropriate committees of the C.C.I.R. and the U.R.S.I. be drawn to the possible uses of standard frequency transmissions for propagation studies.

QUESTION No. 55

ACCURACY OF FIELD STRENGTH MEASUREMENT BY MONITORING STATIONS

(Recommendation No. 21)
(Study Group No. VIII)

The C.C.I.R.,

CONSIDERING :

(a) That it is necessary for monitoring stations to make field strength measurements within the frequency spectrum used by radio communications, including at least the band from 15 kc/s to 300 Mc/s with an accuracy consistent with the state of the art ;

(b) That it is desirable for monitoring stations to make measurements of field strengths as low as 1 microvolt per metre with an accuracy of ± 2 db in the 100 kc/s-30,000 kc/s band. (Recommendation No. 21, Section 1.) ;

(c) That the absolute accuracy of such measurements is largely dependent upon the method of calibration, the type of antenna used, the skill of the operators and the accuracy of calibration of the standard signal generator used (when the locally generated signal is injected directly into the receiving circuit) ;

(d) That under usual field operating conditions for frequencies above 3,000 kc/s and for values of standard signal generator output under 10 microvolts the accuracies obtained may be much less than that specified in *(b)* above ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. The estimated accuracy of measurement of absolute received field strengths throughout the band 15 kc/s to 300 Mc/s at monitoring stations using :

— measuring apparatus without or with automatic recorders with different specified time constants,
— commercial standard signal generators of known types,
— specified antenna installations.

2. The estimated variations in accuracy of measurement of absolute received field strengths at a number of monitoring stations under the conditions set forth in **1**, above, when absolute calibration of the individual standard signal generator at each station is made, using a bolometer secondary voltage standard, or other method of similar accuracy.

References: SELBY, MYRON C. and BEHRENT, LEWIS F., *A Bolometer Bridge for standardizing Radio Voltmeters.* National Bureau of Standards Journal of Research, January, 1950, RP 2055.

SELBY, MYRON C., *High Frequency Voltage Measurements*, National Bureau of Standards, Circular 481, September 1, 1949.

QUESTION No. 56

WATCH ON THE DISTRESS FREQUENCY OF 2182 kc/s

(Former Recommendation No. 24)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That it is practicable and desirable to establish a special alarm signal for the operation of automatic alarm devices on the frequency of 2182 kc/s ;

(b) That the alarm signal shall be such as to permit transmitting means and receiving devices which are simple, rugged, dependable, stable in performance, of low cost, of easy world-wide production, of long life with a minimum of maintenance, and readily adaptable to existing double-side band radiotelephone equipments ;

(c) That in addition to the requirement for reliable operation it is also essential that false operation shall be negligible ;

(d) That to aid in clearing the distress frequency of other emissions, the alarm signal and detecting device must be capable of operation beyond the distance range at which speech transmission is satisfactory ;

(e) That the automatic alarm device must be capable of operating in as short a time as possible, consistent with avoidance of false signals ;

(f) That the choice of the alarm signal shall be such :

1. as to provide reliable operation of the alarm device,
2. as to provide a distinctive signal readily recognized aurally when received in loud speaker or headphones,
3. as to be capable of reception through interference by speech transmissions, through interference of other types and through noise,
4. as may be produced by a simple device, such as a whistle, as well as by electronic or other means ;

(g) That an alarm signal depending essentially on interruption of the carrier wave is not satisfactory, since interference by continuous carriers may be present ;

(h) That the alarm signal shall be formed by modulating the carrier wave with two or more frequencies in order to protect it against false operation. This modulation may be produced by one main modulating frequency, submodulated by a second frequency ; or the modulating frequencies may be independently produced and transmitted either simultaneously or successively, depending on the system adopted ;

(i) That the choice of modulating frequencies shall be such as to avoid :

1. Interference from frequencies below 872 c/s, which is the maximum beat frequency between two interfering carriers, each being within the tolerance of ± 0.02 per cent (relative to 2182 kc/s) ;
2. Interference from strong components of speech which occur around 400-500 c/s ;
3. Interference from the fundamental and harmonics of existing signalling systems which might cause false operation of the alarm devices or be confused with the alarm signal during aural reception, (i.e. 600, 1200, 1500, 1800 and 3000 c/s) ;

4. Interference from the second harmonics of broadcasting stations operating on 1090 kc/s, which results in the generation of beat frequencies between 1540 and 2450 c/s approximately. (These figures may need reconsideration after the revision of European broadcast allocations) ;

(j) That the modulation frequencies shall be chosen within the passband of normal ships'radio telephone transmitting and receiving equipment ;

(k) That if time coding is used, it should be simple and should not involve close tolerances ;

(l) That any selective calling system used on the frequency of 2182 kc/s, (whether combined with, or entirely separate from, the automatic alarm equipment), must not employ signals which might be confused with the alarm signal or result in false operation of the automatic alarm ;

m) That both the system proposed by the United States and the modified system of the United Kingdom considered at the C.C.I.R. Meeting at Stockholm warrant further study ;

RECOMMENDS :

1. That further tests be made before the form of signal and specification of apparatus for standardization on a world-wide basis can be finally determined ; and the results of these tests be communicated, for the purpose of coordination, to the C.C.I.R. ;

2. That the Administrations and Operating Agencies concerned take part in these tests to determine :

(a) The general suitability of the automatic alarm signal and receiving device recommended by the United States in Doc. No. 25 E and No. 35 E of the Vth Meeting of the C.C.I.R. ;

(b) The characteristics and performance of any automatic alarm systems considered by the C.C.I.R. to offer real advantages over the system referred to under *(a)*.

QUESTION No. 57

WATCH ON THE RADIOTELEPHONY DISTRESS FREQUENCY OF 2182 kc/s

(Recommendation No. 24) *
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That, according to the Atlantic City Radio Regulations, the frequency of 2182 kc/s may be used for calls and replies as well as for distress traffic, urgency and safety signals and messages ;

(b) That there is no uniform practice between the various Administrations regarding the use of the radiotelephony calling and distress frequency for calls and replies ;

(c) That long-distance interference may be caused to distress communications by such calls and replies ;

* This Recommendation has become Question No. 56.

(d) That, the work on board small ships, e.g. fishing vessels, voluntarily fitted with radiotelephony equipment, may not permit regular watchkeeping, not even during prescribed silence periods ;

(e) That it is unlikely that automatic alarm equipment will be installed, either compulsorily or voluntarily, in all such ships ;

(f) That it is desirable to have as many ships as possible participating in the watch on the radiotelephony distress frequency ;

(g) That it is desirable to minimise interference to distress calls, particularly with regard to the aural and automatic reception of the alarm signal ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. How can interference to distress communications be reduced without impairing watchkeeping for distress and calling ?

2. Can a system be recommended to facilitate the reception of the radiotelephony alarm signal and distress call by small ships that are not fitted with automatic alarm equipment ?

QUESTION No. 58

STANDARDISATION OF RADIOPHOTO AND TELEPHOTO EQUIPMENT

(Former Recommendation No. 25)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That it is desirable to standardise the characteristics of apparatus employed for phototelegraph transmission over long distances on HF radio circuits ;

(b) That such standardisation is urgently necessary in order to guide the production of new types of apparatus, and thus to lessen and ultimately eliminate the present difficulties encountered in interworking ;

(c) That it is desirable to standardise certain characteristics of the apparatus in such a way that it will be equally suitable for transmission over metallic circuits ;

(d) That the C.C.I.T. having had under consideration the subject of the transmission of half-tone pictures over mixed metallic and radio circuits, has issued a recommendation as yet unnumbered in the C.C.I.T. series but which is contained in Doc. No. 84 of the Vth Meeting of the C.C.I.R. and has, moreover, outlined certain questions which in the opinion of the C.C.I.T. should be studied by a mixed Commission of the C.C.I.T. and C.C.I.R. ;

(e) That :

1. The transmission system of amplitude modulation is unsatisfactory over H.F. radio circuits because of the intolerable fading ratio invariably encountered ;

2. The time modulation system gives insufficiently good definition ;
3. The system of direct frequency modulation of the radio frequency carrier is not yet sufficiently developed for the transmission of half-tone pictures owing to the high stability necessary in the received frequencies representing the picture tones ;
4. The system of subcarrier frequency modulation has proved satisfactory but requires standardisation in respect of the subcarrier and deviation frequencies having regard to the value of picture keying frequencies to be transmitted ;
5. Taking into account the degree of tolerable distortion, the effect of multipath echoes on long distance H.F. radio circuits normally limits the maximum admissible picture keying frequency to approximately 600 c/s, and that this frequency conforms with the use of the following characteristics :

	(a)	(b)
Index of cooperation	352	264
Speed of rotation of cylinder in r.p.m.	60	90

RECOMMENDS :

1. That the subcarrier frequency modulation system be used with the following characteristics :

(a) subcarrier frequency 1900 c/s
white frequency 1500 c/s
black frequency 2300 c/s

(b) Stability of frequencies should not be greater than :
instantaneous 8 c/s
during 15 minutes 16 c/s

2. That, for the present, the following characteristics be used :

	(a)	(b)
index of cooperation	352	264
speed of rotation of cylinder in r.p.m.	60	90

3. That direct frequency modulation of the radio carrier by the picture modulation frequencies would result in a greater signal-to-noise ratio for a given transmitter and that the perfecting of this system be studied ;

4. That a mixed commission C.C.I.T.-C.C.I.R. be established to study and make recomendations for the standardisation of characteristics, including :

(a) cylinder dimensions ;

(b) alternative speeds of rotation ;

(c) effects of land line characteristics in the case of transmission over combined metallic and radio circuits ;

(d) desirable relation between picture light density and deviation frequency in the system of frequency modulated sub-carrier.

QUESTION No. 59

POWER RELATIONSHIPS FOR MODULATED EMISSIONS

(Question No. 22)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That data obtained with automatic radio field intensity recorders is generally interpreted in terms of the mean power radiated by the transmitting station ;

(b) That it is, therefore, necessary to know the mean power radiated during intervals pertinent to the measurement ;

(c) That although the relationship between peak power and mean power is known for certain types of modulation involving material such as on-off telegraphy using Morse Code or International Telegraph Alphabet No. 2, and telephony consisting of smoothly-read text, there is nevertheless, insufficient information about this relationship for types of modulation involving other material such as telegraphic codes, facsimile, conversational speech or music ;

UNANIMOUSLY DECIDES that the following questions be studied :

1. What is the relationship between VU * readings and long-time power averages for different types of speech, music and conversation ?

2. What are the power relationships for the various types of modulation used for transmitting various kinds of intelligence ?

QUESTION No. 60

PREFERRED METHODS OF SPECIFYING POWER SUPPLIED TO AN ANTENNA BY A RADIO TRANSMITTER

(Question No. 22)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That the Radio Regulations, Atlantic City, 1947, Art. 1, Section IV, items 60-64, call for the use of peak power in specifying the power of a radio transmitter, but permit the use of mean power in cases where the peak power specification is not satisfactory or adequate ;

* This refers to readings of a VU meter, which is a volume indicating device having certain specific dynamic characteristics, and which is described in *Proc. I.R.E.*, 28, 1 (Jan. 1940). Such a device reads zero for a 1000 cycle tone delivering 1 milliwatt to a load impedance of 600 ohms. When speech volume is measured by it according to I.R.E. standards, a reading of zero corresponds to zero VU.

(b) That in some cases the mean power of the unmodulated carrier is a preferable method of rating the power of a transmitter with regard to monitoring and interference-producing capabilities ;

(c) That the two alternatives provided in the Radio Regulations may not always be adequate for all the uses to be made of transmitter power ratings ;

DECIDES that the following question be studied :

What methods for specifying the power of radio transmitters, for each type of modulation and transmission, would be of maximum usefulness from the viewpoint of the International Telecommunication Union, especially with reference to :

— monitoring purposes, including the interference-producing capabilities of radio transmitters, and
— frequency assignment problems, including the correlation of field strength measurements and propagation studies with the power specification of transmitters ?

QUESTION No. 61

PULSE TRANSMISSION FOR RADIO DIRECTION FINDING

(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) The errors inherent in direction finding systems which utilize the reception of continuous wave emissions ;

(b) The potential advantages which would accrue from the development of a system of pulse direction finding which would be free of such errors ;

(c) The material contained in the Annex to Doc. No. 84 of Geneva ;

UNANIMOUSLY DECIDES that the following question shall be studied :

Does application of pulse transmission techniques to radio direction finding systems promise a greater degree of accuracy than is now possible with continuous wave transmissions ?

QUESTION No. 62

SINGLE SIDEBAND SOUND BROADCASTING

(Question No. 24)
(Study Group No. X)

The C.C.I.R.,

CONSIDERING :

(a) That Report No. 12 of the C.C.I.R. concludes that Question No. 24 should be modified ;

(b) That it necessary to seek the maximum economy in the use of the spectrum ;

(c) That there exist a great number of broadcast receivers for the reception of standard symmetrical double sideband, amplitude modulated transmissions ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. Can a transmission system with full carrier and two sidebands, one of which is partially suppressed, be used without modifying existing receivers, so as to provide a worthwhile saving of spectrum space or a perceptible decrease in selective fading effects ?

2. If the preceding question cannot be answered in the affirmative, can a receiver for public use be designed to fulfil the above conditions satisfactorily ? If so, would it be possible in practice to change from the existing system to the new system ?

QUESTION No. 63

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Question No. 42)
(Study Group n° X)

The C.C.I.R.,

CONSIDERING :

(a) Question No. 42 ;

(b) Recommendation No. 81 ;

(c) That, lowing to ack of sufficient data, it has not been possible, during the VIth Plenary Assembly of the C.C.I.R. (Geneva 1951), to standardize certain technical characteristics which are of particular importance in the international exchange of recorded programmes :

DECIDES that the following question shall be studied :

What are the recording characteristics that remain to be standardized in order to facilitate the international exchange of recorded programmes between broadcasting organisations, and what are the standards with which these characteristics should comply ?

QUESTION No. 64

TELEVISION STANDARDS

(Former Recommendation No. 29)
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That the interchange of television programmes between countries is desirable ;

(b) That the interchange of such programmes should be done in an economical manner ;

(c) That the economical interchange of television programmes would be facilitated by the adoption of agreed standards for certain characteristics of transmissions ;

(d) That technical standards should be coordinated, insofar as possible, to permit such interchange to facilitate the utilization of receiving equipment, and to minimize mutual interference between television services ;

(e) That the adoption of such standards will result in the most rapid expansion of the television service, by making more readily available a wider variety of programmes and, in addition, giving a reduction in programme costs ;

(f) That it is desirable that world-wide agreement be obtained on those standards which would permit interchange of programmes, both direct and recorded ;

(g) That the interchange of programmes will be effected by radio relay and cable links for direct programmes, and by film for recorded programmes. With interchange between different linguistic groups the sound channel characteristics are of secondary importance, and primary attention needs to be placed on the vision signal ;

(h) That the question of programme interchange is also linked with the desirable technical characteristics necessary to provide :

1. A satisfactory service in the home at reasonable cost ;
2. A reasonable service in the home at minimum cost ;

(i) That in consideration of these problems account should be taken of the following factors :

1. The available bandwidth allocated to Television is limited ;
2. Importance is to be attached principally to the cost of receivers rather than that of transmitting equipment ;
3. The proposed standards should not preclude in due course the possibility of reception, by the addition of a suitable frequency converter, of the following :

   monochrome pictures on a " black and white " receiver of the transmissions from a " colour " transmitter,

   monochrome pictures on a " colour " receiver of transmissions from a " black and white " transmitter ;

(j) That the adoption of transmission standards on as wide a basis as possible will result in the most rapid expansion of the television service, in that it will facilitate the production of receivers at lower cost ;

(k) That a factor of prime importance in arriving at world standards is the problem of operating a television service in which the frame repetition rate is not integrally related to the power supply frequency ;

(l) That it is inevitable that there will be considerable channel sharing in the existing television bands, and therefore, in view of long distance propagation effects, it is desirable that the standards proposed should be such as to minimize interference between stations ;

RECOMMENDS :

That there be undertaken the study of, and publication of Recommendations on the technical factors which would assist in achieving :

(a) Interchange of programmes on the widest possible scale ;

(b) Coordination of standards to permit the use of a receiver on transmissions differing in a minor degree.

The factors which appear of major importance are :

1. For the interchange of direct programmes :
   (a) Frame repetition rate,
   (b) Frame interlacing,
   (c) Number of lines,
   (d) Aspect ratio ;
2. For the interchange of recorded programmes :
   (a) The programmes should be recorded in such a manner as to make them capable of being reproduced on standard 35 or 16 mm motion picture sound equipment ;
   (b) The effects of pattern interference due to transmission of a film on a television system having a different number of lines from that on which the film was recorded;

Among other factors which should be studied to permit interchange of receivers are the following :

(a) Polarity of modulation for vision signal ;

(b) Distribution of channels in the available spectrum space ;

(c) Relative frequencies of sound and vision carriers and the positioning of these carriers and associated sidebands within the channel ;

(d) Type of vision transmission, e.g. double sideband, single sideband, etc. ;

(e) Type of modulation of sound channel ;

(f) Form of synchronizing signal ;

(g) Non-integral relationship between frame repetition rate and power frequency.

Note 1. — Several of the points *(a)* to *(f)* are referred to in question No. 25.

Note 2. — It is realised that due to certain technical factors such as different power supply frequencies and different frequency allocations to television in the various regions, world-wide standardisation may be delayed for a considerable time, but in view of the rapid development expected for television in the next few years urgent attention should be given to the solution of the problems on as wide a geographical basis as possible, with a view to the early formulation of agreed standards.

Note 3. — It is recommended that in respect of the characteristics of international circuits for television programme transmissions the C.C.I.F. should coordinate its work with that of the C.C.I.R.

QUESTION No. 65

ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That appreciable discrepancies may exist between different experts' assessments of the quality of the pictures given by the television systems now in use or proposed ;

(b) That these discrepancies are to be attributed to the fact that it is usually impossible to obtain simultaneous viewing of the pictures under comparison, to possible variations in quality between apparatus nominally using the same system and to alterations that may occur with time in the characteristics of the equipment used ;

(c) That consequently it would be eminently desirable to have some standard method of gauging or even measuring television picture quality which would permit objective comparison of the results obtained in different places and would serve as a guide to the efficient and uniform working of the equipment in service ;

UNANIMOUSLY DECIDES that the following question shall be studied :

The development of standardized methods of accurately and objectively assessing the quality of the pictures given by television systems.

QUESTION No. 66

TELEVISION RECORDING

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

The desirability of perfecting methods for recording television signals for subsequent reproduction ;

UNANIMOUSLY DECIDES that the following question shall be studied :

What are the desirable characteristics of equipment for recording television signals and the corresponding sound ?

Note. — It is recommended that the line-broadening (spot-wobble) technique should be investigated with a view to minimizing the line structure when recording on film.

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* This Recommendation has become Question No. 64.

QUESTION No. 67

RATIO OF THE WANTED TO THE UNWANTED SIGNAL IN TELEVISION

(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That the satisfactory operation of a television service renders it necessary to specify the maximum field-strength of interfering or unwanted signals which can be tolerated without unduly affecting the reception of television programmes ;

(b) That the frequency bands allotted for television broadcasting services are so limited that it is essential for more than one transmitting station to operate in the same channel ;

(c) That, on the frequencies used for television, radio waves in certain cases travel to distances far in excess of the normal service area ;

(d) That the varying propagation of such waves, under different conditions, is the major factor in determining the geographical distances separating television transmitting stations to avoid mutual interference ;

DECIDES that the following question shall be studied :

The determination of the minimum admissible ratio of wanted to unwanted signal, when two television transmitters are operating :

— in the same channel,
— in adjacent channels,
— with dissimilar but partially overlapping bandwidths.

Note. — The answer to the question should state the hours of service it is desired to protect, and the proportion of the programme time for which the stated degree of interference must be avoided. Separate answers may be required for various grades of service area, each of which should be defined in terms of field strength of the wanted signal.

QUESTION No. 68

RESOLVING POWER AND DIFFERENTIAL SENSITIVITY OF THE HUMAN EYE

(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That those responsible for a regular television service must have an exact knowledge of the physiological properties of the human eye, the demands of which they are endeavouring to satisfy ;

(b) That, among these properties, the most important are the resolving power by means of which regular fields and fine details are perceived, the differential sensitivity to brilliance and the differential sensitivity to a change in the shade of the same colour ;

(c) That the results of the numerous physiological studies already undertaken on this subject cannot, a priori, be assumed to be equally valid for the observation of television pictures, because of the special nature of such pictures ;

UNANIMOUSLY DECIDES that the following question shall be studied :

What is the value for the human eye of :
— the resolving power expressed in minutes of angle,
— the differential sensitivity to brilliance,
— the differential sensitivity to a change of shade in the same colour,

for values of contrast, brilliance, colour and distance normally encountered when observing photographs and television pictures ?

QUESTION No. 69

BEST METHOD FOR CALCULATING THE FIELD STRENGTH PRODUCED BY A TROPICAL BROADCASTING * TRANSMITTER

(Question No. 27)
(Study Group No. XII)

The C.C.I.R.,

CONSIDERING :

(a) The importance of being able to calculate the power required to produce a given field strength under given conditions for tropical broadcasting ;

(b) That reliable methods of calculation would assist the planning of new tropical broadcast services and the allotment of frequencies to services in the tropical zone ;

(c) That, for the tropical zone, little basic data exists concerning ionospheric absorption and its dependence upon the time of day, the season and the sunspot cycle ;

(d) That the relation of ionospheric absorption at oblique incidence to that at vertical incidence is not yet fully understood ;

(e) That there is no internationally agreed method of examining the nature of the multiple reflections and of calculating the resultant field strength occurring at the intermediate distances involved in tropical broadcasting ;

DECIDES that the following question shall be studied :

1. What is the best method that may be used for calculating the field strength produced at the earth's surface by the indirect ray, at various distances between 0 and 800 km and between 800 and about 4000 km, by a transmitter situated in the " tropical zone " (as defined in App. 16 of the Radio Regulations, 1947) radiating a power of 1 kW from a half wavelength dipole situated $^1/_4$ and $^7/_{16}$ths of a wavelength above ground respectively, and operating in any of the frequency bands used for tropical broadcasting, (i.e. the " shared bands " listed in Art. 9, § 244, and the general broadcasting bands below 15450 kc/s listed in the Table of Frequency

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* As this service is defined in the considerations of Question No. 27.

Allocations, Art. 5, Radio Regulations, 1947,) at any season, and for sunspot numbers of about 5, 60 and 125, respectively, during normal listening hours (approximately 0600 to 2400 local time ?

1.1 What is the probable error in the proposed method of calculation ?

1.2 What basic data should be used in the proposed method of calculation ?

1.3 What is the probable statistical distribution of the fading of the signal ?

QUESTION No. 70

DESIGN OF AERIALS FOR TROPICAL BROADCASTING *

(Question No. 27)
(Study Group No. XII)

The C.C.I.R.,

CONSIDERING :

(a) That the average radius of a tropical broadcasting service area is about 800 km ;

(b) The necessity for further study of the design of transmitting aerials for tropical broadcasting for the purpose of concentrating the energy transmitted by reflection from the ionosphere as much as possible into the desired service area ;

(c) That the use of efficient aerials for transmission and reception would permit the use of transmitters of lower power ;

(d) The importance of minimizing interference between services which share frequency bands as provided by Art. 9, § 244, 253 of the Radio Regulations, 1947, and

(e) The provisions of Art. 13, § 374 of the Radio Regulations, 1947 ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. What factors determine the best position for the transmitting aerials, with respect to the area to be served, in order to concentrate the energy received by reflection from the ionosphere within the desired service area and to minimize the amount of energy received outside the broadcast service area ?

2. What practical improvements, confirmed by measurement, can be made in the design of transmitting aerials for tropical broadcasting, in order to concentrate the energy received by reflection from the ionosphere within the desired service area and to minimize the energy received outside the broadcast service area ? In particular, what steps can be taken to minimize low-angle radiation ?

3. What practical improvements can be made in the design of aerials for tropical broadcasting reception in order to ensure the highest signal-to-noise ratio and a sufficiently high received signal voltage.

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* As this service is defined in the considerations of Question No. 27.

QUESTION No. 71

DETERMINATION OF NOISE LEVEL FOR TROPICAL BROADCASTING *

(Question No. 27)
(Study Group No. XII)

The C.C.I.R.,

CONSIDERING :

(a) That the determination of the transmitter power required depends upon the value of the signal-to-noise ratio regarded as being the minimum for an acceptable broadcasting service in the tropical zone and it is necessary to have as precise a knowledge as possible of atmospheric noise levels in this zone ;

(b) That present knowledge of the atmospheric noise levels in the tropical zone and for tropical broadcasting frequencies has no agreed scientific significance and is insufficient for practical use ;

(c) That the methods at present in use for the measurement of atmospheric noise are of a subjective nature, likely to be misinterpreted if applied to broadcasting ;

(d) That it, therefore, seems desirable to develop an objective method of measuring atmospheric noise levels for possible application to broadcasting, in particular to tropical broadcasting, and to relate such a method to the subjective effect on the listener ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What parameters, characterising atmospheric noise would determine the response of a broadcast receiver to atmospheric noise and the effect of such noise on the grade of reception ?

2. Subsequent to the question in § **1**, what characteristics of noise can be measured directly, what range of values should be covered by the measuring apparatus and how are these values related to the above mentioned parameters ?

3. What is the best method of atmospheric noise measurement for the specific conditions of tropical broadcasting, with particular regard to type of service, geographical zones, frequencies used and climatic conditions ?

3.1 Can a suitable objective method of noise measurement be developed in the near future ?

3.2 Can the subjective method, at present in use, be modified to obtain as soon as possible an approximate result for the type of service concerned ?

3.3 Is it possible and under what conditions, to correlate the results obtained by a subjective method of noise measurement and those which may be expected from the application of an objective method ?

4. How should the recommended measuring apparatus be designed for the specific conditions imposed by tropical climates and how should it be used to obtain results which can be correlated for the various parts of the tropical zone ?

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* As this service is defined in the considerations of Question No. 27.

QUESTION No. 72

DECIMAL CLASSIFICATION

(Recommendation No. 34)
(Study Group No. XIV)

The C.C.I.R.,

CONSIDERING :

That it is advisable to standardize the classification of documents and articles on radio so as to facilitate librarians' work and make it possible for anyone to find the documents required without delay ;

UNANIMOUSLY DECIDES that the following question shall be studied :

The classification of documents and articles on radio by means of a decimal index, to be made, if possible, within the framework of the universal decimal classification (U.D.C.) and in agreement with the International Federation of Documentation.

QUESTION No. 73

CLASSIFICATION OF THE FREQUENCY AND WAVELENGTH BANDS USED IN RADIOCOMMUNICATION

(Radio Regulations of Atlantic City 1947, Chapter II, Article 2, Section III)
(Study Group No. XIV)

The C.C.I.R.,

CONSIDERING :

(a) That the terms used in describing frequency bands are ambiguous ;

(b) That it is desirable to extend the frequency band classification to cover the range 300,000 to 3,000,000 Mc/s ;

RECOMMENDS that the following question be studied :

Classification of the frequency and wavelength bands used in communications

and for this study recommends that the possibility of evolving more logical descriptive terms, which can be applied up to 3,000,000 Mc/s, be examined.

STUDY PROGRAMMES

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STUDY PROGRAMME No. 1

BANDWIDTH OF EMISSIONS

(Question No. 1.a and Recommendation No. 36)
(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

(a) Recommendation No. 4 of Atlantic City, and Question No. 1.a of the C.C.I.R. ;

(b) Recommendation No. 36 of the C.C.I.R. ;

(c) That the above Recommendation is only a partial answer to Question No. 1.a ;

DECIDES that the following studies shall be carried out :

The study of bandwidths for all classes of emission should be continued in accordance with the principles contained in Recommendation No. 36 and in accordance with the following provisions :

1. The study should be carried out simultaneously by theoretical methods as well as by experimental methods and a detailed comparison should be made of the results obtained by both methods to derive supplementary data on bandwidths of classes of emission which have already been considered, and new data on other classes of emission ;

2. The study of those classes of emission listed below which are used for international communication and particularly those most used in the HF band is of special urgency :

2.1 Class F1 emissions ;

2.2 Class A1 emissions without fluctuations ;

2.3 Single channel and multichannel class A3 emissions ;

2.4 Class F4 emissions ;

2.5 Other classes of emission, including those in the VHF and UHF bands ;

3. These studies should be coordinated with the studies on receivers and on complete systems and particularly with the studies mentioned in Recommendations Nos. 39, 40 and 42 Questions Nos. 2 and 3, Study Programmes Nos. 4, 7, 8, 9, 10 and 35 and Report No. 1.

