INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

C.C.I.R.

DOCUMENTS OF THE

Xth PLENARY ASSEMBLY

GENEVA, 1963

VOLUME V

SOUND BROADCASTING

TELEVISION

Published by the

INTERNATIONAL TELECOMMUNICATION UNION

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* This list includes only those Study Programmes which do not derive from Questions. A Study Programme derived from a Question carries the same serial number as this Question, followed by a letter (e.g. S.P. 102 A (XII)). It is inserted in the book immediately after the text of the Question from which it is derived.

ARRANGEMENT OF VOLUMES I TO VII OF THE DOCUMENTS OF THE Xth PLENARY ASSEMBLY OF THE C.C.I.R.

(Geneva, 1963)

VOLUME I	Emission. Reception. Vocabulary (Sections A, B and K and Study Groups I, II and XIV).
VOLUME II	Propagation (Section G and Study Groups V and VI).
VOLUME III	Fixed and mobile services. Standard frequencies and time signals. International monitoring (Sections C, D, H and J and Study Groups III, XIII, VII and VIII).
VOLUME IV	Radio-relay systems. Space systems. Radioastronomy (Sections F and L and Study Groups IX and IV).
VOLUME V	Sound broadcasting and television (Section E and Study Groups X, XI, XII and the C.M.T.T.).
VOLUME VI	Resolutions of a general nature. Reports to the Plenary Assembly. List of participants. List of documents in numerical order.
VOLUME VII	Minutes of the Plenary Meetings.

Note 1. — To facilitate references, the pagination in the English and French texts is the same.

Note 2. — At the beginning of Volume VI will be found information concerning the Xth Plenary Assembly of the C.C.I.R. and the participation at this meeting, the presentation of texts (Definitions, origins, numbering, complete lists, etc.) together with general information on the organization of the C.C.I.R.

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QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO STUDY GROUP XI (TELEVISION); OPINIONS AND RESOLUTIONS OF INTEREST TO THIS STUDY GROUP

The following texts, which are not contained in this Volume, also concern sound broadcasting and television.

Text	Subject	Volume
The majority of the Recommendations and Reports of Section B	Reception	I
Rec. 368	Propagation below 10 Mc/s	II
Rec. 370	Propagation between 40 and 1000 Mc/s	II
Rep. 228	Measurement of field strength	II
Rep. 240	Propagation between 50 and 1000 Mc/s (Africa)	II
Rep. 264	Ionospheric propagation between 150 and 1500 kc/s	II
Several Recommendations of Section F	Characteristics of radio-relay systems and television	IV
Rec. 354	Communications by satellites	IV
Rep. 212	Communications by satellites	IV
Rep. 215	Broadcasting from satellites	IV

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RECOMMENDATIONS OF SECTION E : (SOUND BROADCASTING AND TELEVISION)

E. 1 - Audio-frequency and recording

RECOMMENDATION 261 *

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

Single track recording on magnetic tape

The C.C.I.R., (Geneva, 1951 — London, 1953 — Warsaw, 1956 — Los Angeles, 1959)

UNANIMOUSLY RECOMMENDS

that single-track recording on magnetic tape should be in accordance with the following technical standards:

1. Speed of tape

Primary speeds: { 15 in./s (38·1 cm/s) nominal value
7½ in./s (19·05 cm/s) „ „

Secondary speed **: 30 in./s (76·2 cm/s) „ „

The actual value of tape speed should be as close as possible to the nominal value. A tolerance of not more than ± 0·5% is considered desirable.

2. Width of tape

0·246 ± 0·002 in. (6.25 ± 0·05 mm)

3. Strength of tape

The tape should be suitable for use on a machine exerting a maximum (transient) stress of 2·2 pounds (1 kg).

4. Direction of winding

If the top surface of a spool is distinguished by markings, by a label or by other means (especially if the hub is asymmetrical), then the tape should be wound in such a way that during reproduction it may be unwound in a counterclockwise direction.

5. Tape spools

Two types of hub are accepted for international programme exchange:

Fig. 1 gives the principal dimensions of the type more generally used in Europe;

Fig. 2 gives the dimensions of the hub more generally used in the United States and of the accompanying flange;

Fig. 3 gives the main dimensions of a typical machine fitting to receive the hub of Fig. 1.

Fig. 4 gives the main dimensions of an adapter to enable the machine fitting of Fig. 3 to receive the hub of Fig. 2.

Whenever the exchange of recorded programmes has to be effected by cine-type flanged spools, the spools must conform to the standards established in Publication 94 of the International Electrotechnical Commission.

As far as possible, for the exchange of recorded programmes, only flanged spools or spool hubs with flanges should be used.

* This Recommendation replaces Recommendation 209.

** The secondary speed should only be used by prior agreement.

6. Maximum diameter of a full spool

for the hub shown in Fig. 1: 290 mm *
for the hub shown in Fig. 2: 267·5 mm

7. Tape leader

A non-magnetic identification strip at least one metre long should be placed at the beginning of the tape giving at least the number of the spool and the reference number (see § 8 below). This information should be given on the side of the leader continuous with the unrecorded side of the tape.

Note. — It is recommended that, whenever possible, the unrecorded side of the tape should be identified by some form of marking continuous throughout the length of the tape.

8. Programme identification

A label giving the following information should accompany each reel:

— broadcasting organization,
— programme title,
— reel number,
— total number of reels,
— reference number,
— total playing time of programme,
— speed of tape (marked as prominently as possible).

9. Reproducing characteristics

A *standard replay chain* is specified and recordings for programme interchange should give a response within the tolerances stated below when reproduced on this standard replay chain:

9.1 *Nominal characteristic*

The *standard replay chain* is defined as one having the same response as that of an " ideal " reproducing head, the open-circuit voltage of which is amplified in an amplifier with a response curve as specified below:

For tape speeds of 15 in./s (38·1 cm/s) and 30 in./s (76·2 cm/s), the specified frequency response curve falls with increasing frequency in conformity with the impedance of a series combination of a capacitance and a resistance having a time constant of 35 μs. This curve is shown in Fig. 6.

For a tape speed of 7½ in./s (19·05 cm/s), the specified frequency response curve falls with increasing frequency in conformity with the impedance of a series combination of a capacitance and a resistance having a time constant of 100 μs. This curve is shown in Fig. 7.

9.2 *Tolerances*

Tapes for international programme interchange should be recorded so that, when reproduced on a standard replay chain the response falls between upper and lower limits defined as follows for tape speeds of 15 in./s (38·1 cm/s) and 30 in./s (76·2 cm/s):

upper limit

— from 50 c/s to 100 c/s falling regularly by 1 db,
— from 100 c/s to 5000 c/s flat,
— from 5000 c/s to 10 000 c/s rising regularly by 1 db,
— from 10 000 c/s to 15 000 c/s flat;

lower limit

— from 50 c/s to 100 c/s rising regularly by 3 db,
— from 100 c/s to 7500 c/s flat,
— from 7500 c/s to 15 000 c/s falling regularly by 3 db.

From 100 to 5000 c/s the flat portions of the upper and lower limits are 2 db apart. These limits are shown in Fig. 8.

* In France, the maximum diameter is 270 mm.

For a tape speed of 7½ in./s (19·05 cm/s), the response should fall within limits defined as follows:

upper limit
— from 50 c/s to 10 000 c/s flat;

lower limit
— from 50 c/s to 100 c/s rising regularly by 3 db,
— from 100 c/s to 5000 c/s flat,
— from 5000 c/s to 10 000 c/s falling regularly by 3 db.

From 100 to 5000 c/s the flat portions of the upper and lower limits are 2 db apart. These limits are shown in Fig. 9.

Note 1. — An "ideal" reproducing head is defined as a ferromagnetic reproducing head, the losses of which are negligible. Normally this means that the gap is short, that the arc of contact with the tape is long compared with the relevant wavelengths on the tape and that the losses in the material of the head are small.

With the reproducing heads used in practice, compensation for the head losses must be added to the replay amplifier.

With good replay heads, a mean value of this equalization may be used for the two higher speeds and even for the three speeds.

Note 2. — The open circuit voltage developed in a ferromagnetic reproducing head depends on the surface induction * on the tape while it is in contact with the head. It has been found that, provided a coated high-coercivity tape is used, the surface induction in free space will be altered, when the tape is placed in contact with the head, by an approximately constant factor over the whole range of wavelengths. Under these circumstances, the relative surface inductions at different frequencies can be measured by at least three methods that are described in the Annex. From such measurements, the departure of the response of a reproducing head from the " ideal " can be defined, and consequently a standard replay chain can be established as a primary standard. Test tapes can then be made which can serve as secondary standards for use in normal operations.

Note on use of reproducing characteristics. — A different standard replay chain has been adopted in the U.S.A. for 15 in/s (38·1 cm/s). The difference between the nominal characteristics of the standard replay chain of the U.S.A. and that of the C.C.I.R., is less than the tolerance in § 9. Furthermore a different characteristic is used in France for 30 in./s (76·2 cm/s).