STUDY PROGRAMME No. 2

HARMONICS AND PARASITIC EMISSIONS

(Question No. 1.b)
(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

(a) That in the case of wave propagation at frequencies where ionospheric reflection plays an important part, the harmonics may propagate differently from the fundamental in different directions due to the wide difference in frequencies ; this effect is in addition to that caused by the antenna directivity not being the same for the fundamental and harmonic frequencies ;

(b) That the harmonics of a transmitter provided for one class of service may interfere with other classes of service in other parts of the spectrum ;

(c) That the relationships between fundamental and harmonic field intensities and between radiated harmonic power and harmonic field intensity measured at a distance from the transmitter differ markedly in the cases :

— where both the fundamental emission and the harmonic involve ionospheric propagation,
— where only the harmonic involves ionospheric propagation,
— where only the fundamental emission involves ionospheric propagation,
— where neither the fundamental emission nor the harmonic involves ionospheric propagation ;

(d) That a more definite evaluation of the effects of the limiting values specified in App. 4 of the Radio Regulations, 1947, should be determined ;

(e) That, in order to achieve or maintain a good standard of practice for transmitters with respect to the suppression of harmonics, it is essential to have readily applicable methods of specifying and testing equipments ;

(f) That, since many existing high power transmitters have a fundamental to harmonic power ratio of 70 db or greater, it is desirable to consider further :

— the need for revised limits for harmonic power output for such cases,
— reduction of harmonic radiation from conductors with non-linear characteristics located within the high intensity fundamental field of the transmitter which might act as subsidiary generators ;

(g) That different relationships exist between the signal-to-noise ratios appropriate for the several services in the various frequency bands and interferences caused by harmonic radiations. For example, in view of the susceptibility of television to interference, the particular harmonics falling within television channels * which are in use in the vicinity of the interfering station are of paramount importance. The attenuation of these particular harmonics may in some cases need to be substantially greater than limits which may be applicable for some other services. Other services may also have special requirements peculiar to their own needs ;

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* Television channels may be set up in certain cases in the following broadcasting bands :
(Band I, 41 to 68 Mc/s ; II, 87.5 to 100 Mc/s ; III, 174 to 216 Mc/s ; and IV, 470 to 960 Mc/s)
For additional details see the Atlantic City Frequency Allocation Table, Chapter 3, Article 5 of the Radio Regulations.

DECIDES that the following studies shall be carried out :

1. App. 4 of the Radio Regulations, 1947, should be re-evaluated, for which purpose the various Administrations should submit data on harmonic power and field intensity measurements to enable a more definite evaluation to be made of the relationships between them. Such evaluation should take into account the signal-to-noise ratio aspects as related to the different services with regard to the harmonic interference problem.

2. To secure further data on methods of measurement of harmonic power by the substitution method and on the equipment to be used, particularly with regard to correctly connecting the auxiliary generator to the antenna feeder.

3. To secure further data on alternative methods of measuring harmonic power.

4. Study of the elements of antenna and antenna feeder design useful in reducing harmonic radiations.

5. Determination of the special conditions which may apply to certain high power transmitters (for example 100 kW or greater) which in many cases at present have a fundamental to harmonic power ratio of 70 db or greater. In this connection consideration should be given to radiation from conductors with non-linear characteristics which such transmitters may excite.

STUDY PROGRAMME No. 3

FREQUENCY STABILISATION OF TRANSMITTERS

(Question No. 1.c)
(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

(a) That Question No. 1.c of the C.C.I.R. refers to frequency stability, by which is meant constancy of frequency ;

(b) That improvement in the utilisation of the radio-frequency bands depends also on the accurate positioning of the mean frequency, that is, on the accuracy of the frequency determining elements as distinct from their stability ;

(c) That degrees of accuracy and stability far in excess of those required by the Radio Regulations of Atlantic City are available, but that such provision may, in certain cases, conflict with economic considerations and design considerations such as weight and volume ;

(d) That advancements in technique are being made in obtaining high accuracy and stability, whilst still meeting economic and design requirements ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Study of improved methods of attaining high accuracy and stability of the frequency of radio emissions, consistent with economic and design requirements.

STUDY PROGRAMME No. 4

FREQUENCY SHIFT KEYING

(Question No. 20)
(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

(a) That frequency shift keying is employed in radio-telegraphy on fixed services and its use may be extended to the mobile services ;

(b) That it is desirable to standardise the main operating characteristics of systems employing frequency shift keying ;

(c) That Recommendation No. 39 of the C.C.I.R. suggests a number of preferred values for some of the characteristics ;

DECIDES that the following studies shall be carried out :

1. The determination of which of the preferred values of frequency shift suggested in Recommendation No. 39 should be used in particular services.

2. The compilation of the corresponding terminology and symbols within the framework of Resolution No. 5 of the C.C.I.R.

STUDY PROGRAMME No. 5

STABILITY OF RECEIVERS

(Question No. 2 and Recommendation No. 4)
(Study Group No. II)

The C.C.I.R.,

CONSIDERING :

(a) That, in practice, the bandwidth of receivers is customarily increased beyond the essential band * because of :

— the variation with time of the filter characteristics of the circuits,
— the instability of the frequency of the received wave,
— the instability of the frequency changer oscillators of the receiver,
— and the possible inaccuracies of resetting these oscillators to a desired frequency ;

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* The essential bandwidth of a receiver is determined by the width of the spectrum of the signal to be received which will permit the reproduction of the intelligence contained in the signal with the minimum of intelligibility necessary for the service considered.

(b) That, in order that the bandwidth of receivers may be reduced as closely as possible to the minimum value, it is desirable to :

— improve the stability of the filter characteristics ;
— reduce the instability of the frequency changer oscillators ;
— reduce the effect of this instability, e.g. by controlling their frequency automatically from the frequency of the received wave ;

(c) That although some information on instability has been given in the submitted documents (see Annex), it is insufficient to justify a general statement ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The measurement of the stability of receivers now in use to determine :

— the drift of mid-band frequency with time (the room temperature and power supply being stable), after the receiver has been switched on, but before equilibrium is attained ;
— after this equilibrium is attained, the frequency variation with room temperature only and the frequency variation with power supply only.

In making the measurements and reporting the results, the following items might be taken into account :

— type of service (fixed, mobile, broadcast, etc.) ;
— type of emission (manual or automatic telegraphy, telephony, television, etc.) ;
— type of modulation (A.M., F.M. etc.) ;
— frequency bands ;
— any special features (crystal control, automatic frequency control, etc.).

2. The methodical study of the applications to all types of receivers of the circuits, compensating devices and manufacturing processes which could improve the stability of circuits and components.

3. The study of automatic frequency control performance.

ANNEX

EXAMPLES OF MEASUREMENTS MADE OF RECEIVER STABILITY IN THE HIGH FREQUENCY BAND

Type of receivers	Number of receivers examined	Frequency drift during warm-up period (1 hour)	Frequency variation	
			due to temperature variation	due to supply voltage variation
		$\times 10^{-6}$	$\times 10^{-6}$ per 1° C.	$\times 10^{-6}$ for 10% change
Domestic broadcast	14	60-900	60-200	10-200
Communication	22	50-500	20-200	10-150
High grade communication for fixed point-to-point service	5	15-300	5-15	10-150
Quartz controlled	2	10	2	—

STUDY PROGRAMME No. 6

SELECTIVITY OF RECEIVERS

(Question No. 2 and Recommendation No. 4)
(Study Group No. II)

The C.C.I.R.,

CONSIDERING :

(a) That selectivity measurements so far produced have been limited primarily to receivers suitable for A1, A2 and A3 types of emission, little information being available for other types of receivers (e.g. F1, F2, F3, Pulse modulation, TV etc.) ;

(b) That such measurements as are available have been chiefly made by the single signal method, little information being available on measurements made by the two signal method ;

(c) That in the determination of the selectivity of the receiver, that is to say its ability to separate the wanted signal from undesired signals, there are some cases where the determination of the amplitude curve is not sufficient ;

(d) That cases where this is particularly true are those where the signal shape is of importance, and must not be distorted and that these cases are already numerous (e.g. A1, facsimile, TV, etc.) ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The production of information on the single signal selectivity of types of receivers designed to receive classes of emission other than A1, A2, A3 ;
2. The production of complementary information on two signal selectivity measurements on the various different types of receivers including those designed to receive classes of emission A1, A2, A3 and other types ;
3. The supplementing mentioned in the cases *(d)* of the amplitude response versus frequency relationship by the corresponding phase response versus frequency relationship ;
4. The development of methods of measuring such phase characteristics.

STUDY PROGRAMME No. 7

PROTECTION AGAINST KEYED INTERFERING SIGNALS

(Recommendation No. 1)
(Study Group No. II)

The C.C.I.R.,

CONSIDERING :

(a) That, according to Recommendations Nos. 1 and 4 and Questions Nos. 1 and 2 of the C.C.I.R., the study of receiver characteristics shall be continued ;

(b) That it is recognised that emissions beyond the necessary band are in practice transmitted to some degree, thus increasing the interference, and that, according to certain theoretical and experimental studies, the transmitted spectrum with the degree of rounding of the keyed

dots at present used is still so wide that it often encroaches on the necessary band of an adjacent channel, thus not permitting full advantage being realised from the high selectivity possible in receivers ;

(c) That the interference caused by a modulated interfering signal depends not only upon the energy content of the interfering signal which falls within the receiver passband and the attenuation of the signals falling outside the passband but also, among other things, upon the overall phase and amplitude characteristic of the receiver ;

(d) That, in deciding the exact shape of the keyed dot, a compromise must be made between the effectiveness of the reception of the signal and the interference the emission will cause in an adjacent channel ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The dependence of the interference produced in receivers on the degree of rounding of the transmitted dots, including the investigation of the resulting transient effects in the receiver, which are influenced not only by the usual selectivity curve, but also by the phase characteristics of the circuits ;

2. The investigation of the total permissible rounding of dots from the transmitter input to the output of the receiving apparatus on a system basis, in order to minimize interference while retaining a maximum of intelligibility, with special attention to the best compromise on the fraction of the rounding to be assigned to the effects of the transmitter, of propagation and of the receiver respectively.

STUDY PROGRAMME No. 8

BANDWIDTH AND SIGNAL-TO-NOISE RATIOS IN COMPLETE SYSTEMS

(Question No. 3)
(Study Group No. III)

The C.C.I.R.,

DECIDES that the following studies shall be carried out, possibly with the help of the C.C.I.F. ;

1. Minimum Conditions Required for Satisfactory Service

1.1 *Telephony*

1.1.1 What are the minimum values of
- bandwidth
- signal-to-noise ratio (assumed to be stable) necessary at the output of the receiver for excellent service ?

1.1.2 What is the value of the same elements at the output of the receiver for just useable service ?

1.1.3 For what maximum duration and percentage of time can the signal-to-noise ratio at the output of the receiver be inferior to the value indicated by the reply to question of § 1.1.2 above, assuming unstable conditions ?

1.1.4 To what extent can the radiation outside the necessary bandwidth be reduced for transmitters now in use ? Can a stricter limitation be imposed on transmitters installed in the future ?

1.1.5 Bearing in mind the replies to the preceding four questions, and the need for each transmission to occupy as narrow a spectrum as possible, what regulations should be proposed to the Administrative Radio Conference concerning :

— the limits to be imposed on the radiated spectrum of existing transmitters ;
— the limits to be imposed on the radiated spectrum of future transmitters ;
— the minimum selectivity characteristics to be provided for receivers ?

1.1.6 In the absence of interference, what minimum field (assumed to be stable) is necessary to obtain excellent reception ?

1.1.7 To what extent and for what percentage of time can the field be less than the value referred to in 1.1.6, the circuit still being regarded as just usable ?

1.1.8 What allowance must be made for fading ?

1.1.9 To what extent can reception be improved by the use of

— directional antennas ?
— diversity reception ?
— noise reducers ?

1.1.10 Bearing in mind the replies to points 1.1.6, 1.1.7 and 1.1.8, what is the median field required for just satisfactory reception ?

Note. — All the studies advocated above should be made for all classes of emission and in particular for the classes mentioned below operating in the range of 10 kc/s to 30,000 kc/s.

Telephony, double side band, full carrier (A3)

Low grade
Commercial
High fidelity

Telephony, single side band, reduced carrier

A3a) single channel (commercial)
A3b) more than one channel (commercial)

Broadcasting

1.2 *Telegraphy*

1.2.1 In the absence of noise and multipath effects, but with an input signal varying in amplitude between specified limits, what is the minimum bandwidth necessary at the output of the receiver in order that the distortion will not exceed a specified amount ?

1.2.2 For the bandwidths determined in § 1.2.1 above, what are the minimum signal-to-noise ratios (assumed to be stable) necessary at the output of the receiver for error free reception ?

1.2.3 For what minimum duration and percentage of time can the signal-to-noise ratios be inferior to these specified in § 1.2.2 for the circuits still to be just usable ?

1.2.4 To what extent can the radiation outside the necessary bandwidth be reduced for transmitters now in use ? Can a stricter limitation be imposed on transmitters installed in the future ?

1.2.5 Bearing in mind the replies to the preceding four questions, and the need for each transmission to occupy as narrow a spectrum as possible, what regulations should be proposed to the Administrative Radio Conference concerning :

— the limits to be imposed on the radiated spectrum of existing transmitters,
— the limits to be imposed on the radiated spectrum of future transmitters,
— the minimum selectivity characteristics to be provided for receivers.

1.2.6 In the absence of interference, what minimum field (assumed to be stable) is necessary to obtain error free reception ?

1.2.7 To what extent and for what percentage of time can the field be less than the value referred to in 1.2.6, the circuit still being regarded as just usable ?

1.2.8 What allowance must be made for :

— fading ?
— multipath effects ?

1.2.9 To what extent can reception be improved by the use of
— directional antennas ?
— diversity reception ?

1.2.10 Bearing in mind the replies to points 1.2.6, 1.2.7, 1.2.8 and 1.2.9, what is the median field required for just satisfactory reception ?

Note. — All the studies advocated above should be made for all classes of emission and in particular for the classes mentioned below operating in the range of 10 kc/s to 30,000 kc/s.

Telegraphy A1

Hand speed	8 baud
,, ,,	24 ,,
Machine speed	50 ,,
,, ,,	120 ,,

Telegraphy A2

Hand speed	8 baud
,, ,,	24 ,,
Machine speed	50 ,,
,, ,,	120 ,,

Telegraphy F1

Speed	50 baud
,,	120 ,,

Facsimile A4

Hellschreiber

Multitone Telegraphy

2. **Separation between Frequencies of Adjacent Channels** (Telegraphy and telephony)

2.1 What are the different factors to be taken into account in determining the minimum separation between frequencies of stations operating in adjacent channels?

2.2 How is the effect of interference at the receiver output to be expressed ?

2.3 When the wanted signal and the interference are both stable, what is the minimum signal-to-interference ratio for excellent reception ?

2.4 To what extent, for given values of the percentage of time of occurrence, can the signal-to-interference ratio be lower than that mentioned in 2.3 for the circuit still to be usable ?

2.5 How is the signal-to-interference ratio at the receiver output affected by the selectivity of the receiver and the separation between the frequency of the interfering signal and the frequency to which the receiver is tuned ?

2.6 How should the instability of transmitters and receivers be expressed and allowed for in determining the channel separation ?

2.7 To what extent would the use of directional antennas at the transmitter and the receiver improve the signal-to-interference ratio ?

2.8 Bearing in mind the replies to the questions in the preceding seven paragraphs and those in to 1.2.10, what is the minimum separation required between the frequencies of stations operating in adjacent channels ?

Note. — All the studies advocated above should be made for all the types of service mentioned in the comments following § 1.1.10 and 1.2.10.

STUDY PROGRAMME No. 9

VOICE FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(Question No. 43)
(Study Group No. III)

The C.C.I.R.,

CONSIDERING :

(a) That different methods are now being tested for the setting up of voice frequency telegraphy on radio circuits (Doc. Nos. 29 and 195 of Geneva) ;

(b) That the study of Question No. 43 will be continued in conjunction with the C.C.I.T. to obtain, if possible, unification of voice frequency equipment on wire and radio circuits ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The comparison of the transmission systems in which marking and spacing are obtained by the two-tone method and by the method of frequency shift of a single tone ;

2. The comparison of the results obtained by single antenna reception or with space diversity or with frequency diversity reception.

Note. — In carrying out these studies, it will be necessary to take into account the fact that the fading encountered on the radio circuit affects markedly the build-up of the signal elements in the receiving filters. This determines bandwidth, but it should be borne in mind that the available bandwidth is affected by the standardization of wire circuit equipment.

STUDY PROGRAMME No. 10

THEORY OF COMMUNICATION AND ITS PRACTICAL APPLICATIONS

(Question No. 44)
(Study Group No. III)

The C.C.I.R.,

CONSIDERING ;

(a) That, in view of the increasing congestion of the radio spectrum and telecommunication circuits, it would be of advantage to discover technical methods of decreasing the bandwidth or the transmission time of a given quantity of information ;

(b) That present studies seek only to perfect existing systems whereas recent theories seem to show that these systems occupy several times the bandwidth strictly necessary for the transmission of the required information at the required speed ;

(c) That even with existing systems it is not possible to reduce the bandwidth to that strictly necessary because of unpredictable noise, natural and man-made interference and complex propagation conditions ; a margin of bandwidth is necessary to decrease distortion and the frequency of errors due to these phenomena ;

(d) That it is not certain that existing codes, some at least of which were not designed in the light of the phenomena peculiar to radio propagation, are making the best use of the occupied bandwidth ;

(e) That a systematic study of such methods can be made by generalizing the procedures in use for certain transmission systems and by applying the results of the general theory of communication to specific practical cases ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The preparation of an indexed bibliography on publications regarding the theory and general practice of communications, and detailed documentation on the characteristics of the various systems of modulation and transmission in practical use. This shall be based on the Annex to this Study Programme and shall include a summary following the title of each document. The documentation and periodic supplements shall be distributed by the Secretariat of the C.C.I.R. to all members as soon as possible.

2. The definition, in co-operation with the URSI, of a practical unit of the quantity of information applicable to all transmission systems, and the study of methods of measuring this quantity.

3. The review of the various codes in use and the study of new codes leading to economy of bandwidth or transmission time, for a given quantity of information, taking into account the phenomena peculiar to radio propagation.

Note. — The above studies seem to be of interest also to the C.C.I.F. and the C.C.I.T.

ANNEX

The text of Question No. 44 reads as follows :

" What technical methods may be adopted to transmit a given amount of information over a given telecommunication circuit :

(a) in a given time, using a minimum bandwidth ;

(b) with a given bandwidth, in a minimum time ? "

This Question is of obvious practical interest, and it is very important and urgent to reach a conclusion because of the increasing congestion in the radio spectrum and in transmission circuits. Although Question No. 44 is very general, it seems that, because of recent progress made in the theory of communication, an early study of the subject may lead to some immediately useful results.

During the last decade, profound changes have taken place in the conceptions of information, the flow of information and in the loss of information through distortion and by the presence of noise. These conceptions have been defined in numerous theoretical studies, as yet incomplete, but it is an open question whether even at their present stage they do not constitute a framework which, without being final, might at least serve as a guide in attempts to make more efficient use of the spectrum, or to save transmission time. One aspect of this framework might be that shown in Table I, which does not, however, attempt to present a complete classification. But there are two points which may or may not be essential, and that is a matter that should be settled.

The first is the relationship between the paragraphs on the right and those on the left in Table 1. This relationship tends to show that the theory of communication is concerned not with new techniques but with a new interpretation of existing techniques.

The second point is as follows : Table 1 does not mention the subject of transmission *quality*. That does not mean to say that the question has not been studied ; it simply seems that, on this point, the relationship between practice and the theory of communication is much more vague. A study of the possibilities of applying the theory of communication to a reduction, acceptable by users, of the bandwidth or of the message transmission time must thus give precedence to the question of " transmission quality ".

It would be very helpful if the telecommunication experts could prepare a two-column table ; one column should consist of the chapter-headings of a detailed description of the characteristics of existing telecommunication systems. In the other column there should be a second list giving, for the items in the first list, the corresponding conceptions expressed in the terms of the theory of communication. For each item the pertinent bibliographical references should be given. Such a table would probably render very great service to users.

The Specialised Secretariat of the C.C.I.R. could, by reason of its central position, materially help in drawing up this table and perhaps, guided by the distribution of the blanks in the second column, instigate useful research.

TABLE I

	USUAL CONCEPTION		TERMINOLOGY OF THE THEORY OF COMMUNICATION
A	*Transmission and reception* *a)* Power and bandwidth at the transmitter *b)* Power and bandwidth at the receiver *c)* Fading and distortion along a channel	A	*Measurement of information* *a)* Information emitted *b)* Information received *c)* Transmission of information
B	*Modulation* *a)* Modulation compression, filtering *b)* Demodulation, expansion, distortion correction	B	*Change of form of information* *a)* Coding *b)* Decoding
C	*Message elements used in practice* *a)* Pulses *b)* Pure frequencies *c)* Various types of modulation	C	*Message elements* *a)* Messages limited in time *b)* Messages limited in frequency *c)* Messages not limited in frequency or time
D	*Studies on the structure of messages* *a)* Telegraph messages — constant amplitude noise *b)* Contrasted messages — sporadic noise	D	*Statistical description of common messages* *a)* Messages of uniform (stationary) structure *b)* Messages of non-uniform (non-stationary) structure

STUDY PROGRAMME No. 11

EFFECTS OF TROPOSPHERIC REFRACTION ON FREQUENCIES BELOW 10 Mc/s

(Question No. 6)
(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That the ground-wave propagation curves for frequencies below 10 Mc/s submitted with Recommendation No. 52, make no allowance for normal tropospheric refraction ;

(b) That allowance is sometimes made for normal refraction by the assumption of an effective earth's radius of $^4/_3$ times the actual value ;

(c) That the effect of normal tropospheric refraction is likely to decrease with decreasing frequency ;

DECIDES that the following studies be carried out :

1. The measuring of ground-wave field strengths over a sufficiently long path of uniform conductivity, such as a sea path, to determine experimentally the modification of the ground-wave curves required to include the effects of tropospheric refraction at frequencies below 10 Mc/s ;
2. The extension of the mathematical analysis relating to ground-wave propagation to include the effects of tropospheric refraction on all frequencies below 10 Mc/s.

STUDY PROGRAMME No. 12

TEMPORAL VARIATION OF GROUND-WAVE FIELD STRENGTHS

(Question No. 6)
(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That there is evidence of a temporal variation of ground-wave field-strength at a fixed receiving point ;

(b) That such variations have been observed to correlate with some of the parameters of the troposhere, such as temperature ;

UNANIMOUSLY DECIDES that the following study should be carried out :

The further investigation of this phenomenon with a view to determining its importance in modifying the ground-wave range of a transmitter.

STUDY PROGRAMME No. 13

GROUND-WAVE PROPAGATION OVER MIXED PATHS

(Question No. 6, section 1)
(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That the method proposed by Millington (*P.I.E.E.*, 3rd Part, **96**, 1949, p. 53) for the calculation of field strengths in propagation over mixed paths has the support of theory and of several experiments designed to test its validity ;

(b) That the method is nevertheless not yet completely substantiated by rigid mathematical analysis except in the case of a single boundary and a flat earth ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The obtaining of further experimental results for propagation over mixed paths under as wide a range of conditions as possible ;

2. The interpretation of these results in terms of the methods proposed by Millington and others for calculating field strengths for propagation over mixed paths ;

3. The further development of the mathematical analysis of this problem ;

4. Make a comparative study of the results obtained by the different methods with a view to determining the possibility of using one method for detecting and estimating changes in conductivity along a land path.

STUDY PROGRAMME No. 14

EFFECTS OF IRREGULAR TERRAIN ON GROUND WAVE PROPAGATION

(Question No. 6, sections 2, 3, 4, and Question No. 7, section 1)
(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That it is most important that the studies concerning propagation over irregular terrain should be pursued ;

(b) That the VIth Plenary Assembly has responded only in part to part of Question No. 6, sections 2, 3, 4 and to Question No. 7, section 1 ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

Propagation of waves over irregular terrain with consideration of the following aspects :

1.1 Propagation along valleys between mountains.

1.2 Propagation across valleys.

1.3 Propagation over very irregular terrain.

1.4 Methods for experimental determination of the best choice of sites, and of the appropriate polarization of antennas for the type of service to be obtained.

STUDY PROGRAMME No. 15

PHASE VARIATIONS IN GROUND-WAVE PROPAGATION

(Question No. 6, section 5)
(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That the problem of phase variations in ground-wave propagation is of great importance in connection with medium and long wave navigational aids ;

(b) That this problem is also fundamental to the study of coastal refraction ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The measurement of the phase changes along a ground-wave path, especially at short distances from the transmitter and in the neighbourhoud of a boundary between sections of different conductivities, in particular in various directions across a coast line ;

2. The further mathematical analysis of mixed path transmission with special reference to changes of phase due to changes in conductivity along the path ;

3. The experimental study of the phase variations produced by irregularities of the terrain.

STUDY PROGRAMME No. 16

REVISION OF THE 1937 C.C.I.R. PROPAGATION CURVES, AND THEIR POSSIBLE EXTENSION TO HIGHER FREQUENCIES

(Question No. 7, sections 1 and 2)
(Study Group No. IV)

The C.C.I.R.,

CONSIDERING :

(a) That the existing 1937 C.C.I.R. curves include a range of frequencies from 30 Mc/s to 150 Mc/s, together with height-gain curves ;

(b) That these curves have been found of use in the past under conditions in which the troposphere does not exert a predominant influence on propagation ;

(c) That it is known that in practice the troposphere exerts a marked influence on transmissions at these frequencies, particularly at considerable distances ;

DECIDES that the following studies shall be carried out :

1. The extent to which such ideal theoretical curves are still considered to be useful ;

2. The need for preparing such curves from 10 Mc/s to 300 Mc/s as an extension of the new ground-wave curves described in Recommendation No. 52 ;

3. The desirability of extending these curves to still higher frequencies in view of the very limited use they would have in any case under most tropospheric conditions ;

4. The desirability of including in such curves a factor, such as an effective radius of the earth, to take account of the normal refraction in the troposphere.

STUDY PROGRAMME No. 17

TROPOSPHERIC PROPAGATION CURVES FOR DISTANCES WELL BEYOND THE HORIZON

(Question No. 7, section 2)
(Study Group No. V)

The C.C.I.R.,

CONSIDERING :

(a) That the curves given in Recommendation No. 55 are of a provisional nature and that they give only a broad representation of the statistical data on which they are based ;

(b) That they refer only to the average meteorological conditions for the specific areas stated in the text accompanying the curves ;

(c) That they specifically refer to transmission over land and that conditions causing abnormal long distance tropospheric propagation may arise more frequently over sea ;

DECIDES that the following studies should be carried out :

1. The continuous recording for distances well beyond the horizon of transmissions in the frequency range 30-300 Mc/s in as many parts of the world as possible over a period of at least two years ;

2. The particular investigation of the problem over sea paths ;

3. The statistical analysis of the results of such experiments along the lines adopted in the production of the curves given in Recommendation No. 55 ;

4. The deduction from this analysis of the modification to these curves to allow for the different average meteorological conditions existing in different parts of the world.

STUDY PROGRAMME No. 18

TROPOSPHERIC WAVE PROPAGATION

(Recommendation No. 15)
(Study Group No. V)

The C.C.I.R.,

CONSIDERING :

(a) That widespread developments are taking place in the practical application of radio waves at frequencies above 30 Mc/s ;

(b) That the propagation of such waves is known to be greatly influenced by the meteorological conditions in the troposphere ;

(c) That a first step in the investigation of such propagation has been the preparation of the terms and definitions given in Recommendation No. 54 ;

DECIDES that the following studies shall be carried out :

1. That Administrations and Operating Agencies should be encouraged to make operational radio data available to national laboratories, which will co-ordinate the radio information with meteorological data, and submit the results of their analysis to the C.C.I.R. The methods used in the analysis should be described.

2. That further steps be taken to devise a suitable standard nomenclature for this subject, together with a uniform method of presenting both the radio and meteorological results. Such presentation might include the preparation of a uniform type of chart indicating the areas of sub-standard, standard and super-refracting conditions.

Note. — National Administrations, the International Scientific Radio Union (U.R.S.I.), the World Meteorological Organization (O.M.M.) and other international radio and meteorological organizations should be encouraged to pursue the investigation of the propagation of radio waves through the troposphere as a matter of great urgency.

STUDY PROGRAMME No. 19

MEASUREMENT OF FIELD STRENGTH OF RADIO SIGNALS

(Question No. 8)
(Study Group No. V)

The C.C.I.R.,

CONSIDERING :

(a) That Question No. 8 of the C.C.I.R. has not yet received a complete reply ;

(b) That Recommendations Nos. 60, 61, 62, 63, 64, 65 and 66, as well as Reports Nos. 4, 5 and 6 reply in part to Question No. 8 ;

UNANIMOUSLY DECIDES that the following study should be made :

Study of the measurements of the field strength of radio signals in accordance with the programme proposed in Question No. 8, taking account of the Recommendations and Reports cited above.