ANNEX

1. Methods of measuring the magnetization of a tape

There are two general ways in which the surface induction/frequency characteristics of a tape may be determined:

1.1 by means which do not affect the surface induction. This implies the use of a non-magnetic reproducing device. For example, reproduction by means of a simple non-magnetic conductor placed in the field at the surface of the moving tape is practicable as a laboratory method and may therefore be used to establish a primary standard. This can be used to determine the relative change of surface induction with wavelength created by the presence of a magnetic head;

1.2 by means of a magnetic reproducing device, which necessarily affects the surface induction of the tape in a manner dependent on recorded wavelength. In this category, there are two ways in which conventional magnetic heads have been used, one method involving heads with a short gap, the other involving heads with a long gap. In both cases, the gap in the

* In this Recommendation and in the Annex the term " surface induction " means the normal surface induction, that is to say the flux density at right-angles to the surface of the tape.

reproducing head must be sufficiently accurate, magnetically, to give well-defined minima of reproduced level, one in the short gap method or several in the long gap method. To ensure that the same results will be obtained with both magnetic and non-magnetic reproducing devices, a coated high-coercivity tape must be used.

Steps must be taken to ensure that the arc of the tape in contact with the head is long enough in relation to the longest wavelengths recorded. If this is not so, it may be found that output level at the lower frequencies is slightly higher than that given by an ideal head and that the deviation increases as the frequency decreases while remaining as a general rule within the tolerances defined above. The error may be reduced by using bigger reproducing heads for the very low frequencies.*

1.2.1 *The " short-gap " method*

The longest wavelength at which a minimum of reproduced level occurs is called the effective gap length d. The necessary correction for the gap length is calculated on the assumption that the output is proportional to

$$[\sin (\pi d/\lambda)] / (\pi d/\lambda)$$

This correction must not exceed 5 db at the shortest wavelength considered. Any necessary correction for eddy current losses must also be determined, for example, by comparing outputs at various tape speeds or by the use of an inducing loop. Once these corrections are known and applied, the head may be used as an " ideal " head to measure relative surface inductions on the tape over the wavelength range considered.

1.2.2 *The " long-gap " method*

In this method, a head is used with a gap some 50 times longer than that of the normal reproducing head. In practice, an erase head can usually be adapted for the purpose. The response of such a head should show a series of well-defined maxima and minima as shown in Fig. 10.

A curve through the successive maxima is a measure of the relative surface induction on the tape, when the necessary correction for the eddy current losses of the head has been made. This curve falls approximately 4 db/octave compared with the curve of surface induction/frequency in air, as determined by a non-magnetic reproducing device, or by a " short-gap " head. This correction must therefore be applied.

The precise steps by which the procedures of §§ 1.2.1 and 1.2.2 may be applied in practice are outlined in the following.

2. Standardization by the short-gap magnetic head

Using the short-gap method, a recording equipment is set to the standard condition in the following way:

2.1 A *gliding tone* is recorded on a tape and reproduced by means of the head to be used for the measurements. The longest wavelength at which the output disappears is noted. This wavelength will be equal to the effective gap length, from which the gap correction may be deduced. If this correction exceeds 5 db the head is unsuitable for this measurement.

Since the measurement must take place at a very short recorded wavelength, a high-coercivity tape should be used, and a certain amount of pre-emphasis will be found useful. To avoid making the measurements at an unnecessarily high frequency, the lowest tape speed available should be used.

2.2 The tape with the gliding tone is reproduced at two different speeds and the output curves are compared. If the curves can be brought to coincidence by displacing one frequency scale so that equal wavelengths coincide, it may be assumed that frequency-dependent losses are negligible. If not, these losses may be deduced from the two curves mentioned or, alternatively, from a measurement with an inducing loop.

* See Report 79.

2.3 The frequency response of the reproducing chain is now adjusted to be that specified in § 9.1 of this Recommendation, together with the gap correction noted in § 2.1 and the compensation for frequency dependent losses noted in § 2.2 above.

2.4 The recording equalization is then adjusted so that a flat overall response is obtained.

3. Standardization by the long-gap magnetic head

Using the long-gap method, a recording equipment is set to the standard condition in the following way:

3.1 The reproducing head used has a well-defined gap, long enough to give successive maxima of response at intervals of 1 kc/s, or less, in the audio-frequency range (with a tape speed of 30 in./s (76·2 cm/s) the gap length required would be about 800 microns). If the successive minima in the response curve are not equally well defined, the head is not suitable for this measurement. A short preliminary experiment is carried out, to determine the exact frequencies at which successive maxima occur at the relevant tape speed.

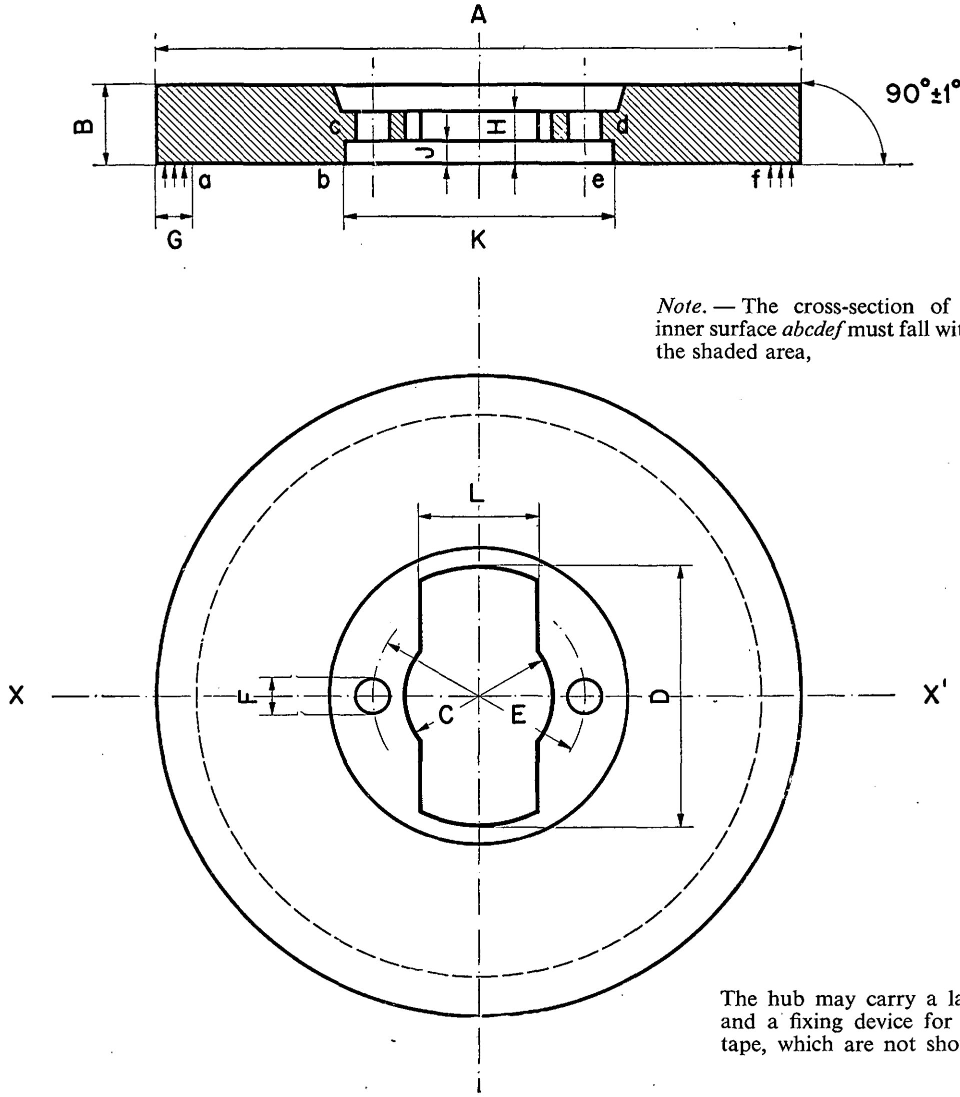
3.2 A *gliding tone* test tape of the audio frequencies of maximum level is then recorded with constant voltage input to the recording chain and the tape is reproduced using the long gap head. The open circuit voltage of the head around these frequencies is then plotted against frequency, and a smooth curve is drawn through the successive maxima.

3.3 The tape with the gliding tone is reproduced at two different speeds using the long gap head and the output curves are compared. If the curves can be brought to coincidence by displacing one frequency scale so that equal wavelengths coincide, it may be assumed that frequency-dependent losses are negligible. If not, these losses may be deduced from the two curves mentioned or, alternatively, from a measurement with an inducing loop.

3.4 When the curve drawn in § 2 has been corrected by a 6 db/octave rise with increasing frequency together with the correction for frequency-dependent losses and a correction of 2 db/octave falling with increase of frequency, the result defines the relative surface inductions on the tape.

3.5 The equalization of the recording amplifier is now altered to obtain a characteristic of surface induction/frequency that is the inverse of the equalization specified for the reproducing chain (without allowance for the replay head losses).

3.6 The reproducing amplifier equalization is then adjusted so that a flat overall response is obtained when using a normal reproducing head.