STUDY PROGRAMME No. 20

NON-LINEAR EFFECTS IN THE IONOSPHERE

(Question No. 5)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

(a) That numerous examples of intermodulation and of the generation of spurious signals in the ionosphere have been observed in the very low, low, medium and high frequency bands ;

(b) That non-linear effects during ionospheric propagation can produce unwanted modulation of radio communications (including broadcasting) ;

(c) That these phenomena can impose limitations on the usefulness of radio communication systems and cause mutual interference between different circuits ;

(d) That the magnitude of these phenomena may increase with the signal intensity in the ionosphere and with the complexity of the system in use ;

(e) That there are, in particular, no quantitative data available on high frequency wave interaction ;

DECIDES that the following studies should be carried out :

All participating Administrations and Operating Agencies should be invited to collect information on the time of occurrence, magnitude, and conditions under which non-linear effects in the ionosphere, such as wave interaction, have been or are being observed, and to co-operate with the International Radio Scientific Union (U.R.S.I.) and other appropriate international scientific bodies in the investigation.

Note. — The U.R.S.I. and other appropriate international scientific bodies should be informed that there is an urgent requirement for further fundamental information on the properties and conditions of occurrence of all forms of non-linear effects in the ionosphere, such as wave interaction.

STUDY PROGRAMME No. 21

RADIO PROPAGATION AT FREQUENCIES BELOW 1500 kc/s

(Question No. 5)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

That the examination of Question No. 5 has led to valuable studies of radio propagation phenomena at frequencies below 1500 kc/s, some of which are summarized in Doc. No. 141 of Washington, and Doc. Nos. 69, 154 and 186 of Geneva, UNANIMOUSLY DECIDES that the following study programme should be carried out:

1. The Study Group on ionospheric propagation should examine carefully the above documents and similar documents made available, and compile therefrom a co-ordinated report.

2. Administrations and laboratories having suitable facilities should undertake work along the following lines, in order to increase available knowledge necessary to understand propagation at frequencies below 1500 kc/s.

2.1 An extended series of vertical-incidence measurements of height, and characteristics of reflection (amplitude, phase and polarization) over as large a range of frequencies and geographical areas as possible.

2.2 Similar measurements at oblique incidence, to be made concurrently if practicable.

2.3 The interpretation of vertical-incidence data, in conjunction with rocket and meteor observations.

2.4 Measurements at very great distances and very low frequencies, in an effort to determine the method whereby these waves are propagated to great distances.

Note. — The International Radio Scientific Union (U.R.S.I.) should be invited to examine basic scientific aspects of this problem, such as:

1. Interpretation and correlation of vertical-incidence data with known or assumed upper-atmosphere physical characteristics of well known types;
2. Extensive study of the theoretical problems with a view to obtaining working hypotheses simplified in terms of approximations known to be valid as a result of corroborative experiments.

STUDY PROGRAMME No. 22

IONOSPHERIC PROPAGATION OF WAVES IN THE RANGE OF 30 TO 300 Mc/s

(Question No. 7, section 3)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING:

(a) That frequencies in the 30 to 300 Mc/s range are of great importance for short distance radio links, for television, for broadcasting, and for other purposes;

(b) That the propagation of waves on such frequencies has now been studied, in so far as propagation by way of the various ionospheric layers is concerned, during several years around the period of maximum solar activity,

UNANIMOUSLY DECIDES that the following study shall be carried out:

The continuous and detailed study of the propagation of waves in the 30-300 Mc/s frequency range by way of the various ionospheric layers during several future years, and particularly during the coming years of low solar activity.

STUDY PROGRAMME No. 23

MEASUREMENT OF ATMOSPHERIC RADIO NOISE

(Questions Nos. 9, 11, 12 and 13, Recommendations Nos. 5 and 10, Opinion No. 2)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

(a) That in the interests of the organization of radio communications it is essential to carry out research on the elements required for the measurement and prediction or forecasting of atmospheric interference to reception ;

(b) That the most widely used direct method of measuring the interference value of atmospherics consists in injecting simultaneously into the receiver natural noise and suitably calibrated artificial signals ;

(c) That this method, when applied to the reception of aural telegraph signals, gives useful results by measuring the signal level for which an average receiving operator makes a given proportion of mistakes ;

(d) That it seems logical, for a transmission system involving a human factor, to apply a method involving the same human element to the measurement of interference produced by noise ;

(e) That, for application to other types of transmission using recorders, the method should be modified to record errors automatically, so that the result is independent of the subjective element ;

(f) That the interference effect of atmospheric noise in radio communication can also be deduced from direct measurement of the atmospheric noise level on various frequencies ;

(g) That it is moreover important to determine what characteristics of atmospheric noise must be known for a rational solution to the problem of noise in radio transmission ;

(h) That a rational method would require :

1. A knowledge of the locality of storm centres in the world, their intensity and their variation in time and space ;
2. A determination of the characteristics of long-range interference caused by natural electrical discharges and their variation as a function of the path between the source and the receiving station, at any time of day, in any season, and for any sunspot period ;
3. The application of simplified methods of characterising the total interference caused by world storm centres at a given place and time ;
4. A knowledge of the nature of the characteristic noise parameters required for the calculation of interference caused by noise in different types of transmission (aural, automatic recording, etc.) ;

(i) That in any case it would be of advantage to collect data for the preparation of world maps of storm centres for the study of local reception conditions ;

(j) That it would also be of general advantage to encourage the study of receiver response to impulse type interference as a function of receiver characteristics ;

DECIDES that the following studies shall be carried out :

1. That the existing method of direct measurement of the interference caused to aural telegraph traffic by atmospheric noise should be continued along the present lines at a number of stations judiciously distributed throughout the world ;

2. That steps should be taken with a view to applying the same method to other types of transmission, making it independent of an operator ;

3. That simultaneously other methods of measuring directly the atmospheric noise level should be developed ;

4. That a comparison of the results obtained by the methods mentioned in **1, 2** and **3** should be carried out with a view to deciding on the most appropriate method for future use ;

5. That more apparatus for locating storm centres (e.g. narrow-beam goniometers, cathode-ray goniometers) should be put into operation and that the laboratories concerned should, through the World Meteorological Organization (W.M.O.), co-ordinate their research in the frequency band between 10 kc/s and 30 Mc/s, and compare the results on different frequencies;

6. That Administrations should be invited, as a matter of urgency, to submit results of tests using devices for counting local (i.e. within about 20 km) lightning discharges ;

7. That, based on the information obtained from **6**, a specification should be drawn up, in close association with the W.M.O., of the characteristics of a lightning recorder suitable for use in meteorological stations ;

8. That the W.M.O. should be asked to obtain and instal counters, having these specified characteristics, in the meteorological stations from which it would be of advantage to obtain the number of daily discharges and their distribution as regards time of day and season ;

9. That experimental research should be undertaken into the form and other characteristics of atmospheric noise from distant storms ;

10. That theoretical research should be undertaken on the characteristics of interference from distant lightning flashes ;

11. That the study should be undertaken and encouraged of the noise characteristics at the receiver input, with a view to determining the response at the output ;

12. That methods should be developed for presenting all the data available on atmospheric noise in the form of world maps and associated curves ;

13. That the attention of the International Radio Scientific Union (U.R.S.I.) should be drawn to the need for conducting the research mentioned in **9** and **10** and for investigating the spectral distribution of radiated energy resulting from a lightning flash and also to the need for research in the field of extra-terrestrial noise ;

14. That the investigation of man-made noise and thermal noise should be pursued by the appropriate study group ;

15. That this Study Programme should be deemed to replace Recommendations Nos. 5 and 10 and Questions Nos. 9, 11 (Sections 1 and 2), 12 and 13, and Opinion No. 2 of the C.C.I.R.

STUDY PROGRAMME No. 24

STUDY OF FADING

(Question No. 14)
(Study Group No. VI)

The C.C.I.R.,

CONSIDERING :

(a) That the practical requirements of radio communication necessitate not only information on the median received field strength of radio signals, but also data on the magnitude, distribution and rapidity of field strength variations ;

(b) That field strength variation involves phenomena of focusing, variation in direction of arrival and interference by components of a single mode, between different modes and between the various magneto-ionic components, as well as variations of ionospheric absorption and scattering phenomena ;

(c) That variations of field strength may, as a first approximation, be divided into three types :

c.1. Irregular short period variations, assumed in general to result from interference and focusing, with an apparent period of occasionally as much as several minutes and dependent to a certain degree on the frequency. In long distance transmissions at high frequencies, these variations follow Rayleigh's distribution law often enough for the latter to be considered satisfactory for the time being. These variations should be allowed for in the definition of a *fading safety factor;*

c.2. Irregular variations of periodicity large compared with the case above (hourly, daily or from one day to another), which may be due to fluctuating absorption or to prolonged large scale focusing or which may result from variations of arrival angle and polarisation. Allowance for them should be made in the definition of an *intensity fluctuation factor;*

c.3. Regular variations with time of day, season and solar activity, to which are added the variations of the two above types ;

(d) That the effects of field strength variations on radio communication involve not only the time distribution of short and long period variations, but also the rapidity of variations with respect to the speed of transmission, the effects of equipment time-constants and, in the case of telephony, selective fading ;

(e) That operational requirements necessitate not only a knowledge of the variations in strength of a single signal, but also a knowledge of the variations of wanted/unwanted signal ratio and the signal/noise ratio ;

(f) That it is important to have comprehensive information on the advantages of time, space, frequency and polarisation diversity reception ;

(g) That waves shorter than 10 metres do not normally concern Study Group VI ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. That statistical studies, both theoretical and experimental on the distribution with time of the received field strength, should be made for the various frequency bands used in radio communication by means of the ionosphere ;

2. That theoretical studies on the effects produced by field strength variations on different receiving systems should be pursued ;

3. That experimental studies should be undertaken with a view to ascertaining the mechanisms which produce field strength variations ;

4. That empirical studies should be undertaken, for the various frequency bands used in radio communications, on :

4.1 The rapidity, severity and time distribution of short period field strength variations ;

4.2 The time distribution of day-to-day variations of hourly median field strengths ;

4.3 The degree of correlation between variations of field strength of signals :
 — on adjacent frequencies arriving over the same path ;
 — on the same frequency, from the same transmitter, received at different places, or with different polarisation at one place ;

5. That empirical studies should be undertaken to evaluate the protection ratio against :
— another steady signal ;
— another fading signal ;
— steady noise ;
— irregular noise ;

for different qualities of service, and for different types of communication services.

These studies should involve the time constants and other characteristics of the receiving equipment used, the resolving power of the ear, etc.

STUDY PROGRAMME No. 25

STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Recommendation No. 18) *
(Study Group No. VII)

The C.C.I.R.,

CONSIDERING :

(a) That Recommendation No. 18 called for the study of the provision and operation of a world-wide standard frequency and time service with the optimum number of transmitting stations ;

(b) That the programme provided for trial transmissions to determine the service areas and the areas of interference with existing transmissions ;

(c) That at present there is only a small number of experimental stations in operation, all being situated in the Northern Hemisphere, and some of them on a limited schedule ;

(d) That it would be desirable for a limited number of additional stations to be set up ;

(e) That the information assembled on service areas and interference areas, although considerable, is still very incomplete ;

(f) That serious interference at certain times, at certain locations and on certain frequencies is nevertheless to be feared in the case of simultaneous multiple emissions ;

* This Recommendation becomes Question No. 54.

(g) That the comparison of the types of modulation frequencies has been only partly carried out ;

(h) That difficulties have been reported in the reception of the time signals with an audio modulation superimposed and in the presence of simultaneous reception of several transmitters ;

(i) That the investigations on the use of directional aerials, of single sideband transmissions with full carrier and on the interruption of the transmissions to permit the measurement of noise have not yet furnished sufficient data ;

(j) That it seems unnecessary to use high power ;

DECIDES that the following studies shall be carried out :

1. Experimental stations should be put into service, particularly in South America, Australia and Asia ;
2. Information on satisfactory service areas, interference areas and interfering stations should be sent regularly, in the uniform manner suggested in forms B, C and D in Ann. I, II and III, by each Administration to the Secretariat of the C.C.I.R. for association and distribution ;
3. Comparative tests should be made between :
   — the transmission of time signals and an audio modulation simultaneously, and
   — the transmission of the time signals and audio modulation consecutively ;
4. Comparative tests should be made using the modulation frequencies 440 c/s, 600 c/s and 1,000 c/s ;
5. Comparative tests should be made using :
   — seconds pulses as described in Recommendation No. 18, section 11, and
   — pulses of the same duration but composed of 800 c/s, 1200 c/s or 1400 c/s ;
6. The possibility of time-sharing of programmes as a means of ultimately minimizing harmful interference between standard frequency transmissions should be studied ;
7. Investigations should be undertaken and actively pursued on the use of directional aerials, the reduction of transmitter power, special types of modulation with carrier, better identification signals of the minutes, and the desirability of interrupting the transmissions for the measurement of noise.

ANNEX I

Form B

SUMMARY OF INFORMATION ON SERVICE AREAS

Location of User	Date	Time of reception (U.T.)	Standard Frequency Station		Number of Observations	Details of quality of reception	Remarks
			Call Sign	Frequency (kc/s)			

ANNEX II

Form C

SUMMARY OF INFORMATION OF INTERFERENCE AREAS

Location of User	Date	Time of reception (U.T.)	Stations received simultaneously		Number of Observations	Difficulties experienced	Remarks
			Call Sign	Frequency (kc/s)			

ANNEX III

Form D

SUMMARY OF INFORMATION ON INTERFERING STATIONS

Location of User	Date	Time of reception (U.T.)	Standard Frequency Station		Interfering Station				Remarks
			Call Sign	Frequency (kc/s)	Call Sign	Type of emission	Estimated location	Frequency (kc/s)	

STUDY PROGRAMME No. 26

IDENTIFICATION OF RADIO STATIONS

(Question No. 17)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

That Recommendation No. 79 of the C.C.I.R., referring to the identification of radio stations, does not cover all aspects of the problem ;

DECIDES that

the following studies shall be carried out :

1. The problem of inserting call signs on multiplex, synchronized and other special systems without practically interrupting the flow of traffic and without increasing the effective bandwidth of the emissions ;

2. The nature of the signal referred to in Recommendation No. 79, Section 2.7, and the amount of information it should contain.

STUDY PROGRAMME No. 27

5-UNIT RADIO TELEPRINTER

(Question No. 19)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

The problems raised in Question No. 19 ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The comparison of the effects of varying radio path conditions upon circuits employing :
- — synchronous systems, for example those which sample at critical instants the envelope of the impulses forming the character and those which employ the method of integrating the envelope of the impulses ;
- — start-stop systems in this connection, the difficulties created by a false " start " generated by a false impulse should be considered ;

2. The possible adoption of special codes on the radio circuit. It should be noted that an error detecting code of seven units has been successfully used on radio circuits. (See Doc. No. 62 of Geneva.)

STUDY PROGRAMME No. 28

WIDE BAND RADIO SYSTEMS OPERATING IN THE VHF (METRIC), UHF (DECIMETRIC) AND SHF (CENTIMETRIC) BANDS

(Questions Nos. 29 and 41)
(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

(a) That wide band radio systems suitable for operation in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands and for incorporation in networks carrying telephone, broadcast programmes, telegraph and television signals, present technical problems of concern to the C.C.I.F., the C.C.I.R. and the C.C.I.T. and in particular to the C.C.I.F. and the C.C.I.R. ;

(b) That Recommendation No. 40 * approved by the VIth Plenary Assembly of the C.C.I.R. concerning radio telephone systems operating in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands is in terms of an objective to be attained and that consequently it is necessary to study many technical problems in detail, in order that suitable recommendations may be given to enable this objective to be achieved in specific cases ;

(c) That the best method of cooperation between the two C.C.I.s appears to be based on the broad principle that those aspects of a given problem concerning only one C.C.I. are dealt with solely by that C.C.I. while those aspects which concern both C.C.I.s are the responsibility of the C.C.I. most concerned, the other C.C.I. being adequately represented at all discussions and meetings ;

(d) That, as described in C.C.I.R. Doc. No. 188 of Geneva, some studies have already been carried out by the C.C.I.F. ;

UNANIMOUSLY DECIDES that the following studies shall be carried out and that the appropriate steps be taken to coordinate the work with the C.C.I.F. on the lines indicated below :

1. Questions for study by the C.C.I.F.

1.1 The overall transmission characteristics for the transmission of multi-channel telephone, broadcast programme, telegraph and television signals over land-line systems and over integrated systems including line and radio.

2. Questions for study by the C.C.I.R.

The studies referred to in this section should be carried out for the VHF (metric), UHF (decimetric) and SHF (centimetric) bands, and should include consideration of the transmission of telephone, broadcast programme, telegraph and television signals. These studies may include consideration of the following items :

2.1 Transmission characteristics of radio systems.

2.2 Radio propagation, fading, diversity reception, noise and interference.

2.3 Considerations involved in choice of sites for radio stations.

* Concerning Questions Nos. 29 and 41 see Doc. No. 423 of Geneva.

2.4 Modulation processes and methods of multiplexing.

Consideration should be given to amplitude, frequency and pulse modulation and to frequency —and time—division systems.

2.5 Radio equipment (transmitters, receivers, relays, aerials and transmission lines).

2.6 Methods of measurement on the radio system.

3. Questions for study by the C.C.I.F. with C.C.I.R. representatives

3.1 The equipment at the radio terminals to provide for connection to the land-line network.

3.2 The merits of the several possible systems of modulation and multiplexing in respect of the effective integration of line and radio systems.

3.3 The addition to, and withdrawal of, channels from a relay system at intermediate stations.

3.4 Transmission characteristics required for the transmission of multi-channel telephone, broadcast programme, and television signals.

3.5 The provision of land-lines for the supervision and monitoring of radio systems.

3.6 Monitoring and basic principles of maintenance and reliability of radio relay links integrated into the general network.

3.7 Methods of measurement on overall line and radio systems.

4. Questions for study by the C.C.I.R. with C.C.I.F. representatives

4.1 Supervisory and monitoring facilities on radio systems.

4.2 The percentage of time during which the required transmission characteristics can be expected to be met for telephone, broadcast programme, telegraph and television signals.

Note. — In the above study programme an attempt has been made to outline the overall studies required, and while it is appreciated that these studies are a matter of some urgency it must be understood that in several respects the proposed studies are of the long-term type and that only with advances in the development of radio relay systems on waves of VHF (metric), UHF (decimetric) and SHF (centimetric) and with measurements of their performances will the necessary information become available.

STUDY PROGRAMME No. 29

ALARM SIGNAL FOR USE ON THE MARITIME RADIOTELEPHONY DISTRESS FREQUENCY 2182 kc/s

(Recommendation No. 24) *

(Study Group No. IX)

The C.C.I.R.,

CONSIDERING :

Recommendation No. 71,

DECIDES that the following Study Programme shall be carried out :

1. Administrations and Operating Agencies should be encouraged to carry out thorough tests, as an urgent matter, with automatic alarm equipment designed or adapted to operate with the alarm signal defined in Point 1 of Recommendation No. 71, with the object of determining as quickly as possible the following factors :

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* This Recommendation becomes Question No. 56.

1.1 The general suitability of the alarm signal, and whether any changes should be made in it prior to its being recommended for final international adoption ;

1.2 The essential characteristics and tolerances of the signal that should be recommended for final international adoption ;

1.3 the performance standards for automatic equipment that should be considered for international adoption ; (e.g. tolerances of essential components, selectivity, sensitivity, A.V.C. characteristic, etc.)

1.4 The best type of manual and automatic devices for generating the alarm signal.

2. Laboratory and field tests should reproduce, as closely as possible, conditions representative of those in which the automatic alarm equipment will be used in practice. In these tests, the alarm signal should be transmitted for 30 seconds on each occasion to enable the results obtained by different Administrations to be compared together. Reports of the tests should include all the relevant test conditions (field strength of the signal, interference level, etc.). Administrations should advise one another beforehand, via the Chairman of Study Group No. IX, of the periods when they will be carrying out tests, in order to avoid mutual interference.

3. The aim should be to complete the tests within 12 months. Reports on items 1.1, 1.2, 1.3 and 1.4 in Section **1** should then be sent for co-ordination to the Chairman as early as possible.

STUDY PROGRAMME No. 30

THE RECEPTION OF HIGH FREQUENCY BROADCASTING WITH SYNCHRONIZED TRANSMITTERS

(Question No. 37)
(Study Group No. X)

The C.C.I.R.,

CONSIDERING :

That in high frequency broadcasting services there is insufficient evidence at the present time to determine whether satisfactory reception can be obtained in contiguous areas when two synchronized transmitters are carrying the same programme ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Experiments to determine whether satisfactory reception can be obtained in contiguous areas when two transmitters, carrying the same programme, are synchronized on the same frequency.

STUDY PROGRAMME No. 31

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Question No. 42)
(Study Group No. X)

The C.C.I.R.,

DECIDES that the following studies shall be carried out :

1. The investigation of methods of measurement on "WOW" and "flutter" for both disk and magnetic tape recording and reproducing, and of the tolerances which may be allowed ;
2. The further study of the disk-recording and reproducing stylus ;
3. The study of the best methods of overlapping programmes recorded at $33^1/_3$ and 78 rpm. ;
4. The further investigation in the field of sound recording, aiming at the refinement of the recommendations already made.

STUDY PROGRAMME No. 32

THE REQUIREMENTS FOR THE TRANSMISSION OF TELEVISION OVER LONG DISTANCES

(Question No. 40)
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That it is necessary to transmit television signals over long distances ;

(b) That the C.C.I.F. needs information upon which to plan circuits ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Determination (See Ann. II) of the values and tolerances for the following factors for the satisfactory transmission of television signals over long distances :

A. *Input and output impedance of the transmission circuit*
Value, whether balanced or unbalanced, tolerance.

B. *Polarity of signal*
Polarity and whether A.C. or D.C.

C. *Amplitude of signal*
Value from peak white to tip of synchronizing pulses.

D. *Picture signal to synchronizing signal ratio*
Value to be used for feeding into and out of transmission circuit.

E. *Non linearity*
The tolerable change of slope of the output-to-input amplitude characteristic.

F. *Stability of overall transmission circuit*
The tolerable change of overall gain at a reference frequency over :
(a) short periods, e.g. of 1 second
(b) medium periods, e.g. of 1 hour
(c) long periods, e.g. of 1 month.

G. *Signal-to-noise ratio*
The tolerable signal-to-noise ratio for :
(a) random uniform noise
(b) periodic noise
(c) impulsive noise.

In order to simplify the comparison of the results of the tests carried out in the various countries, it is suggested that the ratios should be quoted in db and that the ratio should be :

$$\frac{\text{peak-to-peak value of the picture signal}}{\text{peak-to-peak value of the noise}}$$

and the synchronizing signal should not be considered as being part of the picture signal. It should be understood that the ratio can be measured in other terms and a suitable correction factor applied ; in this case the correction factor should be stated, for example the crest factor in the case of random uniform noise.

H. *Attenuation and phase characteristics*
The limits which can be allowed on :
(a) the attenuation frequency characteristic
(b) the phase frequency characteristic
(c) the transient response *.

ANNEX I

Proposals of the C.C.I.F. for the Transient Tests to be made on Television Systems

It is proposed that the following two types of recurrent pulses should be used :

(a) *A square wave* of fundamental frequency equal to the vision field-frequency, and of unity mark/space ratio, for the purpose of indicating the waveform distortion which corresponds to attenuation/frequency and phase/frequency distortions in the lower part of the effectively transmitted frequency range.

(b) *A sine-squared (or raised sine) pulse,* of repetition frequency equal to the vision line-frequency. This pulse is intended to indicate attenuation and phase distortions in the upper part of the

* For the transient response study, attention is drawn to the proposals made by the C.C.I.F. and reproduced in Annex I.

frequency range. Its half-amplitude width should be equal to one half of the period corresponding to the nominal upper cut-off frequency of the television system.

Remark. — The line and field synchronising signals may possibly be inserted in between two such pulses, if it is desired to use the same time bases in the cathode ray oscilloscopes used for these tests, and in those employed for monitoring the television transmission.

ANNEX II

General Requirements for a 405 Line 3000 kc/s Video Band System

The figures in this Annex are given merely for information and do not represent a transmission specification.

A. *Input and output impedance of the transmission circuit*

75 ohms unbalanced and a return loss of not less than 30 db at any frequency between 10 kc/s and 3000 kc/s.

B. *Polarity of signal*

The video signal for transmission to line has positive polarity ; i.e. its amplitude will increase in proportion to the brilliance of the corresponding point of the picture. The D.C. component is not transmitted.

C. *Signal amplitude*

About 1 volt peak-to-peak.

D. *Picture signal to synchronizing signal ratio*

About 70/30.

E. *Non linearity*

For the complete signal from the tip of the synchronizing pulse to peak white, slope should not vary more than 0.9 to 1.1, relative to the ideal.

F. *Stability of overall transmission circuit*

(a) ±0.3 db

(b) ±0.5 db

(c) ±2 db

G. *Signal-to-noise ratio*

(a) 45-50 db

(b) 40-55 db, depending upon frequency

(c) 35-40 db, if not more than one pulse in a 10 second period.

H. *Attenuation and phase characteristics*

(a) Flat to within ±1 db, and free from numerous and marked changes of slope from 20 c/s to 3000 kc/s.

(b) Substantially linear and free from numerous and marked changes of slope ; variation of group delay between 200 kc/s and 3000 kc/s should not exceed a value of about 0.1 microsecond for a 100 kc/s interval.

(c) 0.16 microsecond for 10 to 90% *.

* Using a square waveform with a rise time of 0.1 microsecond.

Limits for overshoot and echoes *

Time after response has reached 50% ideal amplitude	Limits of rapid variation of response % of ideal amplitude
0.2 to 0.5 microseconds	± 4
0.5 to 1.0 microseconds	± 1
1.0 microsecond or longer	± 0.5

* Using a square waveform with a rise time of 0.1 microsecond.

STUDY PROGRAMME No. 33

TELEVISION FIELD FREQUENCY

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That two different values of field frequency are in use in various television systems ;

(b) That it is desirable to determine the lower limit of field frequency for satisfactory performance, in relation to the properties of long-persistence phosphors ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The relation between maximum brightness and field frequency for absence of flicker, for field frequencies of the order of 50 to 60 fields per second, taking into account the decay time of the different colours ;

2. In considering the perceptible and tolerable conditions of flicker, particular attention should be given to the effect of :
   — a wide range of ambient illuminations falling at various angles of incidence upon the viewing screen ;
   — the use of neutral density filters over this range of ambient illuminations ;
   — the use of long-persistence phosphors providing nominally white light ;

3. In the event of these phosphors comprising components of different colours, the effect of colour fringing should be investigated and, in any event, the subjective sharpness of images in motion should be determined.

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* This Recommendation has become Question No. 64.

STUDY PROGRAMME No. 34

PICTURE AND SOUND MODULATION

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.

UNANIMOUSLY DECIDES that the following study shall be carried out :

The respective advantages and disadvantages of positive and negative picture modulation and of amplitude and frequency sound modulation taking into account the following points :

— effect of noise on picture ;
— effect of noise on synchronisation ;
— automatic gain control ;
— inter-carrier sound reception.

STUDY PROGRAMME No. 35

REDUCTION OF THE BANDWIDTH FOR TELEVISION

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) The great technical or financial difficulty encountered in obtaining the required bandwidth in transmitting television signals, both in broadcasting and in transmission over intermediate links ;

(b) The potential value of various techniques, such as dot-interlace or rapid-transition (" crispening ") circuits in improving the resolution of television images without increasing the bandwidth ;

(c) The possibility of reducing flicker by the use of long-persistence phosphors ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The methods which can be used to reduce the bandwidth occupied by the transmission and broadcasting of a television picture without reducing the picture quality, especially its sharpness ;

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* This Recommendation has become Question No. 64.

2. The possibility of transmitting a standard signal from point to point by converting that signal into an intermediate signal (e.g., the dot-interlace type of signal), the bandwidth of the intermediate signal being smaller than that of the terminal signal ;

3. The effect of the field frequency and the use of long-persistence phosphors on inter-dot flicker and inter-dot crawl.

STUDY PROGRAMME No. 36

CONVERSION OF A TELEVISION SIGNAL FROM ONE STANDARD TO ANOTHER

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.

UNANIMOUSLY DECIDES that the following studies shall be carried out :

Methods of converting a television signal from one standard to another :
— when the field frequency is identical in the two standards, but the number of lines differs ;
— when both field frequency and number of lines are different in the two standards.

STUDY PROGRAMME No. 37

BLACK AND WHITE AND COLOUR TELEVISION

(Recommendation No. 29) *
(Study Group No. XI)

The C.C.I.R.,

CONSIDERING :

(a) That many countries will introduce a colour system after having an established black and white system in operation ;

(b) That a number of alternative systems of colour television have been proposed ;

(c) That factors which will influence the choice of a colour system will include :
— picture quality,
— the cost of receivers and possibly converters,
— bandwidth ;

* This Recommendation has become Question No. 64.

(*d*) That where a black and white system is already in operation the foregoing considerations will be affected by the need to avoid making existing receivers obsolete, and to avoid increasing unduly the programme costs ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Ascertain what methods can be used to achieve the best combination of black and white and of colour television systems, from the point of view of picture quality, programme costs and the cost of receivers or converters.