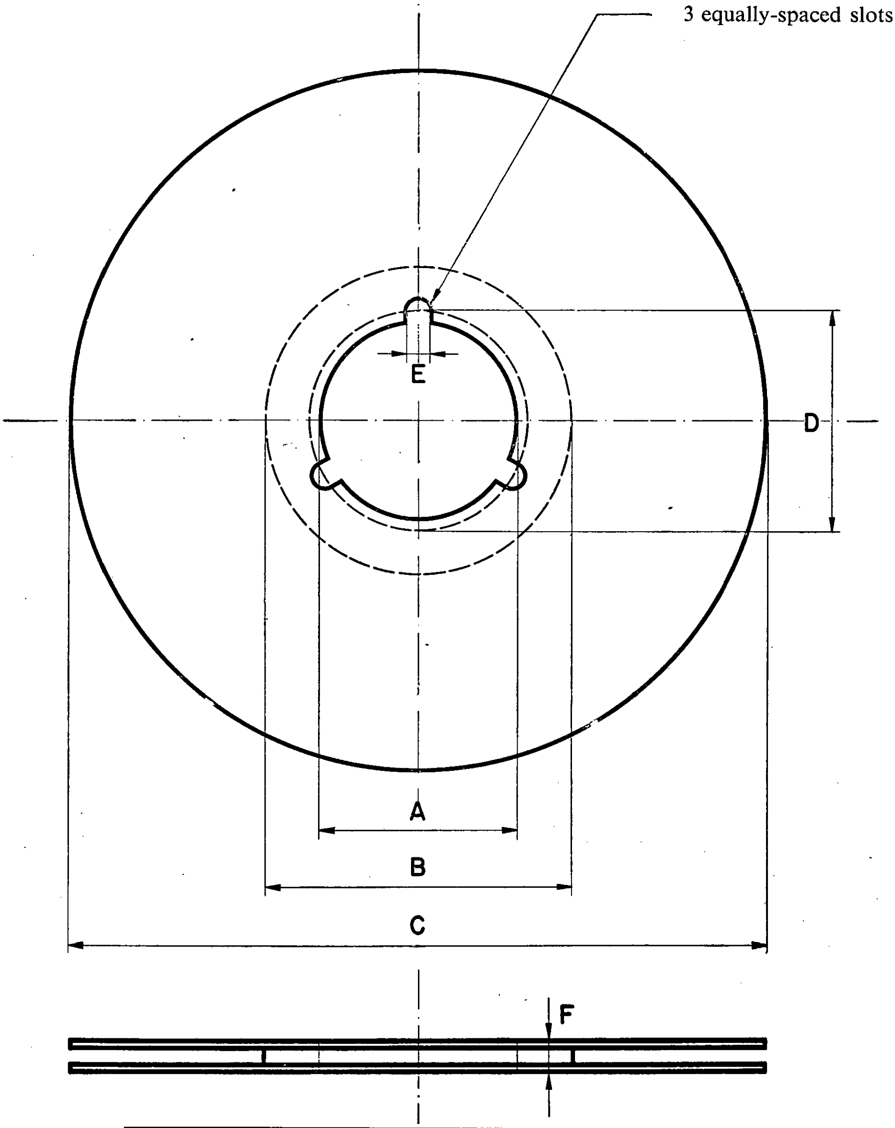


Note. — The cross-section of the inner surface *abcdef* must fall within the shaded area,

The hub may carry a label and a fixing device for the tape, which are not shown.

Dimensions	Millimetres	Inches	Dimensions	Millimetres	Inches
A	58 – 100	2·28 – 39·5	G	4	0·157
B	$11^{+0}_{-0\cdot2}$	$0\cdot433^{+0}_{-0\cdot008}$	H	7^{+0}_{-1}	$0\cdot275^{+0}_{-0\cdot04}$
C	$20\cdot1^{+0\cdot1}_{-0}$	$0\cdot791^{+0\cdot004}_{-0}$	J	3·5 min.	0·138 min.
D	$35^{+0\cdot2}_{-0}$	$1\cdot378^{+0\cdot008}_{-0}$	K	36 min.	1·417 min.
E	$28^{+0\cdot2}_{-0}$	$1\cdot102^{+0\cdot008}_{-0}$	L	$16^{+0\cdot2}_{-0}$	$0\cdot63^{+0\cdot008}_{-0}$
F	$5^{+0\cdot2}_{-0}$	$0\cdot197^{+0\cdot008}_{-0}$			

FIGURE 1
European standards
Spool hub for magnetic tape recording



Dimensions	Inches		Millimetres	
	Minimum	Maximum	Minimum	Maximum
A	3·000	3·004	76·20	76·30
B	4·490	4·510	114·05	114·55
C	10·50	10·52	267·0	267·5
D	3·248	3·252	82·45	82·55
E	0·219	0·225	5·60	5·75
F	0·447	0·457	11·35	11·60