STUDY PROGRAMME No. 38

SHORT DISTANCE HIGH FREQUENCY BROADCASTING IN THE TROPICAL ZONE (TROPICAL BROADCASTING) *

(Questions Nos. 4 and 27 and Recommendations Nos. 47 and 84)
(Study Group No. XII)

The C.C.I.R.,

CONSIDERING :

(*a*) That there is little data on the determination of the power required for a given grade of tropical broadcasting service ;

(*b*) That it would be helpful in the planning of new tropical broadcasting services to have more reliable data ;

(*c*) That more reliable data would be helpful in the organization of services in the bands shared with tropical broadcasting (See Art. 9, § 244 of the Radio Regulations, 1947) ;

DECIDES that the following studies shall be carried out :

1. The experimental determination of the signal-to-noise ratio and the signal-to-interference ratio that should be adopted as representative of an acceptable tropical broadcasting service. The observations should be made with aerials and receivers that are representative of those normally used for tropical broadcasting reception. The reports on this study should indicate as fully as possible the conditions of measurement, the characteristics of the equipment and the methods used, so that the results may be correlated with those of other observers. In particular, the bandwidth of the receiver employed should be given.

2. A practical examination of whether the provisional power limits in Recommendation No. 84 are satisfactory or whether they should be changed to give an acceptable tropical broadcasting service. The reports on this study should include all the relevant factors concerned and, in particular, information on the following points :

— the area and the day, month and year for which observations are made ;
— the distance from the transmitter to the point of observation ;
— the carrier power of the transmitter and its depth of modulation ;
— the details of the transmitting and receiving aerials ;
— the characteristics of the receiver used ;

* As this service is defined in the considerations of Question No. 27.

Information on the signal-to-noise ratio and the signal-to-interference ratio (if possible in a statistical form) would also be helpful (see also § 1 above). Any conditions peculiar to the area concerned and which have an important bearing on the transmitted power required should also be stated.

3. The study of natural noise in the tropical zone, which should be continued, with particular reference to broadcasting conditions. The aim should be to provide noise data (in a statistical form if possible) which could be used in problems concerning the field strength or radiated power required to produce a given grade of broadcasting service. The method of measurement used should be clearly defined, particularly as concerns the bandwidth of the measuring equipment. Particular attention should be paid to those frequency bands allocated to broadcasting below 16 Mc/s which could be used for broadcasting in the tropical zone and to the normal broadcast listening hours (approximately 0600 to 2400 local time).

4. The study of the field strength produced by tropical broadcast transmitters. Reports should, if possible, be evaluated on a statistical basis, and should give, in particular, the following information :

— method of measurement employed ;
— method of analysis ;
— location of transmitter ;
— distance from transmitter at which measurements are made ;
— radiated carrier power ;
— polar diagram of transmitting aerial (or equivalent data) ;
— period during which measurements are made ;
— radio frequency used.

It might be convenient to carry out this study in conjunction with those outlined in § **1** and **2** above. If it is possible to make measurements of the field strength produced outside the service area of the tropical broadcasting station, the resulting information would also be helpful in determining the degree of interference produced to other services which share frequency bands with tropical broadcasting.

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REPORTS

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REPORT No. 1 *

TELEGRAPHIC DISTORTION

(Question No. 18)
(Study Group No. I)

The C.C.I.R.,

CONSIDERING :

That Question No. 18 of the C.C.I.R. suggested a joint study of telegraphic distortion by the C.C.I.T. and the C.C.I.R.,

SUBMITS the following report to the joint Study Group :

The definitions given in Ann. 1, which are based on the C.C.I.T. proposals with slight additions, may only have a limited value in the case of radiotelegraphy.

The study of fortuitous distortion is of the utmost importance in radiotelegraphy and should be continued as an urgent matter. The C.C.I.T. paper I/R51/8 (reproduced in Ann. 2), the C.C.I.R. comments (Ann. 3) should be considered in connection with this study.

ANNEX I

DEFINITIONS

1. *Telegraph modulation and telegraph restitution*

   Telegraph modulation is the series of discrete conditions assumed successively by the appropriate moving part of a telegraph transmitter (or by an electrical device performing a similar function) having a significance according to the code used, with the object of effecting in the appropriate receiving device a series of changes of condition permitting the reconstitution, according to the same code, of the message transmitted. This series of changes of condition is called a *restitution of the telegraph modulation.*

2. *Significant conditions (of a modulation or of a restitution)*

   Discrete conditions assumed by the appropriate moving part of a telegraph instrument (or by an electrical device performing a similar function) used to define the modulation (or the restitution).

3. *Characteristic or significant instants (of a modulation or of a restitution)*

   Instants at which the appropriate moving part of a telegraph instrument (or an electrical device performing a similar function) reaches its significant condition.

4. *Significant interval (of a modulation or of a restitution)*

   The time which elapses between two successive characteristic instants.

5. *Significant element (of a modulation or of a restitution)*

   That part of a modulation (or of a restitution) occurring between two successive characteristic instants.

* This Report was adopted unanimously.

6. *Unit interval*

The modulations appropriate to standardized telegraph systems are composed of significant elements having a duration equal to or a multiple of the duration of the shortest element. The theoretical duration of this shortest element is called the *unit interval.*

An exception to this rule occurs with start-stop systems for which the stop element may have any duration equal to or greater than the unit interval.

7. *Unit element*

A significant element having the duration of a unit interval.

8. *Modulation rate*

The reciprocal of the duration of the unit interval measured in seconds. The modulation rate is measured in Bauds. Example : if the unit is 20 milliseconds, the modulation rate is 50 Bauds.

9. *Restitution delay*

The delay between a characteristic instant of modulation and the corresponding characteristic instant of restitution.

10. *Isochronous modulation*

Modulation appropriate to a standardized system in which the significant intervals are equal to the unit interval or to a multiple thereof.

11. *Start-stop (or arythmic) modulation*

Modulation appropriate to a standardized system consisting of isochronous modulations having a duration limited to a certain number of unit intervals, separated by intervals of any duration equal to, or greater than, the unit interval.

12. *Perfect modulation (or restitution)*

Modulation or restitution conforming accurately to the code adopted (as regards both the significant conditions and the characteristic instants).

13. *Distorted modulation (or restitution)*

Modulation (or restitution) not having all the characteristics of a perfect modulation (or restitution). For standardized modulations and their restitution, the series of conditions must be in accordance with the code, without omission or addition ; this being understood, the distortion concerns only the characteristic instants.

14. *Degree of individual distortion of a particular characteristic instant (of modulation or of restitution)*

Ratio to the unit interval of the displacement, expressed algebraically (i.e. early or late), of this characteristic instant from a specified instant. It is necessary to state in each particular case the basis on which this specified instant is determined.

In the study of telegraph distortion arising in a radio path, it will usually be convenient to define the ideal instant as that at which the instant of modulation would have occurred had it suffered the average restitution delay. The term " individual distortion " defined in this way, is directly applicable to an assessment of the performance of a synchronous telegraph system.

15. *The degree of distortion of an isochronous modulation (or restitution)*

Ratio to the unit interval of the maximum difference, irrespective of sign, between the actual and theoretical intervals separating any two characteristic instants of modulation (or of restitution), these instants being not necessarily consecutive.

This definition, however, is strictly applicable only insofar as the circuit between the terminal equipments is for all practical purposes free from fortuitous distortion.

16. *Degree of distortion of a start-stop (or arythmic) modulation (or restitution)*

Ratio to the unit interval of the maximum difference irrespective of sign, between the actual and theoretical intervals separating any characteristic instant of modulation (or of restitution) from the commencement of the start element immediately preceding it.

(a) *Degree of gross start-stop (or arythmic) distortion*

Degree of distortion determined when the unit interval and the theoretical intervals assumed are those appropriate to the standardized modulation rate ;

(b) *Degree of start-stop (or arythmic) distortion measured synchronously*

Degree of distortion determined when the unit interval and the theoretical intervals assumed are those appropriate to the actual mean modulation rate of the signals under consideration.

17. *Degree of service distortion (of a circuit, including apparatus)*

Degree of distortion of the restitution measured during an unspecified period of time when the telegraph apparatus is in service. The result of this measurement may be completed by an indication of the probability of exceeding this degree of distortion.

18. *Degree of standard test distortion (of a telegraph channel)*

Degree of distortion of the restitution measured during a specified period of time when the modulation is perfect and corresponds to a specific text.

19. *Analysis of types of distortion*

It is useful, for certain applications, to distinguish :

(a) *Bias Distortion*

Distortion suffered by a modulation (or a restitution) of which the characteristic instants corresponding to a particular change of condition are systematically advanced or retarded.

(b) *Inherent Distortion*

Distortion suffered by a restitution when the modulation is perfect and when the receiving device is ideally perfect.

(c) *Characteristic Distortion*

Distortion suffered by a restitution, in the absence of disturbances of any kind, when the modulation is perfect and with the normal receiving device in correct adjustment.

(d) *Fortuitous Distortion*

Distortion resulting from disturbances of any kind affecting the circuit (including apparatus).

20. *Regeneration*

When a telegraph receiver or similar device affects restitution of distorted telegraph modulation in such a manner that the instants of modulation are restored to substantially the correct time relationship appropriate to the telegraph system concerned, the receiver or similar device is said to *regenerate* the telegraph signals.

ANNEX II *

(C.C.I.T. S.G. 1/R51/Doc. No. 8E)

LIMITS TO BE ASSIGNED TO IRREGULAR DISTORTION

Statement on Question III-1b

Study Group No. 1 of the C.C.I.T., considering that study to date has been insufficient to produce a practical method of assigning limits to irregular distortion and that, if study is to be continued, new apparatus will have to be designed, some of which will make it possible to reply to other questions set by the C.C.I.T.,

* The references to different Recommendations, Questions, Study Groups and Documents in this Annex refer to the C.C.I.T. designations.

EXPRESSES THE VIEW :

1. That study should be continued and the question kept in its present form ;

2. That it would be of advantage to enquire whether replies to the questions raised in the Annex to this Recommendation would constitute a useful contribution to the study.

Introductory Note

In the theoretical consideration of methods of measurement of fortuitous distortion, it is convenient to attach a more fundamental significance to the term " distortion " than that given by the definitions of Recommendation No. 301. Fundamentally, the determination of the value of telegraph distortion consists in expressing the relative time displacement of two instants of modulation (or the error in the time interval between two instants of modulation) as a fraction of the unit interval. According to Recommendation No. 301, however, the distortion of a train of telegraph signals is the maximum value of the distortion as defined above. During any particular period of observation, the distortion can therefore have only one value.

In theoretical studies, however, it is convenient to speak of " the start-stop distortion of a particular instant of modulation " i.e. the distortion of that instant of modulation with respect to the commencement of the start unit of the same character. Or again, it may be convenient to speak of " Element distortion ", i.e. the error in the time interval between the beginning and end of a particular signal element, expressed as a fraction of the unit interval.

In the following paragraphs, the term " distortion ", without qualification, will be assumed, in general to include distortion defined in these special ways, and also to include " Individual distortion " as defined in the revised version of Recommendation No. 301, proposed by the United Kingdom. " Distortion " will, however, always mean the value which applies to particular instants of modulation. It is then possible to attach more precise meaning to the expressions " distribution of distortion " or " probability of exceeding a given value of distortion ". Where " distortion " in the sense of " maximum distortion ", as defined in Recommendation No. 301, is intended, the word " maximum " will be included.

If the distribution of fortuitous distortion values ocurring on a telegraph channel follows a normal error law, no definite value can be regarded as the absolute maximum, though the frequency of occurrence of values exceeding x% distortion decreases rapidly as the value of x increases.

In order to define an effective maximum of distortion, it seems necessary to decide on a frequency of occurrence which may be regarded as low enough to be negligible in practice. The value selected might lie between 1 in 10,000 and 1 in 100,000. If the distribution is truly normal, and means are available for measuring either the Root Mean Square value of distortion or the average value of distortion irrespective of sign, it is possible to compute the value which will be exceeded with any desired probability (or frequency of occurrence) from the known shape of a normal distribution curve. It may be desirable to employ an instrument designed to measure either the Root Mean Square or the average value of distortion, or it may even be possible to estimate the Root Mean Square or the average value of distortion by visual observation of a distortion measuring set of conventional type, but in either case the measurement can be made in a short time.

In practice the distortion values on a single telegraph link will, in general, only approximate to a normal distribution. Due to the fact that the fortuitous distortion results from a finite number of causes, there may be an absolute maximum which is less than 100% and which is never exceeded. The departure from a normal distribution will be most marked at the higher values of distortion and lower values of probability, i.e. in the part of the distribution curve which is of greatest interest. Considerable error may, in consequence, result if the practical maximum is computed on the assumption of a normal distribution. It may be, however, that the absolute maximum value of distortion occurs with a frequency which is high enough to enable it to be determined readily from observation of a distortion set of conventional type for a relatively short period. Measurement of fortuitous distortion on telegraph links is of interest, however, mainly with the object of assessing the performance of a circuit consisting of a number of links connected in tandem.

Now assuming that at the telegraph speed concerned, the characteristic distortion of each of a number of links is small (tests have verified that the characteristic distortion of channels of the multi-channel voice frequency telegraph system used by the United Kingdom Administration is sufficiently small) it follows that :

(a) The Root Mean Square value of distortion occurring on the complete circuit is the square root of the sum of the squares of the Root Mean Square values of distortion occurring on the constituent links ;

(b) The distortion values on the complete circuit will approximate to a normal distribution even though the distribution for the constituent links departs appreciably from normal, and will approach more closely to normal as the number of tandem-connected links increases.

If, therefore, it is possible to measure the Root Mean Square value of distortion on each of the tandem-connected links, the Root Mean Square value of the distortion on the complete circuit can readily be calculated. Since the distortion values for the complete circuit can be assumed to follow a normal distribution, with far greater confidence than in the case of a single link, the value of distortion which is exceeded with any specified probability (or frequency of occurrence) can then be calculated by multiplying the Root Mean Square value by the appropriate factor " k ".

Values of factor k *for a normal distribution*

Probability	k	Probability	k
10^{-1}	1.65	5×10^{-4}	3.48
5×10^{-2}	1.96	2×10^{-4}	3.72
2×10^{-2}	2.33	10^{-4}	3.89
10^{-2}	2.58	5×10^{-5}	4.06
5×10^{-3}	2.81	2×10^{-5}	4.27
2×10^{-3}	3.09	10^{-5}	4.42
10^{-3}	3.29		

If this method of determining the effective maximum of distortion were adopted it is doubtful whether the Root Mean Square value of the distortion (or even the average value) could be estimated with sufficient accuracy by visual observation of a distortion measuring set of conventional type, and it would be desirable to use an instrument designed to give a direct indication of the desired value. It might be more convenient to design such an instrument to indicate the average (irrespective of sign) rather than the Root Mean Square value of distortion. This might be an acceptable alternative, for the following reason. If the distortion of the individual link has a normal distribution, the ratio of the Root Mean Square value to the average value is known (1.25). If the distortion has an approximately normal distribution at least over the range of higher probability values, the ratio will not be greatly affected. Even if the distribution is rectangular, i.e. if all values of distortion below a particular value are equally likely, and higher values do not occur at all, the ratio of Root Mean Square value to the average value is 1.15. Hence no large error would result if the average value of the distortion of the link were measured and then multiplied by 1.25 to obtain the Root Mean Square value.

As an example of the application of this method, suppose that the average fortuitous distortion (irrespective of sign) on each of four links is 2% and that it is desired to determine the value which will be exceeded with a probability of 1/20,000 on a circuit consisting of the four links connected in tandem. The estimated Root Mean Square distortion on each link is $1.25 \times 2 = 2.5\%$. The Root Mean Square distortion on the complete circuit will be $2.5 \times \sqrt{4} = 5\%$. For a normal distribution the value which is exceeded with probability 1/20,000 is 4 times the Root Mean Square value, which is 20%.

Direct measurement, either on a single link or on a multi-link circuit, of the value of distortion which is exceeded with a probability of, say 1/10,000, cannot conveniently be made by means of distortion measuring sets of conventional type. If, for example, the measurement is made using, as test signal, 2/2 reversals at 50 bauds, the time required for the transmission of 10,000 instants of modulation is about 6 minutes. On the average, therefore, the value which it is desired to measure will be exceeded only once in 6 minutes. This is an inconveniently long period of time for continuous visual observation. Furthermore, if the value of probability chosen were 1/100,000, the period of observation would be 60 minutes. Some instrument is desirable which will automatically indicate the distribution of the distortion, and which can be left operating unattended for the requisite testing period.

The United Kingdom Administration has developed and used an instrument (intended primarily for radio telegraph circuits) which continuously monitors the incidence of distortion on a telegraph circuit carrying traffic. This instrument records the occurrence of a signal element having a duration which is less than a predetermined fraction of a unit interval. Thus if the distortion dial of the instrument is set at 25%, the instrument records the number of signal elements having a duration less than 15 milliseconds. In order to determine the probability that the particular value of distortion will be exceeded, it is necessary to estimate the average rate of occurrence in traffic signals of elements having a nominal duration of one unit interval. If a number of instruments of this type were used, each set to a different value of distortion, it would be possible, by interpolation, to determine the value of distortion which was exceeded with any particular value of probability.

Summarizing, it seems desirable to consider the following subsidiary questions :

1. Is it agreed that the main object of devising a method of measuring fortuitous distortion on individual links is to enable the distortion of circuits consisting of several tandem-connected links to be forecast ?
2. Apart from rare exceptions, is the distribution of the frequency of occurrence of values of distortion such that the effective maximum distortion on a multi-link circuit can be ascertained by calculation based on a knowledge either of the average value or of the Root Mean Square value of the distortion on the separate links, and on the assumption that the distribution of the frequency of occurrence of values of distortion on the multi-link circuit is in accordance with the normal error law ?
3. Is there a need for an instrument which will measure either the Root Mean Square value or the average value of distortion ?
4. Is there a need for an instrument which will give the distribution of the frequency of occurrence of values of distortion on a circuit, or alternatively, which will indicate the value which is exceeded with a specified probability ?
5. If the answer to 2 is affirmative, what value of probability (or frequency of occurrence) should be adopted when determining the effective maximum ? What should be the permissible limit of effective maximum fortuitous distortion on a single telegraph link ?

Note. — The subsidiary question 1 has already been examined by Study Group No. 1 of the C.C.I.T. and has been answered in the affirmative (see Doc. C.C.I.T. I/7, page 2).

ANNEX III

Comments by the VIth Plenary Assembly of the C.C.I.R. on C.C.I.T. paper 1/R51/8

In deciding the method of measurement of distortion of a telegraph circuit, note should be made of the following points with regard to radio circuits operating over long distances and using frequencies in the range 2 to 30 Mc/s :

— distortion conditions arise from :

  (a) variable multipath propagation conditions,

  (b) variable amplitude (fading) coupled with a restricted bandwidth and consequently a variable build-up time in the receiver,

  (c) the incidence of noise which produces phase modulation of the signal ;

— propagation conditions vary throughout the day and these conditions may not be exactly repetitive from day to day ;

— distortions are not likely to have a normal random distribution ;

— in the absence of a more satisfactory method of determining the quality of a circuit, it will be necessary to continue to utilise the method of error-count in which the actual errors are counted over a period of time determined by the value of probability of error chosen ;
— at present there is no method of assessing the distortion of overall systems including one or more regenerative equipments ;
— the distortion should be measured separately on each radiotelegraph link ;
— it is preferable to employ a regenerative repeater at the junction of two radiotelegraph links ;
— there is need for an instrument to measure the frequency of occurrence of different percentage values of distortion and that the particular value given by each test should be the result of an observation lasting at least 1 or 2 and not more than 3 or 4 minutes.

REPORT No. 2 *

GROUND WAVE PROPAGATION OVER IRREGULAR TERRAIN

(Questions Nos. 6 and 7)
(Study Group No. IV)

1. Contributions relating to Question No. 6 of the C.C.I.R., items 2, 3 and 4, and to Question No. 7, item 1, have been received from the Chairman of the Study Group (Doc. No. 154, of Geneva, § I*b*, I*d* and II*a*), from the U.K. (Doc. No. 128 of Geneva, § 3.2), from the Allied High Commission (Germany) and from Japan, and answer in part the Questions Nos. 6 and 7 of the C.C.I.R.

   The study of this subject has not yet reached the stage at which a Recommendation can be made and this report is therefore an interim statement on the position.

2. *Question No. 6, item 2 and Question No. 7, item 1*

   Effect of hills and other obstacles in diffracting waves in either the horizontal or vertical plane.
   The study of diffraction around single obstacles such as hills falls into two well defined categories :

   (a) Bare hills of approximately knife-edge shape.

   When the terminal points are well removed from the obstacle, it is adequate to apply the classical Fresnel treatment for optical diffraction at a knife-edge profile, but when they are on or near the obstacle, a more rigid approach is necessary. The hill is regarded as a sharp edge at which the direct and ground reflected waves comprising the incident radiation are diffracted. The diffracted field at the receiver can be similarly resolved into the direct and ground reflected components.

   A number of experiments has shown that small irregularities of the ground before and behind the obstacles can have a particularly favourable influence upon the field strength at the receiving points.

   It appears that where Fresnel diffraction theory is applicable, there is no distinction in behaviour between horizontal and vertical polarisation.

   (b) Bare hills of approximately cylindrical shape.

   When the transmitter and receiver are placed close to and on opposite sides of the obstacle, the theory of diffraction around a cylindrical or spherical surface may be applied.

   When the transmitter and the receiver are not very distant from the obstacle, the joint method of reflection and diffraction may be used. The diffraction around the obstacle between the tangents from the transmitter and the receiver is calculated as the associated exponential attenuation given by the diffraction formula.

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* This Report was adopted unanimously.

When the two terminal points are very remote from the obstacle, the two treatments described in *(a)* and *(b)* give approximately the same answer, since the effect of the obstacle in any case becomes small under these conditions.

The converse cases of propagation along and across valleys have not yet been analysed to the same extent and they are therefore, together with the most general case of very irregular terrain, recommended for further theoretical and experimental investigation in Study Programme No. 14.

3. *Question No. 6, item 3*

The siting of aerials for very high frequencies.

The problem of the siting of aerials is closely connected with the question of obstacles discussed above. It is advantageous to raise the aerials where possible, e.g. by placing them on hill tops, in order to reduce the effect of an intervening obstacle and to increase the visibility. In simple cases it is useful to study the ground profile with regard to the avoidance of unwanted reflections ; in such cases it may be possible to place the receiving aerial so that it is screened from such reflections. Unfortunately in most practical cases conditions are exceedingly varied and complex and the experimental results cannot easily be explained. At this stage, therefore, the most appropriate method for siting a VHF aerial is usually the empirical one of trying it in various positions and at different heights on the desired receiving site.

4. *Question No. 6, item 4*

The relative effects obtained with horizontal and vertical polarisation.

The question of the relative merits of vertical and horizontal polarisation is closely connected with the siting of the aerials in relation to irregularities of the terrain. Here again there is, except in the simplest cases, a similar lack of reliable experimental data. Therefore in this case also no precise rules can in general be given, and it is best to adopt an empirical method of choosing the type of polarisation.

REPORT No. 3

REVIEW OF PUBLICATIONS ON PROPAGATION

(Recommendation No. 14)
(Study Groups Nos. IV, V and VI) *

Recommendation No. 14 served to focus attention on the extraordinary amount of effort which is being expended in learning the facts of radio propagation and in applying them to radio operations and to international control and adjustment of the various radio services. This great field of effort is illustrated by the reviews prepared by eleven members in response to Recommendation No. 14, which appear as Annexes ** to Doc. No. 115 of Washington. These reviews in

* Study Group No. IV for ground wave propagation.
Study Group No. V for tropospheric propagation.
Study Group No. VI for ionospheric propagation.

** The reviews of radio propagation work submitted by various countries appear as the following Annexes to Doc. No. 115 of Washington :

Annex "A"	Belgium	Annex "G"	Sweden
Annex "B"	U.S.A.	Annex "H"	Switzerland
Annex "C"	France	Annex "I"	Union of South Africa
Annex "D"	Italy	Annex "K"	Netherlands
Annex "E"	New Zealand	Annex "L"	Canada
Annex "F"	United Kingdom		

most cases report on the period 1938 to 1948 inclusive. The field of radio propagation was summarized under C.C.I.R. auspices in 1937, covering progress up to that time. The results were given in " Report of Committee on Radio Wave Propagation ", which was distributed by the Bureau of the International Telecommunication Union before the 1938 Cairo Conference, and was published in " Proceedings, Institute of Radio Engineers ", **26**, pp. 1193-1234, (October, 1938.)

Since 1937, work on radio propagation has been exceedingly active and extensive. The phenomena of the ionosphere have been intensively studied and the results increasingly applied to the practical determination of optimum frequencies for long-distance transmission over any transmission path at any time. Propagation via the troposphere has been vigorously explored and much has been learned, particularly regarding propagation at VHF and higher frequencies. Microwave propagation has been pioneered. Ground-wave propagation has been reduced to quantitative calculation.

The publications on radio propagation are scattered through many scientific and engineering periodicals and books. References to these papers are given monthly in the lists of " Abstracts and References " published in *Wireless Engineer* and *Proc. I.R.E.*. Annual summaries of the work are given in the *Proc. I.R.E.*, entitled " Radio Progress during 19.. ", published usually in the March or April issue each year. Each of these reviews has a section on radio propagation. The reviews for 1938-1948 give references to 1025 published papers on radio propagation. These annual reviews of work on radio propagation in *Proc. I.R.E.* constitute a useful summary of the work done arranged in chronological order.

It is thus clear that a vast amount of work on radio propagation has been going on and is continuing. This field is now recognised as fundamental to radio operations and engineering. The work in progress is undertaken for a variety of motives and objectives. Some of it is on basic physical phenomena, some directed closely to specific engineering applications, and all of it is of interest.

The extent and value of the work on radio propagation is further illustrated by its extensive use in recent international conferences. Many compilations of methods of using ionospheric propagation data and an extraordinary number of charts have been prepared for and by recent international conferences. These have been indispensable in the conference work and will be needed even more in the future. As they were prepared hurriedly to meet specific needs, a valuable service could be rendered by reviewing them and, if found necessary, supplementing them.

It is believed that no other worth-while specific guidance " regarding desirable future work " could be given in any overall manner by the C.C.I.R. or any other body. On the other hand, the questions established and the studies made by the C.C.I.R. do provide incentives and objectives which are taken into account by the Administrations, companies, research institutes and individuals engaged in radio propagation work. The effect of the C.C.I.R. work as a whole upon the various programmes of radio propagation work will therefore provide the real answers to Recommendation No. 14. The means by which the C.C.I.R. enables the various people in this field to work together is a valuable means of furthering and co-ordinating the work.

The C.C.I.R. Secretariat may be requested to distribute to Study Group chairmen contributions which, in the view of an Administration, may be of interest to other Administrations on the subject of radio propagation and which may be sent to the C.C.I.R. Secretariat for that purpose.

The choice of new Questions and other acts of future Plenary Assemblies will in fact be the " regular recommendations " envisaged in Section B 7 of Recommendation No. 1 adopted by the International Radio Conference, Atlantic City, 1947.

REPORT No. 4 *

METHODS OF MEASURING FIELD STRENGTH

(Question No. 8)
(Study Group No. V)

In the following considerations of Question No. 8 of the C.C.I.R., particular attention is given to the ultimate purpose for which radio field strength measurements are made. Usually they are to serve one of two purposes, as follows :

1. To provide an index of the serviceability of the radio signal for a given service.
2. To provide an index of its interference-producing capabilities.

To provide a serviceable signal at a given point, a radio station must produce a radio field at that point such that the ratio of the radio field strength to the interference field strength is sufficiently large for a given percentage of time. Under such conditions the signal-to-interference ratio at the receiver output will exceed a given minimum value during the specified percentage of time. Specification of this minimum signal-to-interference ratio will determine the grade of service obtained. The minimum ratio will, in general, vary with the type of service.

To determine the transmitter power output needed to maintain the prescribed signal-to-interference ratio at the receiving point will require taking account of both the radio noise field strength measurements and wave propagation data. The determination is complicated by the fact that there is a variation with time of the intensity of the signal field as well as of the interference field.

In some cases, a much more direct approach to the problem may be made which does not require separate measurements of the field intensity of either the desired station or of the interference, nor interpretation of wave propagation phenomena. In this approach, only signal-to-interference ratio measurements are made at the output of the receiver, with constant transmitter power. With this method, the power required for various grades of service may be directly determined.

Field strength measurements have not only the fundamental use indicated in the foregoing, but also the following uses : study of radio wave propagation ; study of the efficiency, radiation patterns, and other characteristics of radio antennas ; study of tropospheric and ionospheric phenomena ; and measurements of the electrical properties of the ground.

The following three paragraphs taken from the 1948 Report of the U.R.S.I. Commission on Standards and Measurements, summarize current thought with regard to field strength measurements :

" In recent years little improvement in field strength measurements up to 30 Mc/s has taken place. Accuracies of $\pm 20\%$ are achieved. Considerable advances have taken place in the higher frequency range up to 10,000 Mc/s. Between 30 Mc/s and 600 Mc/s the equipment is usually calibrated by establishing a known radiation field from a local source ; while above 600 Mc/s a comparison is made between the power radiated and the power received at a fixed distance. Identical antenna systems of the waveguide horn type are used at both stations. Such field strength measurements depend upon reference standards of current, voltage or power and the resulting precision is based upon these standards.

* This Report was adopted unanimously.

Facilities for radio field strength measurements are needed for many operations. Atmospheric and radio noise studies are becoming more important. This requirement, together with the need for field strength measurements from radar signals and unwanted electrical system interference, has been met in the U.K. by developments suitable for pulse modulated fields between 20 Mc/s and 650 Mc/s for a wide range of pulse widths and recurrence frequencies.

Many of the foregoing problems are of an international character and an exchange of knowledge of progress is desirable. There should also be an arrangement for the inter-comparison of methods used by different countries. A method for the exchange of reference apparatus would be valuable and would result in an improvement of the international consistency of standards. "

Response to most of the points of Question 8 are given in separate Recommendations and Reports of the VIth Plenary Assembly of the C.C.I.R.

REPORT No. 5 *

MEASUREMENT OF FIELD STRENGTH

(Respective Merits of the two Main Types of Equipment Now in Use)

(Question No. 8, Paragraph A.6)
(Study Group No. V)

The two main types given in Question No 8 of the C.C.I.R. are :

(a) that in which the locally generated signal is injected directly into the receiving circuit ;

(b) that in which a locally generated field is applied to the wave collector of the measuring equipment.

It is believed that the same degree of accuracy of field strength measurements may be obtained by either method, provided that equipment of suitable design is used and that careful installation and operating procedures are employed.

The current state of measurement technique generally dictates the particular arrangement and type of measuring equipment employed in a particular frequency range. Methods employing direct injection of a locally generated signal into the receiver or the receiver-antenna circuit are most applicable for mobile measurements. Methods employing either a locally generated field or direct injection of a locally-generated signal into the antenna are most applicable for primary calibration purposes.

The locally-generated field may be produced by the use of a loop antenna or dipole, the measurements being made close enough to the antenna so that the induction field constitutes an appreciable or a predominant portion of the total field. Alternatively, the use of a standard field produced by a transmitting antenna at distances sufficiently large so that the field is primarily a radiation field is generally preferred for calibration of a receiving equipment by the substitution method. In this method the use of horizontal polarization, rather than vertical polarization, is to be preferred where feasible. The method can, however, be more subject to site irregularities, and thereby give erroneous indications on waves arriving from a distance.

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* This Report was adopted unanimously.

Equipment also exists in which the reference voltage is introduced into the antenna, even when this antenna is distant from the rest of the equipment. This method eliminates errors due to mismatching and possible attenuation in the transmission line between the antenna and the receiver. It also avoids possible errors due to site irregularities.

Finally, it is noted that it is often necessary to take into consideration, in choosing a method, the convenience and availability of equipment.

It is believed that the methods now in use may be better described as follows :

(a) those in which the locally-generated signal is applied directly to the receiver ;

(b) those in which the locally-generated signal is applied to the antenna of the receiver ;

(c) those in which use is made of a locally-generated standard radiation field.

REPORT No. 6 *

MEASUREMENT OF FIELD STRENGTH

(Merits of a Standard Noise Generator as the Source of the Locally-Generated Signal)

(Question No. 8, Paragraph A.7)
(Study Group No. V)

The major advantage of a standard noise generator as a calibrator for a field strength meter is its simplicity of operation. No tuning is necessary. Therefore, there are no tracking problems. Minor advantages are its inherent stability and the ease of maintaining a known output.

The response of a receiver to a noise signal is a function of the receiver bandwidth as well as of the gain of the receiver. Care must therefore be exercised in using a standard noise generator as a field strength meter calibrator. If the bandwidth is governed by the intermediate frequency amplifier over the entire frequency range of the receiver, the ratio of the response of the receiver to a sine wave to its response to a noise signal may be established for a single frequency, and the standard noise generator may be used to standardize the gain at all other frequencies.

If for some reason the bandwidth of the receiver is not likely to remain constant over the entire frequency range, the use of a standard noise generator as a calibrator is not recommended for field strength meters.

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* This Report was adopted unanimously.

REPORT No. 7 *

LONG DISTANCE PROPAGATION OF WAVES OF 30 TO 300 Mc/s BY WAY OF IONIZATION IN THE E AND F REGIONS OF THE IONOSPHERE

(Question No. 7, Section 3)
(Study Group No. VI)

I. *Introduction.*

As formulated at Stockholm, Question No. 7 asked that a study be made, for the frequency band indicated above :

1. for ground-wave transmission,
2. for transmission through the troposphere, and
3. for transmission to long distances by way of ionozation in the E and F regions of the ionosphere.

This study has now been made, in so far as section 3 is concerned, and this Report, together with Doc. No. 124 of Washington and Doc. No. 72 of Geneva, form an answer to this part of the Question.

This Report summarizes the information, contained in Doc. No. 124 of Washington and in Doc. No. 72 of Geneva, as to long-distance propagation of waves of 30 to 300 Mc/s, and as to their interfering potentialities at considerable distances. These two documents contain the detailed information obtained from studies made in the United States of America and in the United Kingdom respectively. This Report also embodies information from Doc. No. 136 of Geneva, compiled by the U.R.S.I., and may therefore be regarded as a summary of the information contained in all three of the above documents.

II. *Survey of Problems*

A survey of the problems presented is given in Section II of Doc. No. 124 of Washington and they are also generally surveyed in pages 2 to 12 of Doc. No. 72 of Geneva. They fall under six headings :

1. Transmission by way of Regular E-layer ionization
2. ,, ,, ,, ,, Regular F1-layer ionization
3. ,, ,, ,, ,, Regular F2-layer ionization
4. ,, ,, ,, ,, Sporadic E ionization
5. ,, ,, ,, ,, Meteoric ionization
6. ,, ,, ,, ,, Anomalous and irregular ionization of other kinds.

It is not intended in the present Report to go into the details of the nature of the problems presented, but rather to summarize the results obtained. For detailed information as to the nature of the problems, reference should be made to those sections of the documents already quoted. A summary of the results of the studies now follows, appropriate references to the documents being given.

* This Report was adopted unanimously.

III. *Summary of Results.*

1. *Transmission by way of Regular E-layer ionization.*

A study of regularly made vertical incidence measurements indicates that it is unlikely that transmission of waves of 30 to 300 Mc/s would ever occur by way of the regular E-layer.

2. *Transmission by way of Regular F1-layer ionization.*

A study of the vertical incidence measurements indicates that it is unlikely that transmission of waves of 30 to 300 Mc/s would ever occur by way of the regular F1-layer, except near noon at maximum solar activity in tropical regions only. Since the F2-layer MUF's would, under the same conditions, exceed those for the F1-layer, this fact is of little importance.

3. *Transmission by way of Regular F2-layer ionization.*

A study has been made of the vertical incidence measurements for a number of widely distributed ionospheric stations and, in addition, a considerable amount of observational evidence has been collected from actual transmissions, both in the United States and the United Kingdom. These data relate mainly to the years 1946-1948, when solar activity was high. They indicate that during certain seasons of the year long-distance transmission by way of the regular F2-layer ionization can occur in temperate latitudes on waves of up to about 50 Mc/s, although the percentage of the total time during which such transmission is possible is small, being, for example, of the order of 4.5% on 50 Mc/s over the London/New York circuit during the most favourable month of the year at sunspot maximum. In the tropics, however, such transmission can occur on waves of up to 60 Mc/s, with almost regular transmission on waves of 30 to 40 Mc/s. The field strengths observed on these waves are very variable, ranging from values exceeding the inverse-distance value to those near or below the receiver noise level, over very short periods of time. However, since the radio noise fields on these waves are also very low, reception is often continuous for long periods of time and serious interference may result to services which are designed to provide communication at relatively low field strengths.

It is clear that, for several years around the solar maximum, intolerable long-range interference may be expected on frequencies below about 50 Mc/s during daylight hours in the equinox and winter seasons. The lowest frequency at which such interference becomes so infrequent as to be inappreciable is about 50 Mc/s for stations in temperate latitudes, and about 60 Mc/s for stations in the tropics.

World-wide predictions of F2-layer MUF's are given in monthly charts published by the C.R.P.L. in the U.S.A., by the D.S.I.R. in the U.K. and by other authorities.

4. *Transmission by way of Sporadic E ionization.*

Because of the nature of sporadic E ionization, implicit in its name, transmission by way of it is ordinarily confined to a single hop and is thus limited to a maximum distance of about 2300 km. Since, in the most intense form of sporadic E ionization, the skip-distance is about 650 km., the transmission range is, in practice, restricted to distances between about 650 and 2300 km.

It exists in different forms in different latitudes, the most clearly distinguished types being the auroral-zone type and that occurring at temperate and low latitudes. The auroral-zone type occurs most frequently at night and the studies indicate that transmission by way of it may occur on frequencies up to about 90 Mc/s and, infrequently, even higher. The temperate and low latitude type can occur at any time of day, but has a broad peak around midday and a subsidiary peak around sunset. The studies indicate that transmission may occur by way of it on frequencies up to about 80 Mc/s and, infrequently, up to 100 Mc/s.

It is to be noted that this type of sporadic E exhibits a marked seasonal variation, which is especially prevalent during the months of May to September inclusive (in the Northern Hemisphere) and of relatively small importance during the remaining months. Doc. No. 124 of Washington contains some evidence that there is a variation in its occurrence over the sunspot cycle, suggesting that a maximum of sporadic E may occur at sunspot minimum, and vice-versa, but this evidence can hardly be regarded as conclusive.

During the months of May to September inclusive and during the hours of 0700-2000 L.T. (period during which temperate and low latitude sporadic E is most prevalent) the studies indicate that transmission at 2300 km may occur in accordance with the following frequency/time distribution :

Frequency	Percentage of Total Time
30 Mc/s	28.0 %
40 Mc/s	6.0 %
50 Mc/s	1.5 %
60-80 Mc/s	<1.0 %

This frequency/time distribution is given in the graph in Fig. 3 of Doc. No. 72 of Geneva.

Field strengths for transmission by way of sporadic E may be high, and Doc. No. 124 of Washington indicates that the peak fields would occur at distances between about 1600 and 1800 km.

The expected world distribution of sporadic E is indicated in world charts published monthly by the C.R.P.L., in the U.S.A. and by other authorities.

5. *Transmissions by way of Meteoric Ionization.*

A study has been made both in the United States and the United Kingdom of the reflections which occur from meteor trails. On 30 Mc/s such reflections have been found at times to occur as often as one per minute, and on 70 Mc/s at a rate of about two per hour. They were found to last from a fraction of a second to about 10 seconds. The field strength of the signals obtained from the meteoric ionization was found to be very low. Because of these facts these reflections are considered to be of negligible importance from the interference point of view, such interference being generally limited to scanty occasional bursts of signal from stations normally out of range.

6. *Transmission by way of anomalous and irregular ionization of other kinds.*

The studies indicate that there may at times occur bodies of ionization at virtual heights different from those of any of the recognized ionospheric layers. Such ionization patches may occasionally give rise to reflections of waves in the 30 to 300 Mc/s range, the principal case being that of reflection from the edges or sides of such patches which occur within or near the auroral zone. It is not considered, however, that such reflections would constitute a serious source of interference to stations working on waves of 30 to 300 Mc/s.

IV. *Summary.*

A tabular summary of the main causes of interference to stations working on waves 30 Mc/s to 300 Mc/s is given below.

Type of Interference	Zone	Period Maximum Effect	Highest Frequency with severe interference and range of distances affected	Lowest Frequency with slight interference
Regular F2 Layer Reflection	Temperate Latitude	Midday Period Equinox-Winter Solar Cycle Maximum	45-50 Mc/s 3200-4800 km E/W 3200-9600 km N/S	50 Mc/s
Regular F2 Layer Reflection	Tropics	Midday Period Equinox-Winter Solar Cycle Maximum	50-55 Mc/s 3200-4800 km E/W 3200-9600 km N/S	60 Mc/s
Sporadic E Auroral type	High Magnetic Latitude	Night (associated with local magnetic disturbances)	Night 80 Mc/s Day 45-50 Mc/s 650-2300 km	Night 90-100 Mc/s Day 50 Mc/s
Sporadic E Temperate type	Temperate Latitude	May-Sept. inclusive Day	55 Mc/s 650-2300 km	80-100 Mc/s
Meteoric Ionization		During meteoric showers	Seldom severe 650-2300 km	Varies with power used

V. *Bibliography.*

An extensive Bibliography concerning the matter is given at the ends of Doc. Nos. 124 of Washington and 72 of Geneva.

REPORT No. 8

ATMOSPHERIC NOISE DATA

(Question No. 10)
(Study Group No. VI)

1. Although Report No. 5 of the United States Army Signal Corps Radio Propagation Unit contains, as far as is known, the most complete information on atmospheric noise in all regions of the world, experimental verification is rather limited. There are other sources which contain more accurate information for specific locations and for specific frequency bands. For example, measurements of atmospheric noise made by the Federal Communications Commission in the standard broadcast band have been extended by means of thunderstorm data to show noise levels throughout the United States. This material is presented in the *Report and Recommendations of Committee No. 1 as to What Constitutes a Satisfactory Signal*, by Committee No. 1 of the Clear Channel Hearing, Docket 6741, January 14, 1946.

2. Other sources of pertinent information are :

   (a) L. ESPENSCHIED, C. N. ANDERSON and A. BAILEY, *Transatlantic Radio Telephone Transmission.* Proc. Inst. Radio Engineers, N.Y., 1926, **14**, pp. 7-57.

   (b) L. W. AUSTIN, a series of papers in *Proc. IRE* prior to 1933.

(c) Special Report No. 15, *Survey of Existing Information and Data on Atmospheric Noise Level Over the Frequency Range 1-30 Mc*, Great Britain Radio Research Board, 1947. (H.M. Stationery Office, London).

(d) *Hydrometeorological Report No. 5*, U.S. Weather Bureau, 1947.

(e) *Low Frequency Noise and Propagation Studies*, Progress Reports, Electrical Engineering Section, University of Florida, Gainseville, Florida. (Obtainable from Office of Technical Services, Department of Commerce, Washington U.S.A.)

(f) H. V. Cottony, *Memorandum Report on Observation of Atmospheric Radio Noise in Arctic Regions*, Memorandum Report of C.R.P.L., January 15, 1948.

(g) H. A. Thomas, *A Subjective Method of Measuring Radio Noise* and *Some Measurements of Atmospheric Noise at High Frequencies*. (Proc. Inst. of Electrical Engineers). **97**, Pt 3, 1950, pp. 329-343.

3. Studies of required field intensity data obtained both by the Thomas equipment and by field intensity recorders suggest modifications of the predictions in Report No. 5 *, as indicated by the following comparisons :

(a) All data available from the north temperate zone (23° to 52° N) when compared with predictions show the observed midnight values about 6 db lower at 2 to 2.5 Mc/s, coincident at 5 Mc/s and 7 db lower at 7 Mc/s.

(b) The same data show that the seasonal variations of the observed values are greater than indicated by the curves of Report No. 5 *.

(c) The seasonal variations follow a sine curve which has an amplitude at midnight of about ±6 db at frequencies between 2 and 6 Mc/s while the curves of Report No. 5 * show about ±3.5 db.

(d) At Tatsfield, England, the only station for which supposedly valid noon values have been obtained, the predicted midday values are about 10 db below those observed at 2.5 Mc/s, 5 db below at 5 Mc/s and coincide at 7 Mc/s.

(e) Sunspot cycle effects should also be taken into account in applying the predictions ; the original curves, drawn for 1945 levels, were in very good agreement for that period near sunspot minimum.

(f) In tropical zones the worst local storm conditions may give rise to values 20 db above those predicted for frequencies 2 to 5 Mc/s for summer late afternoon and evening. On the other hand, the minimum values in the daytime may be 12 db below those predicted for all frequencies in the high frequency band.

4. The atmospheric noise data curves of Report No. 5 * have been replotted in another form and appear in the NBS Circular 462, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D.C.

* Report No. 5 of the U.S. Army Signal Corps Radio Propagation Unit.

REPORT No. 9

INTERFERENCE TO RADIO RECEPTION AT SEA DUE TO ATMOSPHERIC CAUSES

(Question No. 36)
(Study Group No. VI)

The question of interference to radio reception at sea due to atmospheric causes has been studied. Although only a limited amount of basic information is available on the subject, the following reference material will be useful in estimating the radio noise levels to be expected at sea :

1. Statements of K. A. NORTON, R. BATEMAN and C. A. ELLERT before the Federal Communications Commission at the Ship Power Hearing, November 14, 1938.

2. H. V. COTTONY, *Memorandum Report on Observations of Atmospheric Radio Noise in Arctic Regions*, National Bureau of Standards, Central Radio Propagation Laboratory, January 15, 1948.

3. *Minimum Required Field Intensities for Intelligible Reception of Radiotelephony in presence of Atmospherics or Receiving Set Noise.* Report No. 5, Radio Propagation Unit, Baltimore Signal Depot, October 1949.

4. BUREAU and BARRÉ, *Variations à grande échelle de l'activité des atmosphériques au cours de la croisère antarctique du Commandant Charcot*, Comptes-rendus, Académie des Sciences, Paris **229**, p. 626, 26 September 1949.

Reference 1 contains measurements of atmospheric noise on 250 and 540 kc/s made on shipboard during several ocean voyages in the summer of 1938. In this report the noise levels are presented both diurnally and in cumulative time distributions. Table VI on page 43 of the Statements shows the distribution of noise with latitude. This table can be used in estimating world-wide noise levels since they appear to be substantially independent of longitude.

Reference 2 contains atmospheric noise measurements over a wide range of frequencies made on shipboard during the summer of 1947. These measurements were made primarily at Arctic latitudes ; however, some of the measurements extend to latitudes as low as 22° North.

Reference 3 gives predictions of world-wide noise levels to be expected for various frequencies, seasons and times of day. Although it is subject to some error (see C.C.I.R. Report No. 8), it is considered to be the most complete overall treatment of noise levels.

In making estimates of noise levels over ocean areas, Reference 1 is provisionally recommended where applicable, i.e., as to frequency and season. In view of the fact that in the 2000 kc/s range, noise levels are lower than in the 500 kc/s range, it may be desirable to use higher frequencies than those dealt with in Reference 1. References 2 and 3 will then be useful in estimating noise levels on these higher frequencies.

REPORT No. 10 *

RAPID EXCHANGE OF INFORMATION ON PROPAGATION

(Recommendation No. 11, § 1)
(Study Group No. VI)

The following have been designated by their respective countries as the official agencies for the reception, co-ordination, liaison and exchange of information relating to radio propagation.

Germany (Allied High Commission)

Fernmeldetechnisches Zentralamt
(Arbeitsgemeinschaft Ionosphäre)
Darmstadt (Allemagne)
Rheinstrasse 110

Telegraphic address :
Ionosphäre Darmstadt

Australia

Officer in charge
International Section
P.M.G. Dept.
Treasury Gardens
Melbourne C2

Telegraphic address :
Gentel Melbourne

Belgium

Chef du Service du Rayonnement
Institut Royal Météorologique
3, Avenue Circulaire
Uccle — Bruxelles

Spain

Departemento de Servicios Técnicos de Telecomunicación
Dirección General de Correos y Telecomunicación
Madrid
Espagne

United States of America

Central Radio Propagation Laboratory
National Bureau of Standards
Washington 25, D.C.
U.S.A.

France

Bureau Ionosphérique Français
196 rue de Paris
Bagneux (Seine)
France

Telegraphic address :
Gentelabo Paris

Italy

Istituto Nazionale di Geofisica
Cittá Universitaria
Rome

Telegraphic address :
Geofisica — Rome.

Note : All messages should begin with the word " Ionosphere ".

Japan

Central Radio Wave Observatory
Radio Regulatory Commission
4-chome, Aoyama-Kitamachi
Minatoku, Tokyo
Japan

New Zealand

The Secretary
Department of Scientific and Industrial Research
P.O. Box 18
Government Buildings
Wellington
New Zealand

Netherlands

Radio Receiving Station PTT
Nederhorst den Berg
Netherlands

* This Report was adopted unanimously.

Great Britain

Director
Directorate of Radio Research
Radio Research Station
Slough, Bucks
England

Switzerland

Laboratoire de Recherches et d'Essais
de la Direction Générale des PTT
Speichergasse 6
Bern
Switzerland

Union of South Africa

Telecommunications Research Laboratory
C.S.I.R.
Department of Electrical Engineering
University of the Witwatersrand
Johannesburg
Union of South Africa

REPORT No. 11

STANDARDISATION OF RADIOPHOTO AND TELEPHOTO EQUIPMENT

(Recommendation No. 25) *
(Study Group No. IX)

The study has not, up to the present, disclosed the possibility of making any recommendations of a purely radio character since Recommendation No. 25 of the C.C.I.R. was made.

Before further progress can be made in the study of this problem, it is essential to convene the mixed commission referred to in § 4 of Recommendation No. 25.

It is suggested, therefore, that the Director of the C.C.I.R. should initiate the convening of the mixed commission, and that the relevant documents submitted to the VIth Plenary Assembly of the C.C.I.R. should be considered by that commission.

REPORT No. 12 **

SINGLE SIDEBAND SOUND BROADCASTING

(Question No. 24)
(Study Group No. X)

After considering the various documents supplied by administrations on this question ***, the VIth Plenary Assembly of the C.C.I.R. finds that, generally speaking, the studies already made are not nearly advanced enough for a precise answer to be given. As the problem is important, the C.C.I.R. has decided to continue the study and to set a new question on the subject.

* This Recommendation has become Question No. 58.

** This Report was adopted unanimously.

*** Cf. Docs. of Geneva, Nos. 17 (U.S.), 25 (C.C.I.R. Secretariat), 26, 54 (France), 160 (Chairman of C.C.I.R. Study Group No. X), and No. 234 (U.K.), and Doc. No. 84 of Washington.

The discussions that have taken place during the VIth Plenary Assembly have nevertheless given a clearer idea of the opinions of the various Administrations on the different points of Question No. 24 in the present state of sound broadcasting technique.

These opinions are summarized below * :

A. Receivers

1. For practical and commercial reasons, it is felt that the broadcast receivers in current public use cannot be altered to receive SSB emissions of the type specified in § 1*(a)*, 1*(b)* and 1*(c)*.

   Experience over a number of years in various fields shows that the public is definitely opposed to buying devices for adapting existing receivers to new transmission systems. Hence the use of adapters (which is still to be examined from a technical and commercial point of view) would seem to be out of the question.

2. It appears that existing receivers cannot be used satisfactorily for the transmission systems specified in § 2*(a)* and 2*(b)*, i.e. with single sideband and full carrier, whatever the AF passband and the spacing between carriers. This conclusion is obvious as regards transmission on medium and low frequencies in the ground-wave region, and it is probably valid for sky wave transmissions.

   However, in the case of transmissions with full carrier and with one of the two sidebands partially suppressed, it is possible that, in reception of the sky wave, the loss of quality due to detector distortion will be offset by the improvement in quality due to the decrease of selective fading effects.

   Continued experiments in this direction seem indispensable, since such a system would make better use of the radio spectrum. Tests carried out in the United Kingdom have given encouraging results although no final conclusion can be drawn from them so far.

3. If the answer to 1 is accepted, this point is no longer of interest. If not, it is difficult to find an answer, which will naturally depend on the kind of alteration that has been made to the receiver. It seems probable, however, that this answer will, on the whole, be affirmative.

4. At present there are no grounds for giving an affirmative reply to this question. Results obtained in other branches of the art show that there is no advantage in trying to design a receiver for transmissions with completely suppressed carrier, as in § 4*(a)*.

   A new type receiver for one of the types of transmission mentioned in 4*(b)*, 4*(c)* or 4*(d)* will have to include the following among its specifications :

   — it must be easy for the listener to tune. In particular, it must have a special device for accurate tuning to the desired frequency ;
   — its cost should be fairly low.

   Special attention must also be paid to the problems involved in the transition from the existing transmission system to a new one. An abrupt transition is impossible on account of the number of old type receivers now in use. Some delegates, however, feel that, after suitable study, a gradual transition staggered over several years would be feasible.

   Of the various types of detection proposed for the new-type receivers, those using carrier amplification and those using synchronous detection may be mentioned.

5. The answer is affirmative in principle. However, some distortion is to be expected depending on the type of the new receiver and its passband (harmonic distortion due to out of phase sidebands before detection and over-emphasis of the lower frequencies in the detector stage). Accurate tuning will also be extremely difficult, unless there is some special device for that purpose.

* Refer to corresponding paragraph of Question No. 24.

On the other hand, the new-type receiver will be far less influenced by selective fading on sky-wave listening.

6. It is difficult to give a firm answer to this question, as the new devices are not yet known. However, any special oscillator that may be required will, in all likelihood, be placed in the I.F. part of the receiver, i.e. fairly far from the antenna, where there should be little difficulty in preventing radiation.

7. It is too early to give any answers to *(a)*, *(b)* and *(c)*. However :

   (a) Concerning cost of receivers, transmission with normal carrier and asymmetrical sidebands will probably be more economical at the present stage of receiver manufacturing technique ;

   (b) Concerning the fidelity obtained, the degree of quality obtainable with the various detector systems is still an unknown factor ; SSB systems are certainly preferable as regards distortion due to selective fading ;

   (c) Concerning the improvement in signal-to-interference ratio, with noise spread over a wide band (rather than interference from other emissions), a better signal/noise ratio is obtainable with a system using as narrow a passband as possible ;

   (d) Concerning saving in spectrum space, there will be a maximum saving with systems using a minimum bandwidth (i.e. SSB) and as weak a carrier as possible, though the possible saving with different systems cannot be assessed for the moment.

B. Transmitters :

1. There are at present no technical reasons for choosing which sideband is to be transmitted. However, a choice may be imposed by the state of congestion of the spectrum.

2. Reply premature.

3. Reply premature.

4. The adoption of one of the proposed systems would have no influence on the audio band to be transmitted.

5. This question raises the whole problem of spectrum economy, for a reduced carrier transmission system makes it possible either to reduce carrier spacing or to reduce the geographical distance between stations operating on adjacent channels.

   There is another possibility *, involving the use of an SSB system, or one in which one sideband is partially suppressed. It consists in using the upper sideband for a transmitter F1 and the lower sideband for the next transmitter F2, with normal spacing between F1 and F2. The next transmitter, F3 would use the upper sideband and could thus be much closer to F2 than with the present spacing ; hence there would be considerable saving of spectrum space *.

   Moreover, especially on medium waves, the use of a system whereby one programme was transmitted on the upper sideband and another on the lower would make it possible to double the number of programmes transmitted on the same number of available frequencies.

6. Reply premature.

   In conclusion, the VIth Plenary Assembly of the C.C.I.R. considers that the following problem should first be studied :

   Can a transmission system with full carrier and asymmetrical sidebands be used, without modifying existing receivers, with a view to making worthwhile economies of spectrum space,

* See Doc. No. 26 of Geneva.

or possibly to improving the quality by reducing the effects of selective fading ? This problem mainly concerns emissions on decametric waves.

If there is no solution to the above problem, it must be ascertained what system will provide the maximum economy of spectrum space, bearing in mind that receivers of a new type will have to be used. In this case it would be essential to decide whether a progressive changeover from the present to the new system would be possible in practice.

REPORT No. 13

THE MINIMUM NUMBER OF FREQUENCIES NECESSARY FOR THE TRANSMISSION OF A HIGH FREQUENCY BROADCASTING PROGRAMME

(Question No. 37)
(Study Group No. X)

The C.C.I.R. has studied the technical data contained in Doc. No. 635 of Mexico, and agrees that it is essential to secure the greatest possible economy in the use of radio frequencies and that to this end, as a general rule, only one frequency should be used for the transmission of one programme to one reception area. It is, however, of the opinion that technical conditions do exist which would justify the use of more than one transmission frequency to assure the continuous reception of one programme in one reception area (i.e. the area to which the programme is directed) at certain times and over certain paths.

Wave propagation conditions over certain paths may be difficult to forecast (e.g. very long paths or paths passing through the auroral zones) or the rate of change of F.O.T. may be high (e.g. at sunrise or sunset). Listeners to broadcasting cannot advise the transmitter of an unexpected deterioration in reception conditions as may be the case in radio services other than broadcasting.

The existence of these conditions could justify the simultaneous use of more than one frequency, each in a different band, to cover such periods and paths. In addition there may be cases where the depth of the area extending outward from the transmitter is too great to be served by a single frequency and more than one frequency may be needed.