FIGURE 2

U.S.A. type of spool for magnetic tape recording

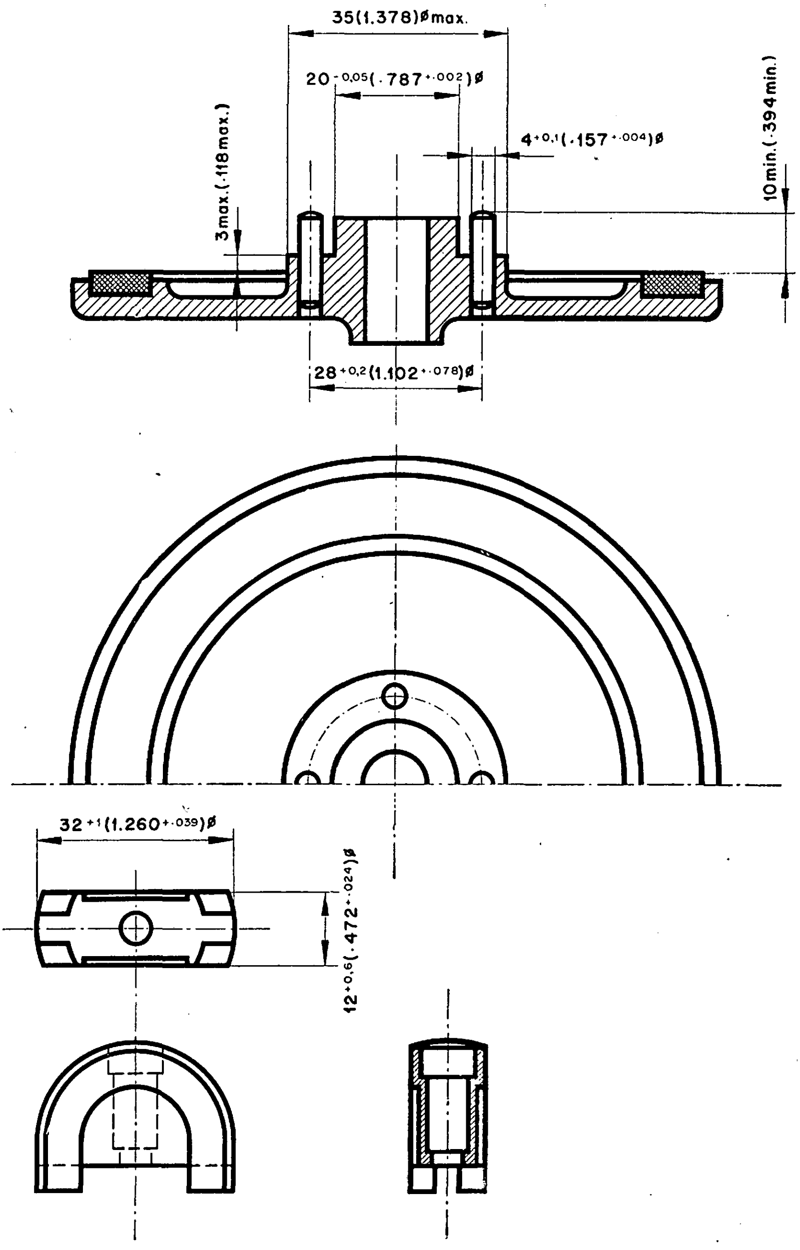


FIGURE 3

European standards

Machine fitting to receive spool hub

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

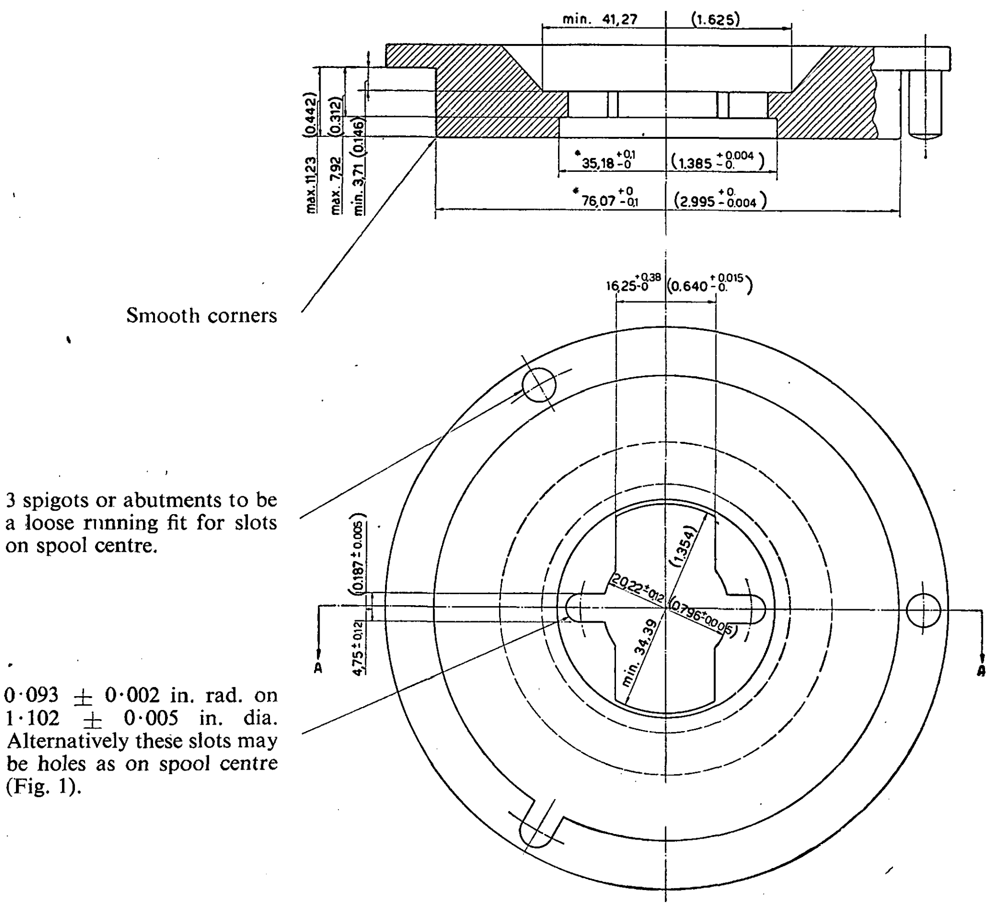
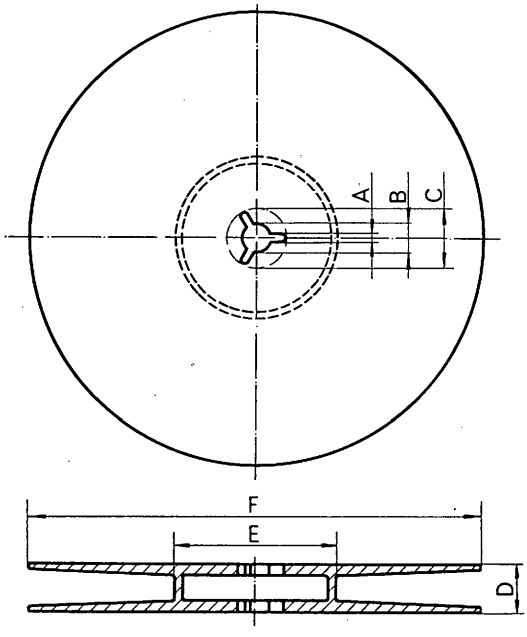


FIGURE 4

Typical adapter to enable the European type of machine fitting to receive the hub of Figure 2

Note. — Diameters marked thus * to be concentric within 0·003 in.

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



Not to scale

The millimetre dimensions are derived from the original dimensions

Third angle projection

Ref.	Millimetres			Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	1·524		1·651	0·060		0·065
B	8·027		8·102	0·316		0·319
C	16·01			0·63		
D	12·75		13·512	0·502		0·532

Nominal capacity		F* Nominal diameter		E Minimum core diameter	
m	ft	mm	in.	mm	in.
50	150	76	3	35	1 3/8
100	300	101·5	4	35	1 3/8
200	600	127	5	44·5	1 3/4
400	1200	178	7	57·1	2 1/4

* Tolerances on F
−0·00 in. (−0 mm)
+0·08 in. (+2 mm)