The use of directional antennas is essential in most cases to ensure a satisfactory signal-to-noise ratio, as recommended by the Mexico City High Frequency Broadcasting Conference, and this limits the geographical area covered by each transmitter and its associated antenna to an extent differing with each particular case. Because of this, it may be necessary to use more than one transmitter and associated antenna to cover a given reception area. By synchronising transmitters, the number of frequencies in the same band may be reduced to not more than two. At the present time there is insufficient evidence to determine whether one frequency only would give satisfactory reception. Further study should be carried out.

The angle subtended by the reception area at the transmitter, its mean distance from the transmitter and its depth, may differ greatly from one case to another. This limits the value of adopting defined geometric reception areas as it would give rise to insufficient coverage in some cases and a wasteful use of frequencies in others.

Thus it would seem that defining the above factors could not produce a useful criterion for the justification on technical grounds of the use of more than one frequency for transmitting one programme to a reception area, but that each case must be considered on its merits taking these factors into account.

REPORT No. 14 *

HIGH FREQUENCY BROADCASTING RECEPTION

(Question No. 39)
(Study Group No. X)

This report has been prepared utilizing the available results of past research regarding the short and long term variability of high frequency broadcasting signals, atmospheric noise and industrial noise intensities, together with the results of subjective tests of the acceptable ratios of steady desired to undesired signals and of steady signal to atmospheric and industrial noises.

Although it is believed that further theoretical and empirical work should be carried out in this field, it is felt that available material makes it possible to supplement provisionally the existing information and to estimate allowances which should be made to take into account the short and long term variability of signal and atmospheric noise intensities in order to provide acceptable service for any specified percentage of the time. Table I sets forth, for purposes of information, the fading safety factors which are necessary to assure a specified signal-to-interference ratio for particular percentages of the time **.

Consideration has not been given to the allowances to be made when there is more than one interfering signal or a combination of interfering signals and noise. This is known to be an exceedingly complex problem, and, although some theoretical investigations have been performed, there is no available information on the subjective aspect involved.

Table I

	1	2	3	4
Desired Signal to Undesired Signal	10 db	13 db	23 db	16 db
Desired Signal to Atmospheric Noise	6 db	16 db	22 db	17 db
Desired Signal to Industrial Noise	6 db	10 db	16 db	12 db

* This Report was adopted unanimously.
** Refer to Doc. Nos. 43 and 66 of Washington, and Doc. Nos. 160, 178 and 215 of Geneva.

Column 1 This is the short-term fading allowance which must be made to ensure that the steady state ratio is achieved for 90% of any given hour.

Column 2 This is the long-term fading allowance which must be made to ensure that the steady state ratio is achieved for 90% of the hours in any one month at a particular time of day in 90% of the cases.

Column 3 By adding the values in Columns 1 and 2, this is the overall variability allowance which must be made to ensure that the steady state ratio is achieved for 90% of any hour in 90% of the hours in any month at a particular time of day and in 90% of the cases. This represents an assured steady state ratio for 96% of the overall time.

Column 4 By taking the square root of the sum of the squares of the values in Columns 1 and 2, this is the overall variability allowance which must be made to ensure that the steady state ratio is achieved for 90% of the overall time.

The figures in Table I relating to the time availability of service were selected on a theoretical basis and on experience derived principally from medium wave broadcasting. Some doubt exists as to the practicability of achieving these percentages, since recent calculations of the transmitter power required, in order to provide this time availability at presently accepted steady state conditions, have produced quite unrealistic results.

The C.C.I.R. is of the opinion that Question No. 39 should remain on the agenda, and that further theoretical and empirical work should be carried out on this question. These studies should include the gathering of data on the time availability versus signal-to-interference ratio for services which are regarded as being normally acceptable under actual operating conditions.

REPORT No. 15 *

TELEVISION SYSTEMS

(Recommendation No. 29) **
(Study Group No. XI)

It has not been possible to arrive at unanimous agreement on certain television standards. An extensive study has been made of four systems of black and white television, identified by the number of lines per picture as the 405-line system, the 525-line system, the 625-line system, and the 819-line system.

As a result of this study, the attached table has been prepared for the information of those Administrations which may wish to establish one of these systems.

The possibility has been discussed of achieving unification of the television systems by the adoption of a channel width of 8.4 Mc/s. No specific proposals for the number of lines, and other transmission standards, have been discussed in connection with this bandwidth.

* This Report was adopted unanimously.

** This Recommendation has become Question No. 64.

ANNEX

Details of four Television Systems

Item	Description of Item	Systems			
		405	525	625	819
1	Number of lines per picture . .	405	525	625	819
2	Video bandwidth . . . . Mc/s	3	4	5	10.4
3	Channel width . . . . . Mc/s	5	6	7	14
4	Sound carrier relative to vision carrier . . . . Mc/s	—3.5	+4.5	+5.5	—11.15 [2]
5	Sound carrier relative to edge of channel . . . . Mc/s	+0.25	—0.25	—0.25	+0.10 [2]
6	Ideal vision transmitter characteristic	(See Fig. 1)	(See Fig. 4)	(See Fig. 7)	(See Fig. 10)
7	Interlace [1]	2/1	2/1	2/1	2/1
8	System capable of operating independently of power supply frequency [1]	Yes	Yes	Yes	Yes
9	Line frequency . . . . . . c/s	10,125	15,750	15,625+0.1 %	20,475
10	Field frequency . . . . . . c/s	50	60	50	50
11	Picture frequency . . . . . c/s	25	30	25	25
12	Aspect ratio [1]	4/3	4/3	4/3	4/3
13	Scanning during active periods [1]	L. to R. & Top to B.	L. to R. & Top to B.	L. to R. & Top to B.	L. to R. & Top to B.
14	Type of vision modulation [1] . .	Amplitude	Amplitude	Amplitude	Amplitude
15	Vision emission characteristics [1]	Asymmetric	Asymmetric	Asymmetric	Asymmetric
16	Sense of vision modulation . . .	Positive	Negative	Negative	Positive
17	Black level independent of picture content [1]	Yes	Yes	Yes	Yes
18	Level of black as % of peak carrier	30	75	75	25
19	Minimum level of carrier as % of peak carrier	0	$\leqslant$ 15 [3]	10	$\leqslant$ 3
20	Synchronizing waveform	(See Figs. 2 & 3)	(See Figs. 5 & 6)	(See Figs. 8 & 9)	(See Figs. 11 & 12)
21	Sound modulation	A3	F3 ±25 kc/s 75 micro-seconds pre-emphasis	F3 ±50 kc/s 50 micro-seconds pre-emphasis	A3

[1] Items 7, 8, 12, 13, 14, 15 and 17 are in accordance with Recommendation No. 82.

[2] The Administrations which desire to adopt this system should conform to the provisions of Recommendation No. 82.

[3] At maximum luminance.

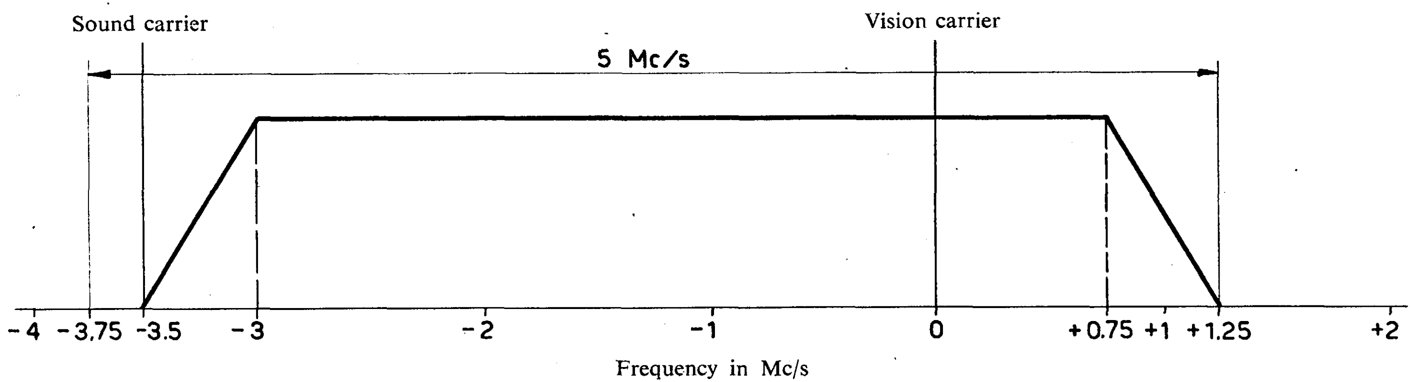


FIGURE 1

Ideal vision transmitter characteristic, 405-line system

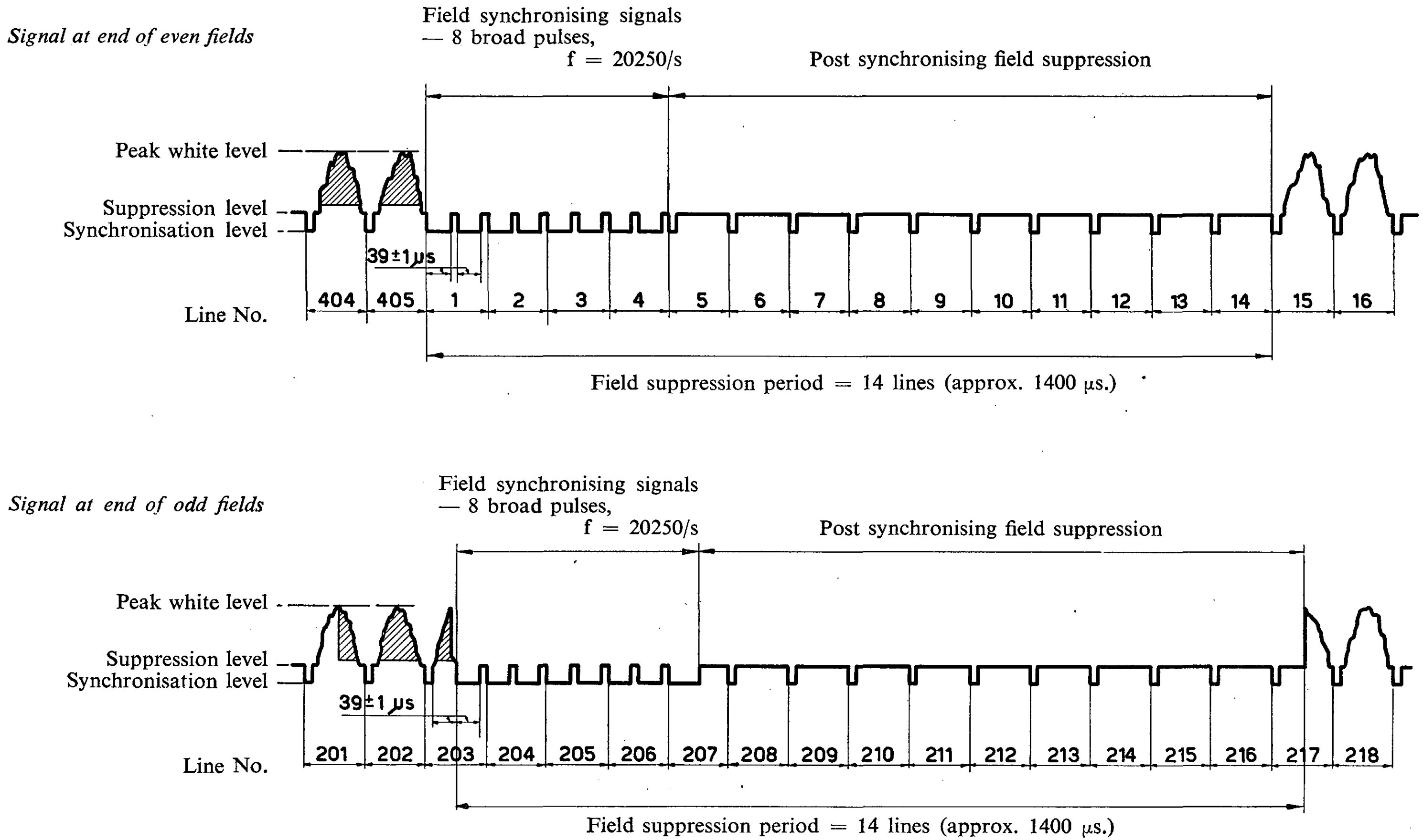


FIGURE 2

Synchronising waveform, 405-line system

The hatched part of the signal shown can either be occupied by a suppression pulse up to 2 lines in length or by picture signal as shown.
A small pre-synchronising suppression pulse is shown at the opening of the frame suppression. This may be between 0 and 10 μs in length.

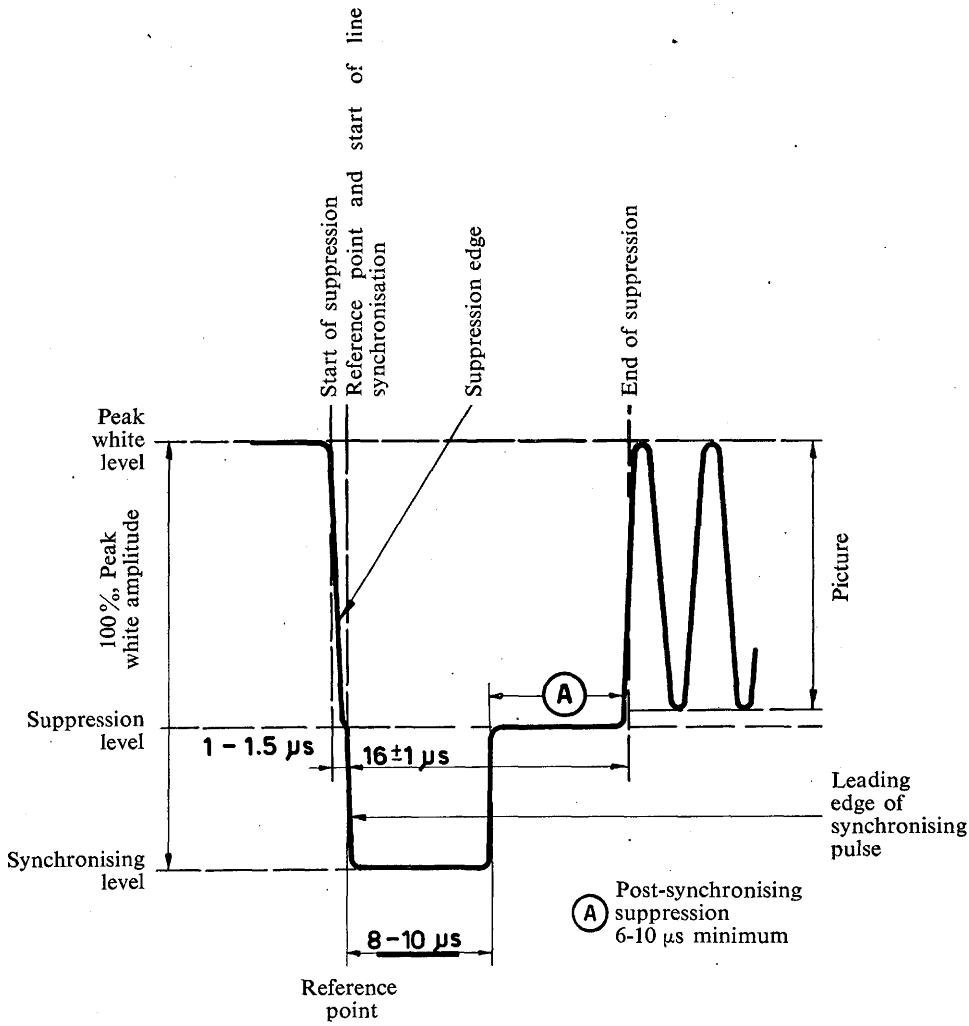


FIGURE 3

Details of synchronising signal, 405-line system

The signal is shown in its video form, but synchronising level corresponds to 0-3%.
Suppression level 30% ± 3%, and peak white 100% of carrier amplitude.
Time of rise of synchronising pulse (10% to 90%) 0.25 μs.
Time of rise of suppression edge (10% to 90%) should not exceed 7 μs.
Minimum post-synchronising suppression period 7 μs.
Field suppression period 14 lines and variation must be such as not to cause visible jitter on picture.
Field frequency is tied to frequency of mains.

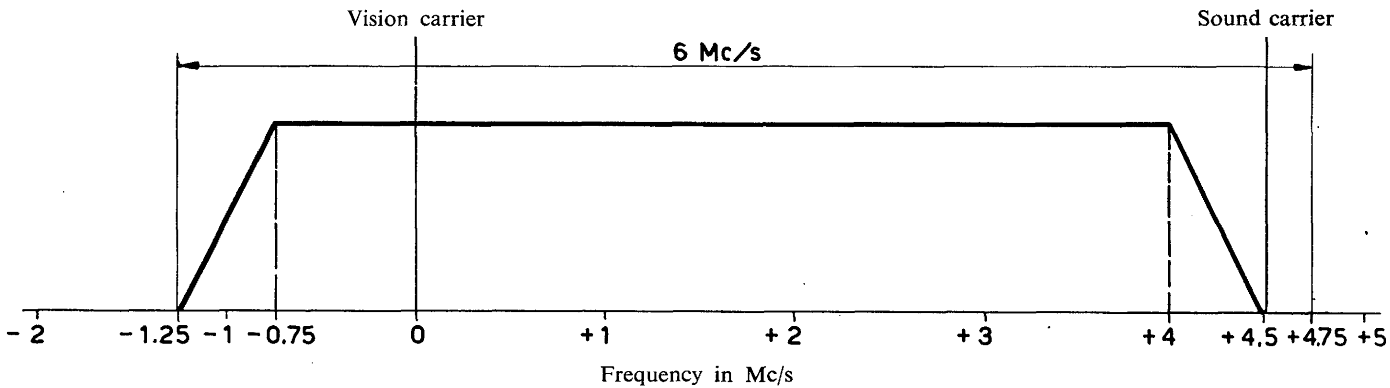
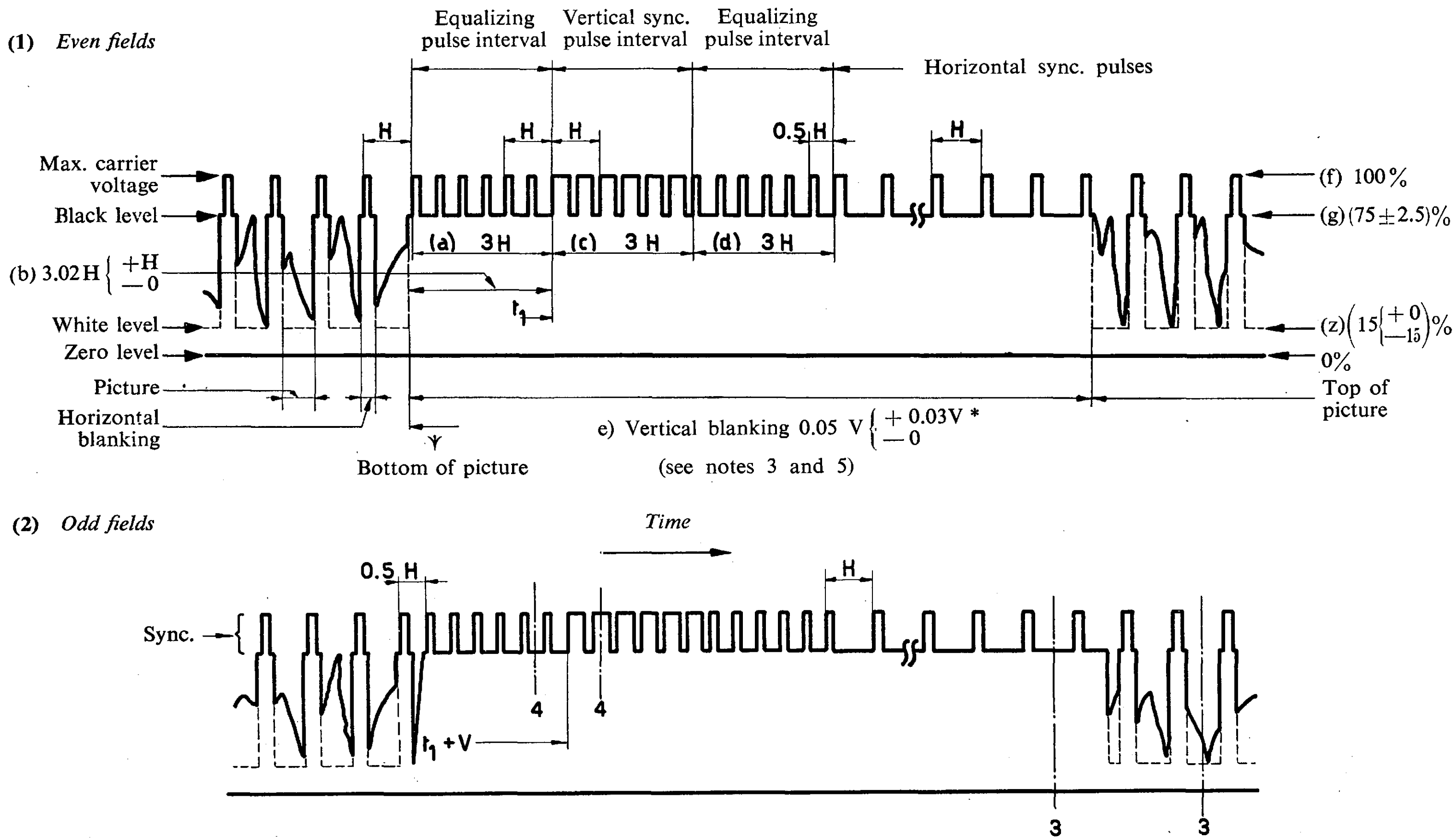


FIGURE 4

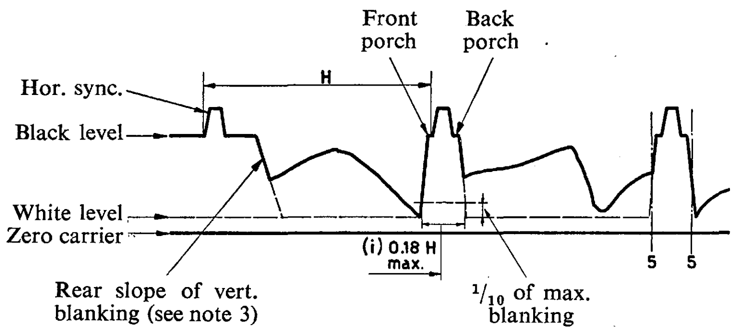
Ideal vision transmitter characteristics, 525-line system



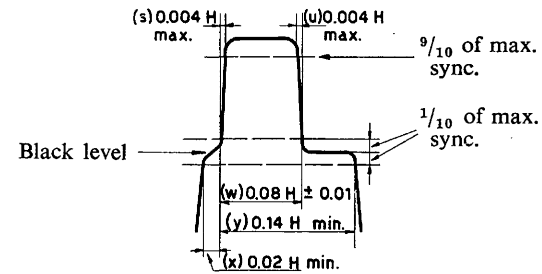
Horizontal dimensions not to scale

FIGURE 5

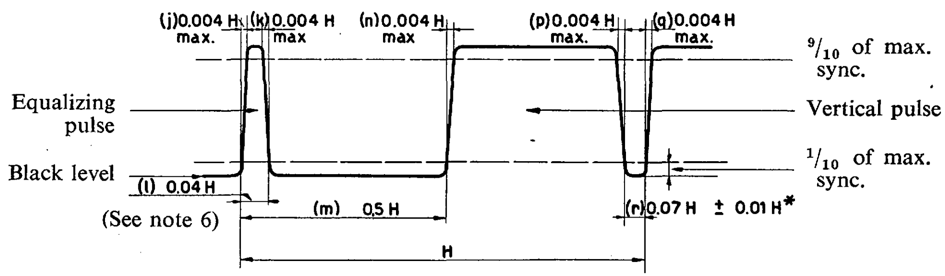
Synchronising waveform, 525-line system



(3) Details between 3-3 in **(2)** of fig. 5.



(5) Details between 5-5 in **(3)**.



(4) Details between 4-4 of fig. 5

Horizontal dimensions not to scale

FIGURE 6

Details of synchronising waveform, 525-line system

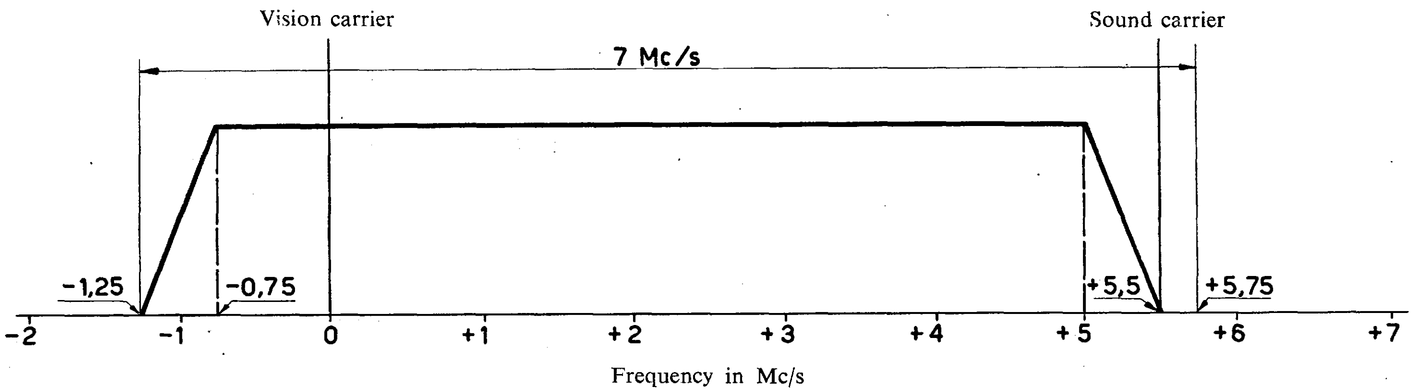
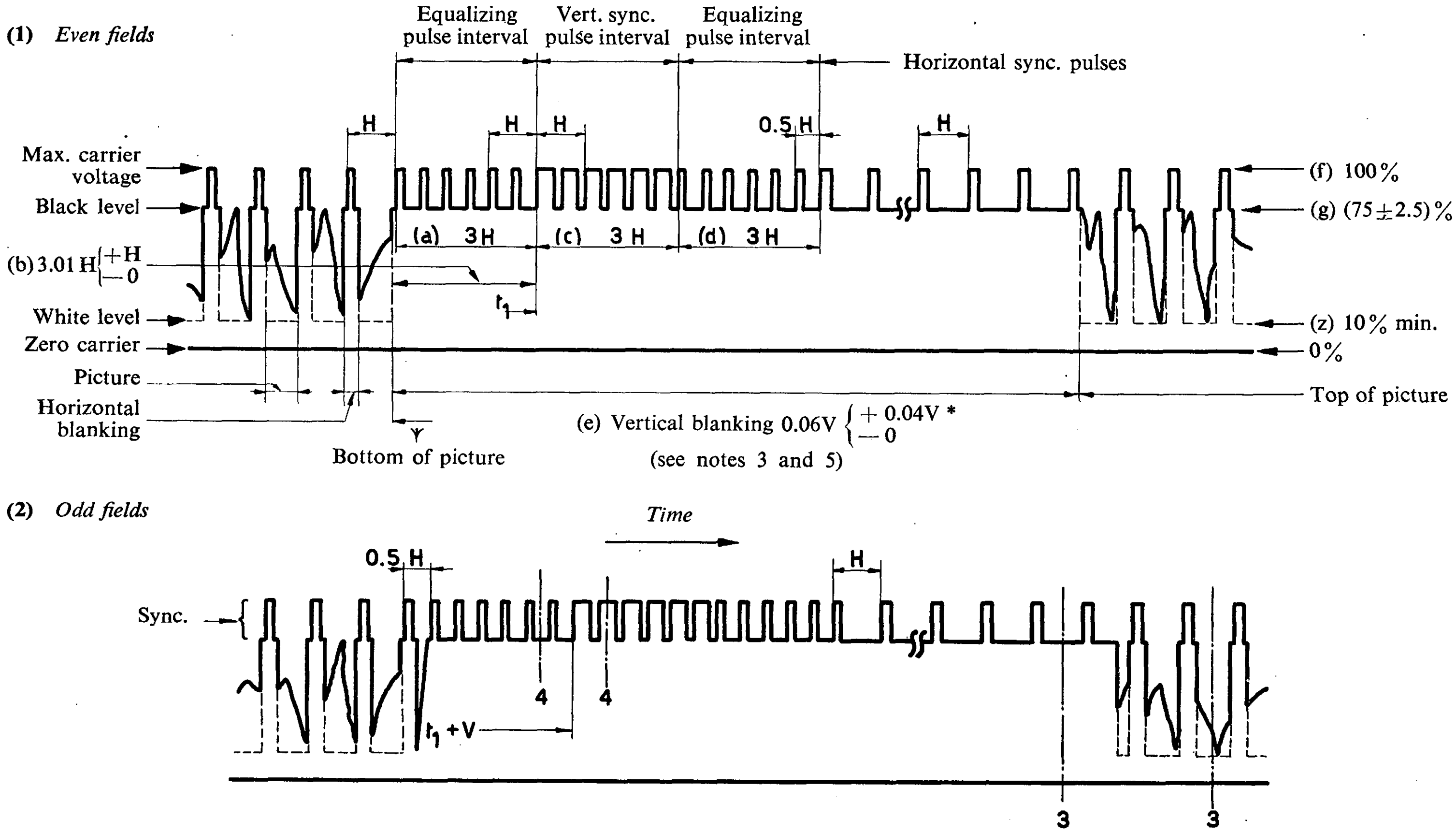


FIGURE 7

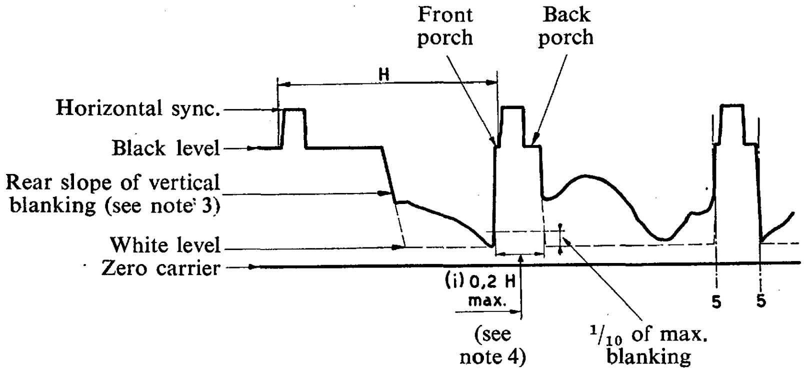
Ideal vision transmitter characteristic, 625-line system



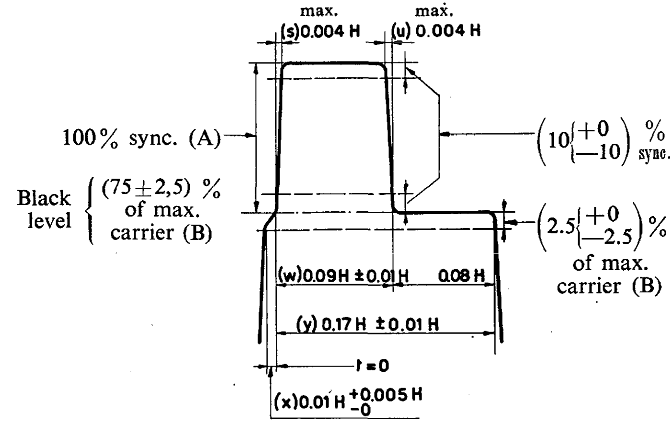
Horizontal dimensions not to scale

FIGURE 8

Synchronising waveform, 625-line system



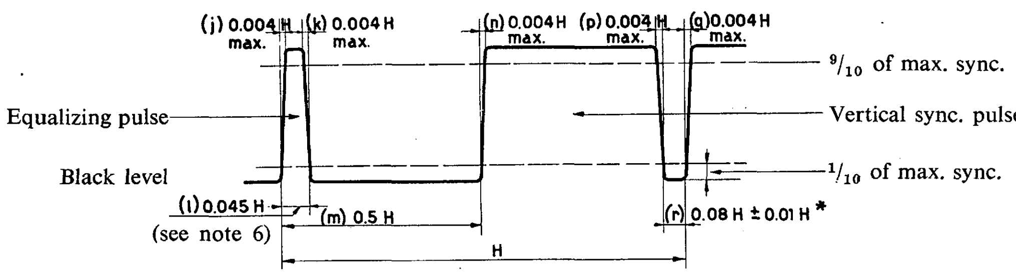
(3) Details of 3-3 in (2) of fig. 8.



(A) Measured before modulation.

(B) Measured after ideal detection.

(5) Details between 5-5 of (3).



(4) Details of 4-4 in (2) of fig. 8.

Horizontal dimensions not to scale

FIGURE 9

Details of synchronising waveform, 625-line system

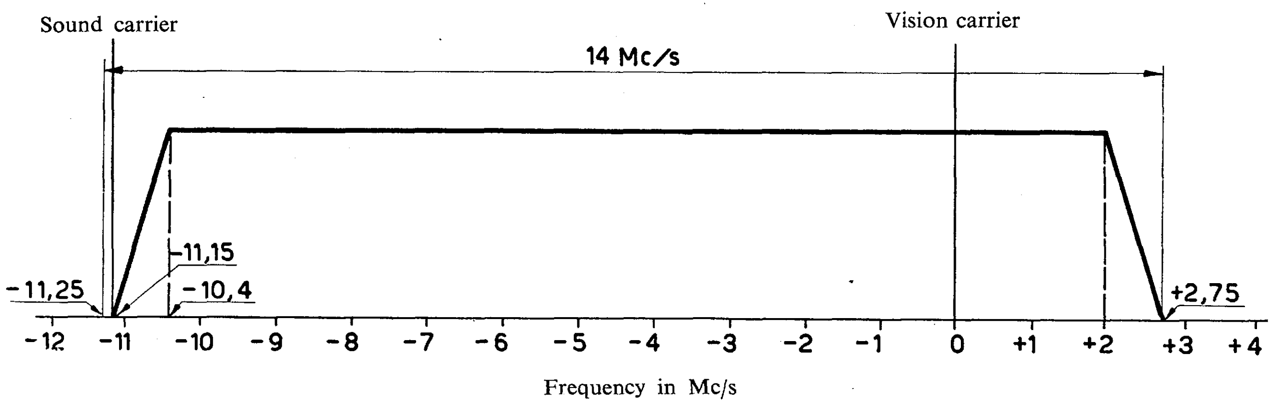


FIGURE 10

Ideal vision transmitter characteristic, 819-line system

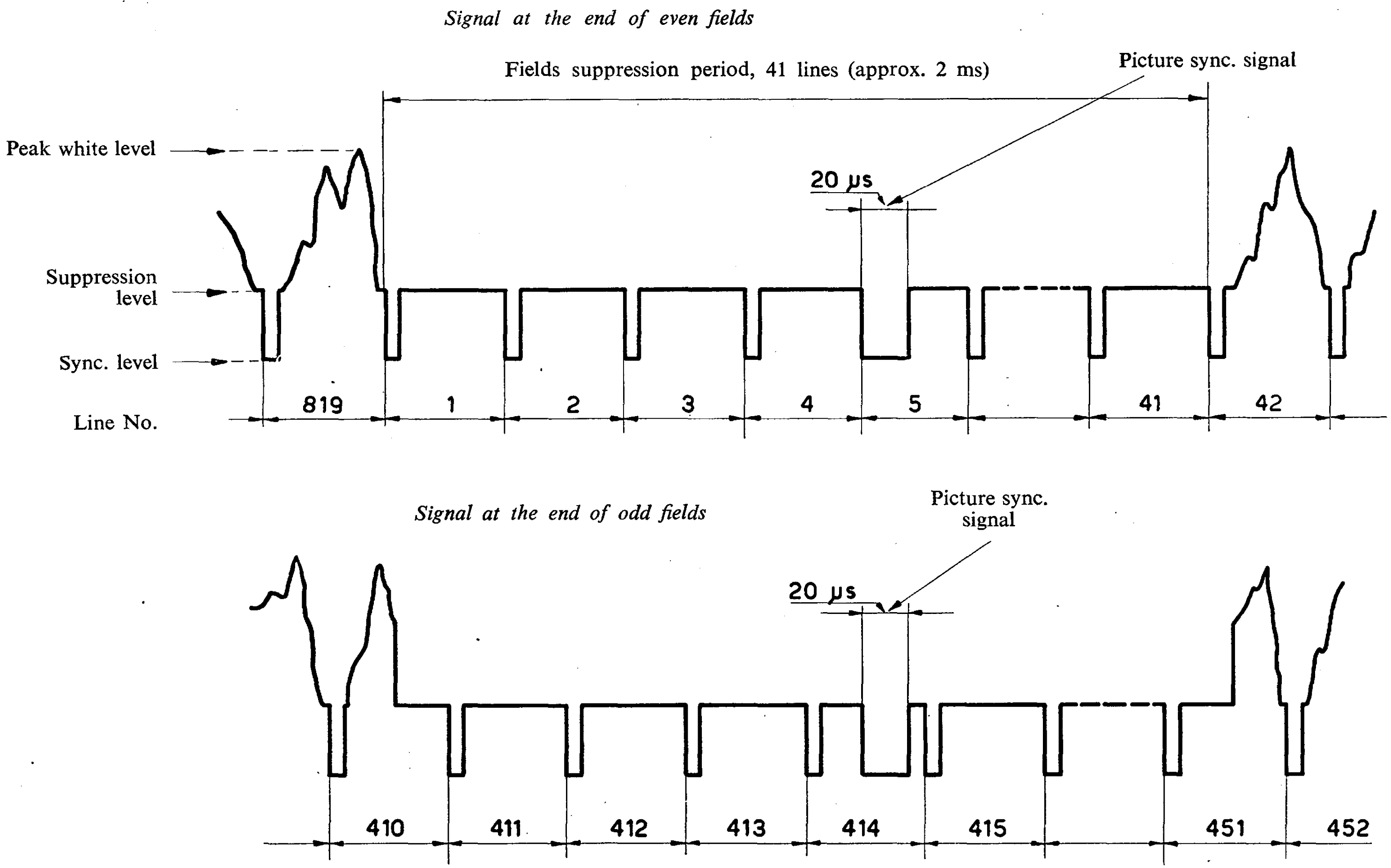


FIGURE 11

Synchronising waveform, 819-line system

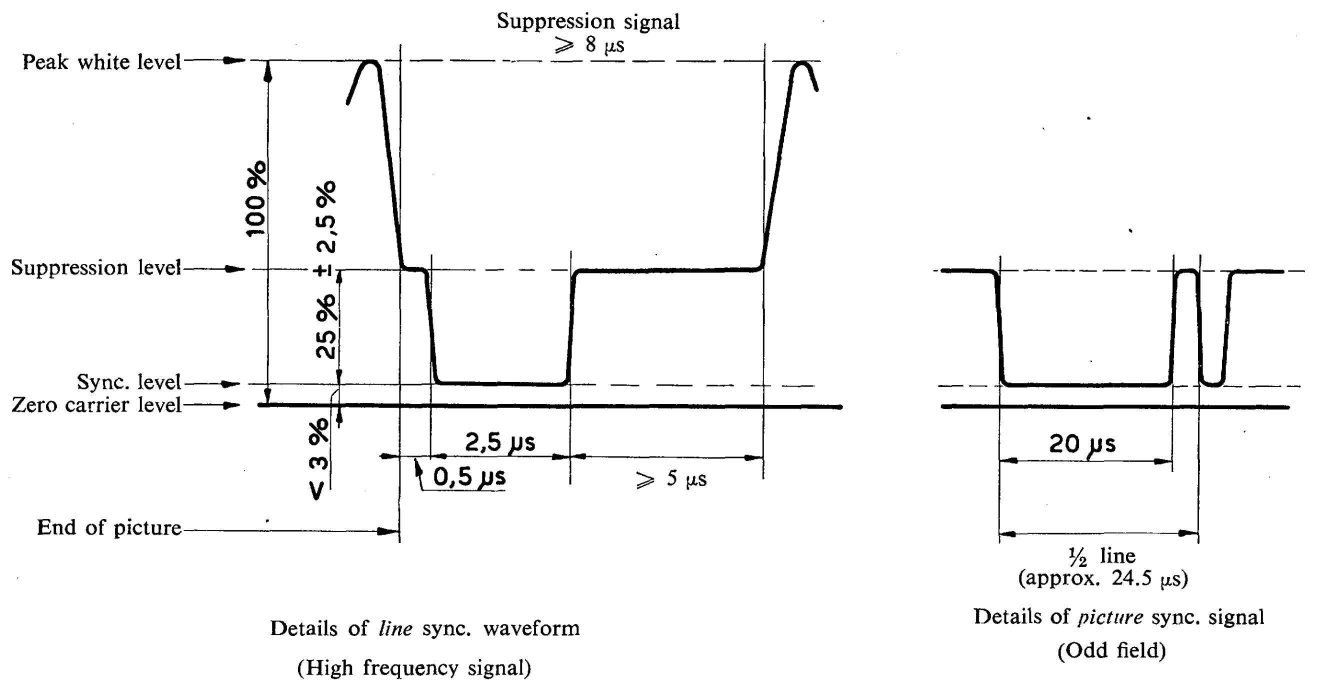


FIGURE 12

Details and duration of synchronising waveform, 819-line system

NOTES

Concerning Figures 5, 6, 8 and 9

1. H = Time from start of one line to start of next line.
2. V = Time from start of one field to start of next field.
3. Leading and trailing edges of vertical blanking should be complete in less than 0.1 H.
4. Leading and trailing slopes of horizontal blanking must be steep enough to preserve min. and max. values of (x + y) and (i) under all conditions of picture content.
5. Dimensions marked with an asterisk indicate that tolerances given are permitted only for long time variations, and not for successive cycles.
6. Equalizing pulse area shall be between 0.45 and 0.5 of the area of a horizontal sync. pulse.

NOTE BY DIRECTOR C.C.I.R.

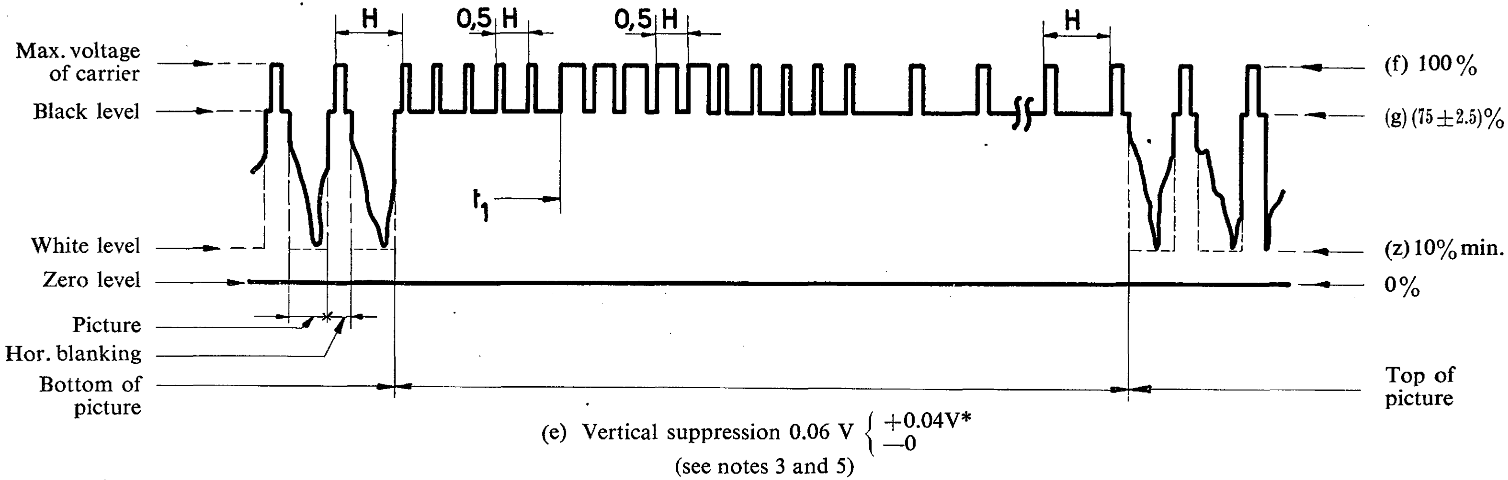
Variation to Figure 8 of Report No. 15

At the 6th meeting of Study Group No. XI during the VIth Plenary Assembly it was agreed (See Doc. No. 490 of Geneva) that the Swiss delegate should initiate a discussion by correspondence amongst those concerned, on a modification of the vertical synchronisation signal to be used with the 625-line system. Doc. No. 360 of Geneva gives details and the new form proposed is reproduced in Fig. 8*bis*.

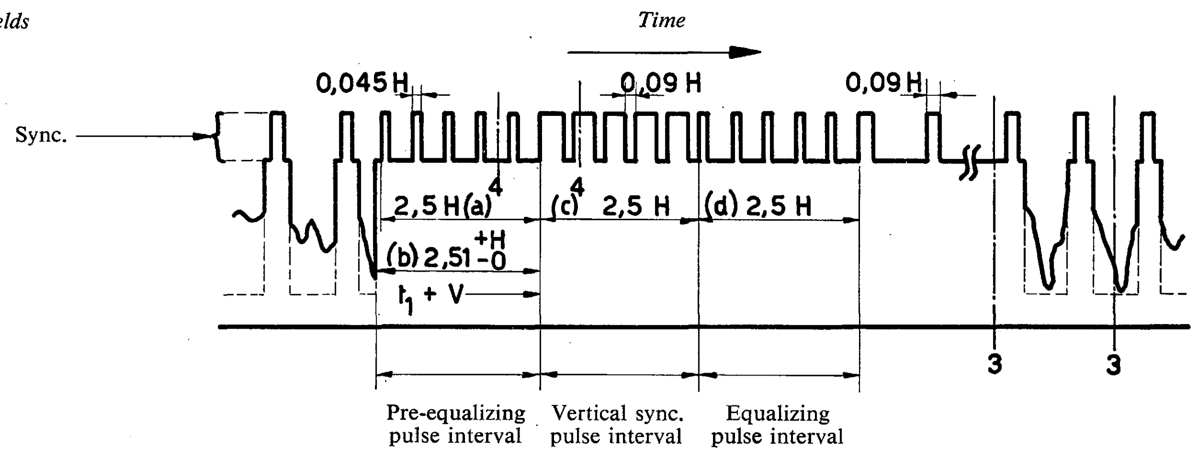
The Swiss Administration now informs us (Oct. 17th 1951) that following upon this consultation by correspondence no objection has been received to the adoption of this modified form.

---

(1) *Even fields*



(2) *Odd fields*



Horizontal dimensions not to scale

FIGURE 8 *bis*

Synchronising waveform, 625-line system

(Variation of fig. 8)

RESOLUTIONS

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RESOLUTION No. 3

PUBLICATION OF ANTENNA CHARTS

(Question No. 23)
(Study Group No. X)

The C.C.I.R.,

CONSIDERING :

(a) Question No. 23 ;

(b) That it is deemed desirable for the C.C.I.R. to publish certain antenna charts (spatial power distribution diagrams) as presented in the appendices to the statement of the Specialised Secretariat of the C.C.I.R. on the subject : " The Gain, Directivity and Protection Ratio of a directional antenna or antenna array " ; *

UNANIMOUSLY RESOLVES :

That the specialized Secretariat of the C.C.I.R. shall take whatever steps are necessary to :

— obtain as complete information as possible for inclusion in such charts ;
— arrange to have these charts published at as early a date as possible ;
— complement this documentation whenever necessary.

RESOLUTION No. 4

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMS

(Question No. 42)

The C.C.I.R.,

CONSIDERING :

(a) Question No. 42 ;

(b) Recommendation No. 81 (particularly section 4) ;

(c) Question No. 63 ;

(d) That owing to insufficient data, it has not been possible, during the VIth Plenary Assembly of the C.C.I.R. Geneva, 1951, to standardize certain technical characteristics which are of particular importance in the international exchange of recorded programmes ;

* Doc. No. 24 of Washington.

(e) That the importance of some of these standards makes it imperative not to wait for the next Plenary Assembly of the C.C.I.R. ;

RESOLVES :

1. That members should aim, before the end of 1951, to reach agreement on certain standards, in particular on recording characteristics as stated in the attached Annex. (These refer equally to disks and magnetic tape) ;

2. That the Chairman of the Study Group dealing with Broadcasting, after obtaining the agreement of the members of the Group, should submit a draft recommendation to the Director of the C.C.I.R., who will submit it in writing to members for their approval.

ANNEX

1. *Frequency characteristics of disc recordings* (lateral cut).

After examining the various proposals submitted, as well as a number of characteristics actually in use, the C.C.I.R. defined an average characteristic which may be represented approximately by a curve of recorded velocity/frequency described as follows :

(a) Frequencies below 1000 cycles : rising in conformity with the admittance of a series combination of a capacitance and a resistance with a time constant of 450 microseconds.

(b) Frequencies above 1000 cycles : rising in conformity with the admittance of a parallel combination of a capacitance and a resistance with a time constant of 50 microseconds.

The C.C.I.R. proposes that consideration be given to the adoption of a characteristic consisting of a combination of the above described curves with a tolerance of plus or minus 100 microseconds for the frequencies below 1000 cycles and plus or minus 10 microseconds for the frequencies above 1000 cycles.

The combined curve and tolerances are shown in the attached figure 1.

2. *Frequency characteristics of magnetic tape recordings.*

After examining the various proposals submitted as well as the difficulties encountered in the exchange of programmes on the various types of magnetic tape, the VIth Plenary Assembly of the C.C.I.R. proposes that consideration should be given to the adoption of the procedure of recording on magnetic tape so that the frequency response obtained when the tape is reproduced on a reproducing equipment defined below always falls within the limits indicated in the attached figure 2.

The proposed reproducing equipment shall be equivalent to an ideal reproducing head, the E.M.F. of which is amplified in an amplifier with a response curve that results from the superposition of a curve that falls with increase of frequency at the rate of 6 decibels per octave and a curve that rises with increase of frequency in conformity with the admittance of a parallel combination of a capacitance and a resistance with a time constant of 50 microseconds (Fig. 3).

In this connection an ideal reproducing head is defined as one in which all corrections such as those for gap width, reluctance effects and losses are negligible.

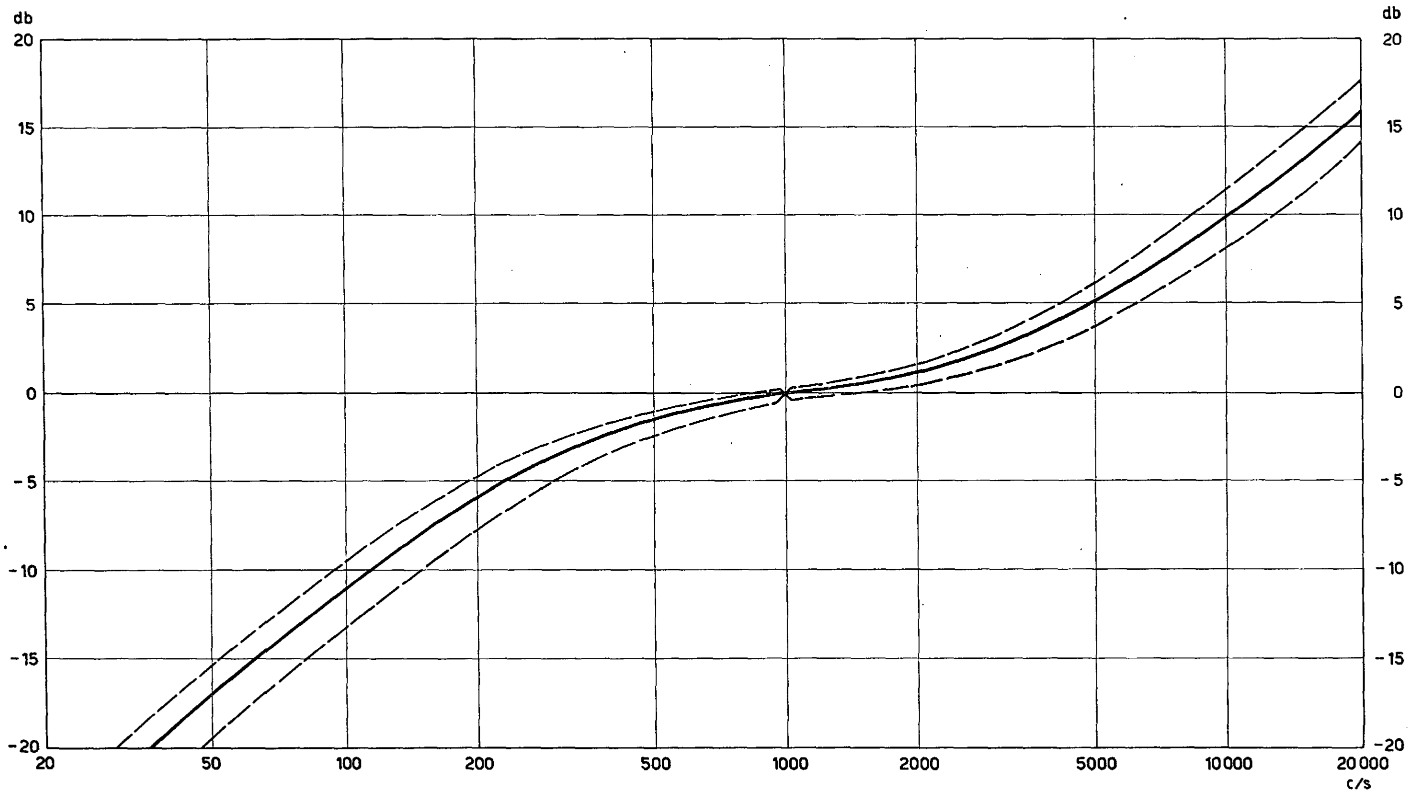
db
20
15
10
5
0
-5
-10
-15
-20
20
50
100
200
500
1000
2000
5000
10000
20000
c/s

FIGURE 1

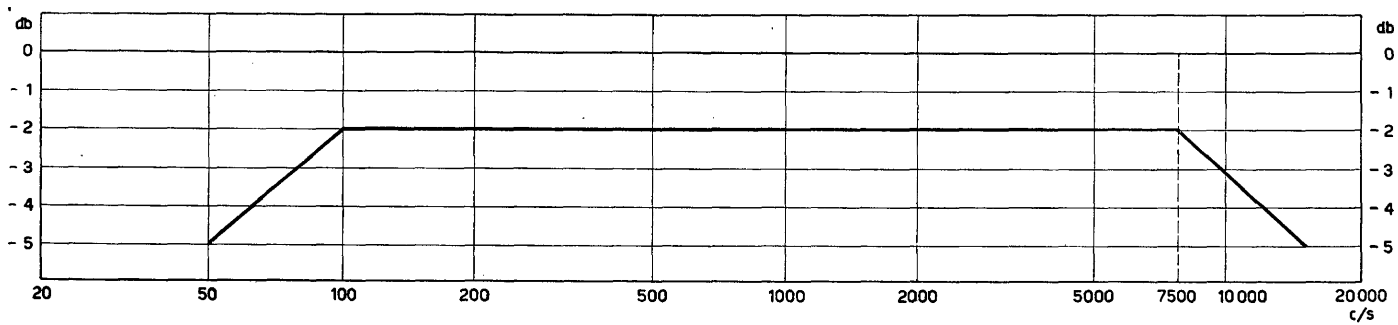
db
0
- 1
- 2
- 3
- 4
- 5
db
0
- 1
- 2
- 3
- 4
- 5
20
50
100
200
500
1000
2000
5000
7500
10 000
20 000
c/s

FIGURE 2

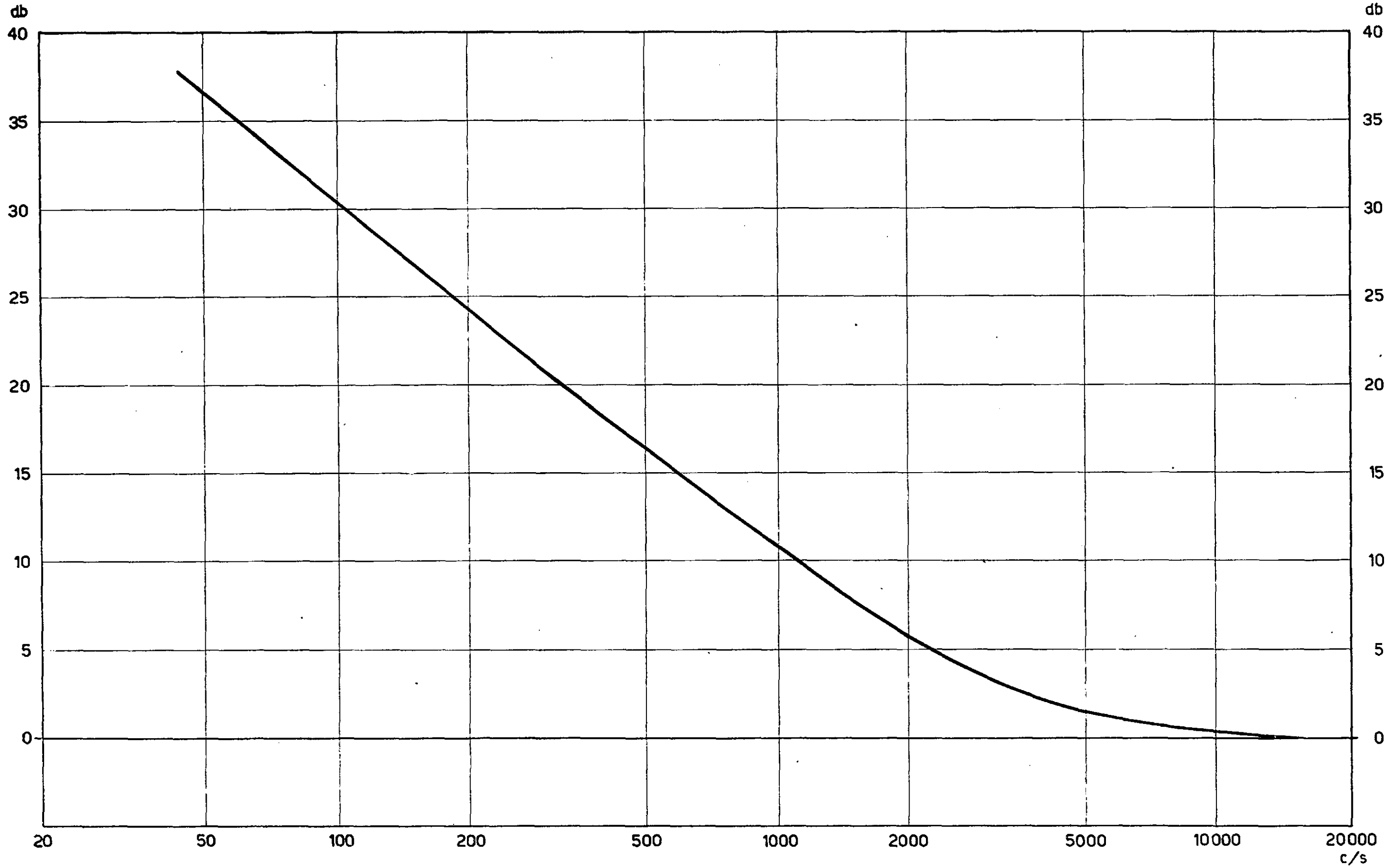
db
40
35
30
25
20
15
10
5
0
db
40
35
30
25
20
15
10
5
0
20
50
100
200
500
1000
2000
5000
10000
20000
c/s

FIGURE 3

RESOLUTION No. 5

MEANS OF EXPRESSION
(Definitions, Vocabulary, Graphical and Letter Symbols)

(Recommendations Nos. 26 and 34 of the C.C.I.R. and Resolutions Nos. 66, 67 and 175 of the Administrative Council of the I.T.U.)
(Study Group No. XIV)

The C.C.I.R.,

CONSIDERING :

(a) That it is of the first importance to standardize the means of expression (terms, symbols, measurement units) with a view to better and more rapid understanding among the participants in the work of the C.C.I.'s ;

(b) That such standardization is far from being accomplished ;

UNANIMOUSLY RESOLVES :

1. That each study group of the C.C.I.R. should establish a list of definitions of the principal terms and symbols used in the branch of radiocommunications with which it is concerned ;

2. That the Director of the C.C.I.R., as his other duties permit, shall collect available information concerning the standardization of means of expression, (terms with their definitions, graphical and letter symbols) ;

3. That Administrations should collaborate to their utmost in the preparation of a list of radio communication terms, by forwarding to the Director of the C.C.I.R. the glossary of technical terms and documents of national standards, if any, together with any other documents that may be of value in compiling a first draft list of terms and symbols, with a view to examination by the VIIth Plenary Assembly of the C.C.I.R. ;

4. That the Director of the C.C.I.R. should examine all the documentation he is thus able to collect and reach agreement with the chairman of the Study Group on Vocabulary as to subsequent work ;

5. That care should be taken not to duplicate work already carried out by national or other international organizations.

RESOLUTION No. 6

UNIT SYSTEMS

(Study Group No. XIV)

The C.C.I.R.,

CONSIDERING :

(a) That the International Electrotechnical Committee, meeting at Torquay in 1938, resolved to adopt the Giorgi M.K.S. system of measurement units ;

(b) That the International Union of Pure and Applied Physics, meeting at Amsterdam in 1948, requested the International Committee on Weights and Measures to adopt the same universal practical system of units for international relations ;

(c) That the Bureau National Scientifique et Permanent Français des Poids et Mesures has prepared a draft legislative text and draft regulations as a basis for the establishment of complete regulations covering units of measurement ;

(d) That the International Committee on Weights and Measures decided, in Resolution 6 adopted by the IXth General Conference on Weights and Measures at its meeting on 21st October 1948, to open an official enquiry into the opinions of scientific, technical and educational circles in all countries (on the basis of the French documents) and to pursue it actively with a view to centralising replies and issuing recommendations regarding the establishment of a standard practical system of measurement units which might be adopted by all countries signatory to the Metric Convention ;

(e) That the B.N.F.P.M. draft does not solve the problem of standardization as regards " rationalization " ;

(f) That it would be of every advantage for technicians to adopt a system standardized in every detail so that formulae may be numerically applied without ambiguity and conversions may once and for all be eliminated ;

(g) That, of the two systems—rationalized and non-rationalized—the first has certain advantages of simplification and clearly shows the duality of electrical and magnetic phenomena by bringing the corresponding formulae into line ;

RESOLVES :

That Administrations and recognized private operating agencies should consider the advisability of adopting the rationalized MKS Giorgi system in their relations with the I.T.U. and its permanent organs.

RESOLUTION No. 7

C.C.I.R. BUDGETS 1951, 1952 AND 1953

The C.C.I.R.,

CONSIDERING :

(a) That the Administrative Council has already approved the ordinary budgets of the C.C.I.R. for the years 1951 and 1952, due to the fact that they held their Sixth Session just before the VIth Plenary Assembly of the C.C.I.R. started ;

(b) That according to Chapter 14, § A 6 of the General Regulations, the Plenary Assembly of a C.C.I. has to approve the estimate of expenditure for the following two years ;

(c) That the budget for 1953 has not yet been considered by the Administrative Council ;

UNANIMOUSLY APPROVES :

1. The budgets for 1951 and 1952 as shown in the annex which have already been approved by the Administrative Council ;

2. That the estimated expenditure for 1953, as shown in the same annex, should be submitted to the Secretary General for incorporation in the annual estimates of the Union.

ANNEX

Ordinary Budgets C.C.I.R. for 1951-1953

Item	1951		1952		1953	
	Swiss Francs		Swiss Francs		Swiss Francs	
1. Personnel						
10 Salaries	265 000		292 300		309 000	
11 Superannuation and benevolent Funds	42 825		48 070		50 000	
12 Expatriation allowances	17 300		14 100		14 800	
13 Family allowances	4 800		5 600		6 400	
14 Removal expenses	3 000		5 000		—	
15 Overtime	500		500		500	
16 Gratuities for long service	—		—		—	
17 Home loave	24 500		1 500		25 000	
18 Temporary staff (incl. insurance)	5 325		5 950		5 325	
19 Other staff expenses	—		—		—	
191 Other contributions by the Union to the Pension Fund	39 800	403 050	43 00	377 320	22 000	433 025
2. Travel and Entertainment Expenses						
20 Travel expenses in Switzerland	500		500		500	
21 Travel expenses for exterior assignments	20 000		14 000		20 000	
22 Expenses for representation at meetings of other organizations	—	20 500	—	14 500	—	20 500
3. Offices						
30 *Rent*						
301 Rent of Palais Wilson						
302 Rent of Maison des Congrès						
303 Rent of Villa Bartholoni	15 000	15 000	18 000	18 000	18 000	18 000
31 *Office Equipment*						
310 Books, maps, papers	5 000		5 000		5 000	
311 Furniture and machines	2 000	7 000	2 000	7 000	2 000	7 000
32 *Office Overheads*						
320 Office supplies	5 000		5 000		5 000	
321 Lighting, Heating	2 500		3 500		3 500	
322 Postage, Telephone charges and subscriptions	6 000		6 000		6 000	
323 Service (cleaning, upkeep, concierge)	300	13 800	500	15 000	500	15 000
33 *Installation, Transfer and Repairs*						
331 Installation of the Office and repairs to premises	—		—		—	
332 Technical apparatus	20 000		10 000		10 000	
34 *Central Library* (Participation)	3 000		3 000		3 000	
35 *Photographic Laboratory* (Participation)	500	23 500	500	13 500	500	13 500
5. Miscellaneous and Unforeseen						
51 Miscellaneous	3 000		3 000		3 000	
52 Unforeseen	2 650	5 650	2 650	5 650	2 930	5 930
		488 500		450 970		512 955
Reduction on 1951 budget (as a whole)		16 000				
		472 500				

RESOLUTION No. 8

CHARGING OF EXPENSES OF C.C.I.R. STUDY GROUPS

(Recommendation No. 35 and Resolution No. 171 of the Administrative Council of the I.T.U.)

The C.C.I.R.,

CONSIDERING :

(a) That the Vth Plenary Assembly of the C.C.I.R. adopted Recommendation No. 35 relating to the charging of expenses of Study Groups of the C.C.I.R. ;

(b) That the Administrative Council has again studied this matter, and, in Resolution No. 171, has invited the C.C.I.R. to adopt the same rule as the C.C.I.F. and the C.C.I.T whereby the expenses of Study Groups are charged to the expenses of the subsequent Plenary Assembly of the C.C.I.'s. ;

(c) That a uniform handling of this matter by the C.C.I.'s is desirable ;

(d) That the method of charging expenses of Study Groups as laid down in Administrative Council Resolution No. 171 provides a more equitable basis for the allocation of Study Group expenses than C.C.I.R. Recommendation No. 35 ;

UNANIMOUSLY RESOLVES that :

1. Recommendation No. 35 of the C.C.I.R. Vth Plenary Assembly be cancelled, and

2. The rules for charging the expenses of Study Groups to the expenses of each subsequent Plenary Assembly of the C.C.I.R., as contained in Resolution No. 171 of the Administrative Council, be adopted.

RESOLUTION No. 9

STAFF OF C.C.I.R. SPECIALISED SECRETARIAT

(Request of the Administrative Council of the I.T.U. during its 6th Session)

The C.C.I.R.,

CONSIDERING :

(a) The request of the Administrative Council regarding the filling of a post of Technical Editor ;

(b) The importance of ensuring the optimum efficiency of its specialised Secretariat consistent with economy in expenditure ;

(c) The difficulty of securing suitable personnel when only temporary appointments can be offered ;

UNANIMOUSLY RESOLVES :

1. That the post of Technical Editor should be filled on a permanent basis ;

2. That in addition, the posts of 1 Technical Operator, Class 6,
1 Shorthand typist, Class 6,
1 Typist, Class 6,

at present filled by temporary staff, should be filled on a permanent basis ;

3. That the post of Concierge should continue to be filled only on a temporary basis ;

4. That the post of Office Technical Assistant, Class 4, not yet filled, but provided for in the budget for 1951 and 1952 already approved by the Administrative Council, should be permanently filled ;

5. That the posts : 1 Shorthand Typist (Spanish language), Class 6,
1 Typist, Class 6,
1 Junior Technical Operator, Class 7,

not yet filled, but similarly provided for in the budget, should only be filled when in the opinion of the Director it becomes necessary to do so, and then only on a temporary basis.

ALLOCATION OF QUESTIONS, STUDY PROGRAMMES, REPORTS AND RESOLUTIONS TO STUDY GROUPS

STUDY GROUP No. I
(Transmitters)

Chairman : Dr. Ernst METZLER (Switzerland)

Question N° 1	Revision of Atlantic City Recommendation No. 4.
Question No. 18	Telegraphic distortion.
Question No. 20	Frequency shift keying.
Question No. 46	Arrangement of channels in multi-channel transmitters for long-range circuits.
Study Programme No. 1	Bandwidth of emissions.
Study Programme No. 2	Harmonics and parasitic emissions.
Study Programme No. 3	Frequency stabilisation of transmitters.
Study Programme No. 4	Frequency shift keying.
Report No. 1	Telegraphic distortion.

STUDY GROUP No. II
(Receivers)

Chairman : Mr. Pierre DAVID (France)

Question No. 47	Sensitivity and noise figure.
Study Programme No. 5	Stability of receivers.
Study Programme No. 6	Selectivity of receivers.
Study Programme No. 7	Protection against keyed interfering signals.

STUDY GROUP No. III
(Complete radio systems employed by the different services)

Chairman : Dr. H. C. A. VAN DUUREN (Netherlands)

Question No. 3	Revision of Atlantic City Recommendation No. 4.
Question No. 11	Presentation of the results of atmospheric radio noise measurements for the requirements of operational services.
Question No. 43	Voice frequency telegraphy on radio circuits.
Question No. 44	Theory of communication.
Question No. 48	Directivity of antennas at great distances.
Study Programme No. 8	Bandwidth and signal-to-noise ratios in complete systems.
Study Programme No. 9	Voice frequency telegraphy on radio circuits.
Study Programme No. 10	Theory of communication and its practical applications.

STUDY GROUP No. IV
(Ground wave propagation)

Chairman : Professor L. SACCO (Italy)

Question No. 6	Ground wave propagation.
Question No. 49	Presentation of antenna radiation data.
Study Programme No. 11	Effects of tropospheric refraction on frequencies below 10 Mc/s.

Study Programme No. 12	Temporal variation of ground wave field strengths.
Study Programme No. 13	Ground wave propagation over mixed paths.
Study Programme No. 14	Effects of irregular terrain on ground wave propagation.
Study Programme No. 15	Phase variations in ground wave propagation.
Study Programme No. 16	Revision of the 1937 C.C.I.R. propagation curves, and their possible extension to higher frequencies.
Report No. 2	Ground wave propagation over irregular terrain.
Report No. 3	Review of publications on propagation (ground wave).

STUDY GROUP No. V

(Tropospheric propagation)

Chairman : Dr. R. L. SMITH-ROSE (United Kingdom)

Study Programme No. 17	Tropospheric propagation curves for distances well beyond the horizon.
Study Programme No. 18	Tropospheric wave propagation.
Study Programme No. 19	Measurement of field strength of radio signals.
Report No. 3	Review of publications on propagation (tropospheric).
Report No. 4	Methods of measuring field strength.
Report No. 5	Measurement of field strength (respective merits of the two main types of equipment now in use).
Report No. 6	Measurement of field strength (merits of a standard noise generator as the source of the locally generated signal).

STUDY GROUP No. VI

(Ionospheric propagation)

Chairman : Dr. J. H. DELLINGER (United States of America)

Question No. 50	Practical uses of radio propagation data.
Question No. 51	Severity of fluctuations in field at reception.
Question No. 52	Allowances for fading.
Question No. 53	Choice of a basic index for ionospheric propagation.
Study Programme No. 20	Non-linear effects in the ionosphere.
Study Programme No. 21	Radio propagation at frequencies below 1500 kc/s.
Study Programme No. 22	Ionospheric propagation of waves in the range of 30 to 300 Mc/s.
Study Programme No. 23	Measurement of atmospheric radio noise.
Study Programme No. 24	Study of fading.
Report No. 3	Review of publications on propagation (Ionospheric).
Report No. 7	Long distance propagation of waves of 30 to 300 Mc/s by way of ionization in the E and F regions of the ionosphere.
Report No. 8	Atmospheric noise data.
Report No. 9	Interference to radio reception at sea due to atmospheric causes.
Report No. 10	Rapid exchange of information on propagation.

STUDY GROUP No. VII

(Radio time signals and standard frequencies)

Chairman : Mr. B. DECAUX (France)

Question No. 54	Standard frequency transmissions and time signals.
Study Programme No. 25	Standard frequency transmissions and time signals.

STUDY GROUP No. VIII

(International monitoring)

Chairman : Mr. A. H. CANNON (Australia)

Question No. 55	Accuracy of field strength measurement by monitoring stations.

STUDY GROUP No. IX

(General technical questions)

Chairman : Capt. C. F. BOOTH (United Kingdom)

Question No. 56	Watch on the distress frequency of 2182 kc/s.
Question No. 57	Watch on the radiotelephony distress frequency of 2182 kc/s.
Question No. 58	Standardisation of radiophoto and telephoto equipment.
Question No. 59	Power relationships for modulated emissions.
Question No. 60	Preferred methods of specifying power supplied to an antenna by a radio transmitter.
Question No. 61	Pulse transmission for radio direction finding.
Study Programme No. 26	Identification of radio stations.
Study Programme No. 27	5-unit radio teleprinter.
Study Programme No. 28	Wide band radio systems operating in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands.
Study Programme No. 29	Alarm signal for use on the maritime radiotelephony distress frequency 2182 kc/s.
Report No. 11	Standardisation of radiophoto and telephoto equipment.

STUDY GROUP No. X

(Broadcasting including questions relating to single sideband)

Chairman : Mr. Neal McNAUGHTEN (United States of America)

Question No. 23	High frequency broadcasting, directive antenna systems.
Question No. 37	High frequency broadcasting, justification for use of more than one frequency per programme.
Question No. 39	High frequency broadcasting, conditions for satisfactory reception.
Question No. 62	Single sideband sound broadcasting.
Question No. 63	Standards of sound recording for the international exchange of programmes.
Study Programme No. 30	The reception of high frequency broadcasting with synchronized transmitters.
Study Programme No. 31	Standards of sound recording for the international exchange of programmes.
Report No. 12	Single sideband sound broadcasting.
Report No. 13	The minimum number of frequencies necessary for the transmission of a high frequency broadcasting programme.
Report No. 14	High frequency broadcasting reception.
Resolution No. 3	Publication of antenna charts.
Resolution No. 4	Standards of sound recording for the international exchange of programmes.

STUDY GROUP No. XI

(Television including questions relating to single sideband)

Chairman : Mr. Erik ESPING (Sweden)

Question No. 64	Television standards.
Question No. 65	Assessment of the quality of television pictures.
Question No. 66	Television recording.
Question No. 67	Ratio of the wanted to the unwanted signal in television.
Question No. 68	Resolving power and differential sensitivity of the human eye.
Study Programme No. 32	The requirements for the transmission of television over long distances.
Study Programme No. 33	Television field frequency.
Study Programme No. 34	Picture and sound modulation.
Study Programme No. 35	Reduction of the bandwidth for television.
Study Programme No. 36	Conversion of a television signal from one standard to another.
Study Programme No. 37	Black and white and colour television.
Report No. 15	Television systems.

STUDY GROUP No. XII

(Tropical broadcasting)

Chairman : Mr. Moorthy S. S. RAO (India)

Question No. 4	Interference in the bands shared with broadcasting.
Question No. 27	Maximum power for short distance high frequency broadcasting in the tropical zone.
Question No. 69	Best method for calculating the field strength produced by a tropical broadcasting transmitter.
Question No. 70	Design of aerials for tropical broadcasting.
Question No. 71	Determination of noise level for tropical broadcasting.
Study Programme No. 38	Short distance high frequency broadcasting in the tropical zone (tropical broadcasting).

STUDY GROUP No. XIII

(Operation questions depending principally on technical considerations)

Chairman : Mr. J. D. H. VAN DER TOORN (Netherlands)

Nil

STUDY GROUP No. XIV

(Vocabulary)

Chairman : Professor Tullio GORIO (Italy)

Question No. 72	Decimal classification.
Question No. 73	Classification of the frequency and wavelength bands used in radiocommunication.
Resolution No. 5	Means of expression (definitions, vocabulary, graphical and letter symbols).
Resolution No. 6	Unit systems.

APPENDIX

Questions submitted to the C.C.I.R. between the Vth and VIth Plenary Assemblies (in accordance with the provisions of Art. 8, par. 2 of the International Telecommunication Convention Atlantic City, 1947) which no longer remain for study since the VIth Plenary Assembly *

* The text of Questions No. 37, 39, 43 and 44, submitted to the C.C.I.R. between the Vth and VIth Plenary Assemblies, and which still remain for study, will be found in that portion of the book relating to Questions under study. (See pp. 116, 117, 118.)

QUESTION No. 34

" The Maritime Regional Radio Conference, Copenhagen (1948),

CONSIDERING :

(a) That the level of interference to radio reception on ships is a complicated question on which little data is available ;

(b) That the Safety of Life at Sea Conference, London (1948) requested that all steps be taken to eliminate as far as possible the causes of radio interferences from electrical and other apparatus on board ;

RECOMMENDS to Administrations and the C.C.I.R. :

To study the question of interference to radio reception caused by electrical installations on board ship ;

and DRAWS THE ATTENTION of Administrations :

To the need to take all steps possible to eliminate or at least to reduce to a minimum the level of such interference. "

QUESTION No. 35

" The Maritime Regional Radio Conference, Copenhagen (1948),

CONSIDERING :

(a) That there is a possibility of interference to radio reception due to ships' radar ;

(b) That there is a lack of information on the extent and value of such interference ;

(c) That the Safety of Life at Sea Conference, London (1948), recommended that Governments consider the possibility of issuing specifications to indicate the standards desired ;

RECOMMENDS to Administrations concerned and the C.C.I.R. :

That performance specifications for the installation and operating of ships' radar apparatus should include the provisions necessary to ensure that such apparatus does not cause interference with the radio-communication apparatus on board. "

QUESTION No. 36

" The Maritime Regional Radio Conference, Copenhagen (1948),

CONSIDERING :

(a) That interference to radio reception due to atmospheric causes results in great difficulties for the maritime mobile service ;

(b) That no definite figures are available indicating the general levels of such interference ;

RECOMMENDS to Administrations and the C.C.I.R. :

(a) To study the question of interference to radio reception at sea due to atmospheric causes, and subsequently ;

(b) To determine figures for the level of atmospheric interference in the frequency bands allocated to the maritime mobile service for the different regions of the European Maritime Area. "

QUESTION No. 38

" The International High Frequency Broadcasting Conference, Mexico City,

CONSIDERING :

That it has not been possible to make a complete study of a number of questions mentioned in the Report of the Committee on Technical Principles and Standards (Doc. No. 635) *,

DRAWS THE ATTENTION of the C.C.I.R.

To the technical data contained therein and requests the C.C.I.R. to undertake the further study of the following question :

The formulation of general standards for high frequency receivers, for use in the preparation of high frequency broadcasting assignment plans. "

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* Of Mexico.

QUESTION No. 40

" The XVth Plenary Assembly of the C.C.I.F., Paris (July, 1949),

SUBMITS the following question to be studied by the C.C.I.R. :

Are the suggestions * made by the C.C.I.F. for carrying out tests of appreciation of the quality of television transmissions the most suitable ? If not, what modifications do you propose ?

What are the results of any such tests which have been carried out in your country and what are the technical conclusions to be drawn as far as the international exchange of television programmes is concerned ? "

Note. — To be studied in collaboration with the International Telephone Consultative Committee (C.C.I.F. Study Group No. 3).

QUESTION No. 41

" The XVth Plenary Assembly of the C.C.I.F., Paris (July, 1949)

SUBMITS the following question for study by the C.C.I.R. :

This question concerns the use of radio links in international telephone circuits, taking into account that these radio links should allow the establishment of groups of circuits, each group to contain a minimum of twelve telephone circuits. "

Note. — To be studied in collaboration with the International Telephone Consultative Committee (C.C.I.F. Study Groups Nos. 3 and 5).

* For ref. see pp. 54-57 of Doc. C.C.I.F. 1947/48, 3rd C.R., Doc. No. 36.

QUESTION No. 42

The Administrations of :

Austria	France	Norway
Belgium	India	Sweden
Canada	Italy	Switzerland
Denmark	Netherlands	United Kingdom
	New Zealand	

SUBMIT the following question for study by the C.C.I.R. :

What method or methods of sound recording are preferred to facilitate the international exchange of recorded programmes between broadcasting organisations, and to what technical standards should these methods conform ?

QUESTION No. 45

" The International High Frequency Broadcasting Conference (Florence/Rapallo, 1950),

CONSIDERING :

(a) That the phases of a High Frequency broadcasting plan would necessarily have to be based on indices of solar activity ;

(b) That no internationally agreed forecast of such indices of solar activity exists at present ;

(c) That the International High Frequency Broadcasting Conferences and their technical groups have prepared a very large volume of propagation data, in the form of optimum working frequency (OWF) and field intensity curves, for various values of the solar index as determined by the method of predicting solar activity used by the Central Radio Propagation Laboratory of the Bureau of Standards of the United States of America ;

(d) That it is therefore essential to correlate the results obtained by any method to be internationally agreed upon, with the particular index figures of solar activity mentioned in *(c)* above ;

(e) That solar and related observations and predictions are available in many countries of the world ;

(f) That it is not contemplated that the permanent organs of the I.T.U. should undertake special observations of their own,

INVITES the C.C.I.R.

1. To study, and formulate recommendations on the method or methods which should be adopted to forecast, about six months in advance, from the data available, internationally agreed values of solar index, specifying clearly the precise definitions of the terms used in making the forecast ;

2. To send a report to Administrations as soon as possible ".

DECLARATIONS OF COUNTRIES * CONCERNING THE ADOPTION OF TEXTS CONTAINED IN THIS VOLUME

1. The following countries :

   Australia (Federation),
   Union of South Africa

   declared that they reserved their opinion on Recommendation No. 84.

2. The following countries :

   Bielorussian Soviet Socialist Republic,
   Ukrainian Soviet Socialist Republic,
   Union of Soviet Socialist Republics

   declared that they reserved their opinion on Recommendation No. 71 ;
   they also declared that they did not accept Recommendation No. 57 ;
   they further declared that they had abstained from expressing any opinion on Resolution No. 9.

3. The following countries :

   Bielorussian Soviet Socialist Republic,
   Bulgaria (People's Republic of),
   Hungary (People's Republic of),
   Poland (Republic of),
   Roumania (People's Republic of),
   Ukranian Soviet Socialist Republic,
   Czechoslovakia,
   Union of Soviet Socialist Republics

   declared that they reserved their opinion on the following documents :

   Recommendations Nos. 39, 41, 43, 46, 47, 48, 49, 52, 53, 55, 56, 59, 69, 72, 73, 77, 80, 83, 84,
   Questions Nos. 46, 50, 60, 69,
   Study Programmes Nos. 1, 2, 4, 11, 16, 17, 18, 20, 25, 26, 29, 31,
   Report No. 13,
   Resolution No. 6 ;

   they also declared that they did not accept the following documents :

   Recommendations Nos. 36, 44, 50, 51, 58, 67, 68, 70, 79, 81, 82,
   Question No. 63,
   Study Programmes Nos. 8, 23,
   Reports Nos. 3, 8, 9, 11,
   Resolution No. 4 ;

   They further declared that they had abstained from expressing any opinion on the following documents :

   Resolutions Nos. 7 and 8.

4. The following countries :

   Bulgaria (People's Republic of),
   Hungary (People's Republic of)

   declared that they reserved their opinion on Recommendations Nos. 57 and 71 ;
   they also declared that they had abstained from expressing any opinion on Resolution No. 9.

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* For list of countries taking part see Annex on p. 246.

5. The following country :

   Egypt

   declared that they reserved their opinion on Recommendations Nos. 50 and 84.

6. The following country :

   The United States of America

   declared that they reserved their opinion on Recommendation No. 50.

7. The following country :

   Poland (Republic of)

   declared that they reserved their opinion on Recommendation Nos. 57 and 71 and on Question No. 67 ; they also declared that they had abstained from expressing any opinion on Resolution No. 9.

8. The following country :

   Yugoslavia (Federal People's Republic of)

   declared that they reserved their opinion on Recommendation No. 81 ; they also declared that they did not accept Recommendation No. 58.

9. The following country :

   Roumania (People's Republic of)

   declared that they reserved their opinion on Recommendation No. 71 ; they also declared that they did not accept Recommendation No. 57.

10. The following country :

    Czechoslovakia

    declared that they reserved their opinion on Recommendation No. 57 ; they also declared that they had abstained from expressing any opinion on Resolution No. 9.

Note. — The texts of Questions Nos. 11, 54, 56, 58 and 64 which are taken from the texts adopted by the Vth Plenary Assembly of the C.C.I.R. (Stockholm 1948) were the subject of opposition (or reserve for Question No. 64) by the following countries :

Albania (People's Republic of), Bielorussian Soviet Socialist Republic, Bulgaria (People's Republic of), Hungary (People's Republic of), Poland (Republic of), Yugoslavia (Federal People's Republic of), Roumania (People's Republic of), Ukranian Soviet Socialist Republic, Czechoslovakia, Union of Soviet Socialist Republics.

ANNEX

LIST OF COUNTRIES OF WHICH THE ADMINISTRATIONS TOOK PART IN THE WORK OF THE VIth PLENARY ASSEMBLY OF THE C. C. I. R.

Australia
Austria
Belgium
Bielorussia (Soviet Socialist Republic of)
Bulgaria (People's Republic of)
China
Overseas Territories of the French Republic
Costa-Rica
Cuba
Denmark
Egypt
Ecuador
Spain
United States of America
Finland
France
Hungary (People's Republic of)
Italy
Japan
Luxemburg
Morocco (Spanish Zone and the whole of the Spanish Colonies)
Monaco
Nicaragua
Norway
New Zealand
Netherlands, Netherlands Antilles, Surinam, New Guinea
Poland (Republic of)
French Protectorate of Morocco
Federal People's Republic of Yugoslavia
Ukrainian Soviet Socialist Republic
Roumania (People's Republic of)
United Kingdom of Great Britain and Northern Ireland
Sweden
Switzerland
Czechoslovakia
Territories of the United States of America
Turkey
Union of South Africa
Union of Soviet Socialist Republics
Uruguay
Yemen (Kingdom of)