FIGURE 5

Cine type spool

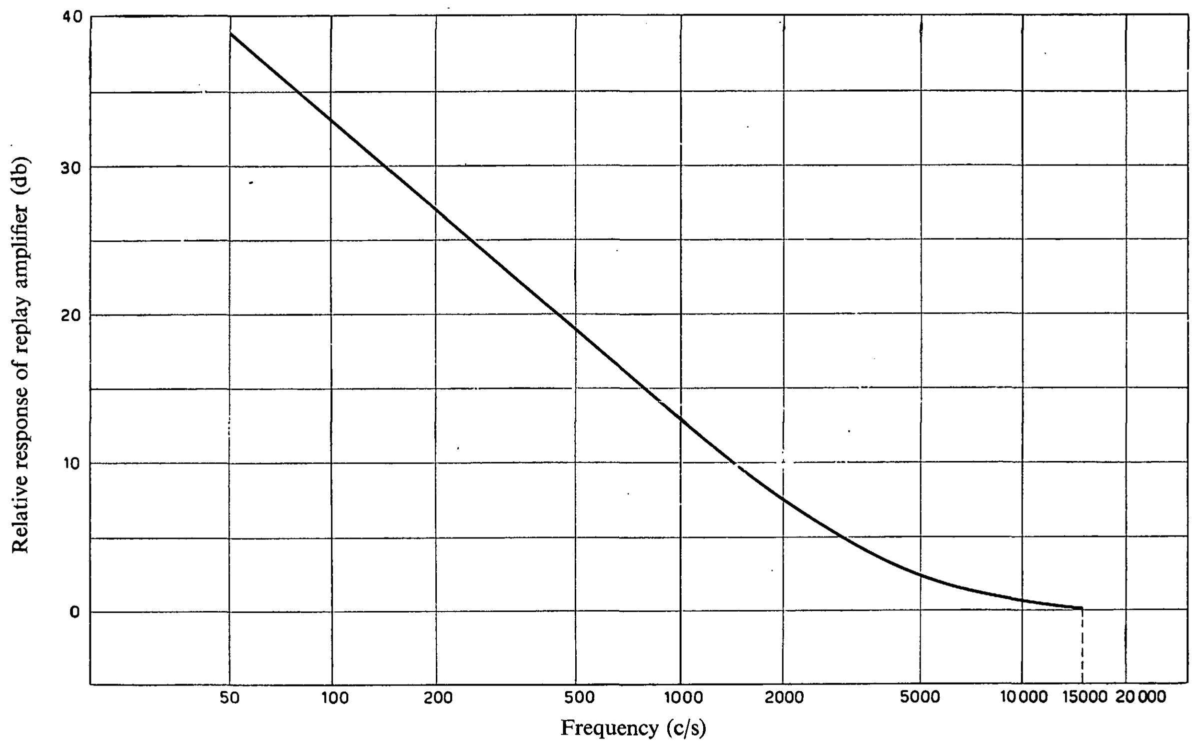


FIGURE 6

Nominal reproducing characteristic for magnetic tape at 15 in./s and 30 in./s

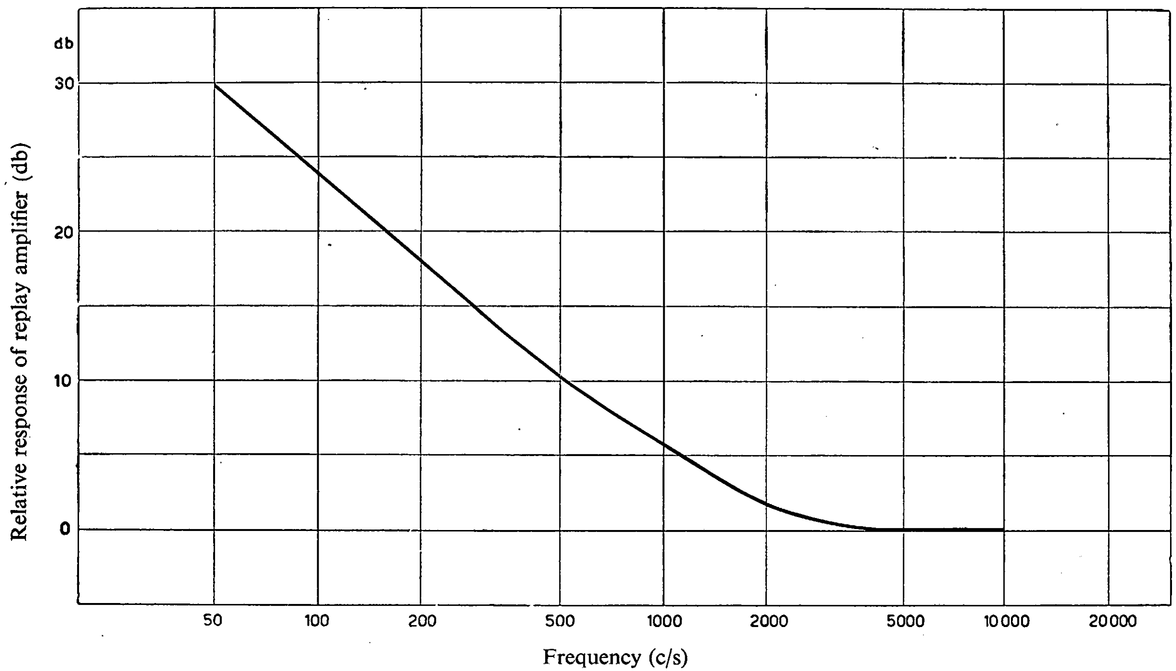


FIGURE 7

Nominal reproducing characteristic for magnetic tape at 7½ in./s

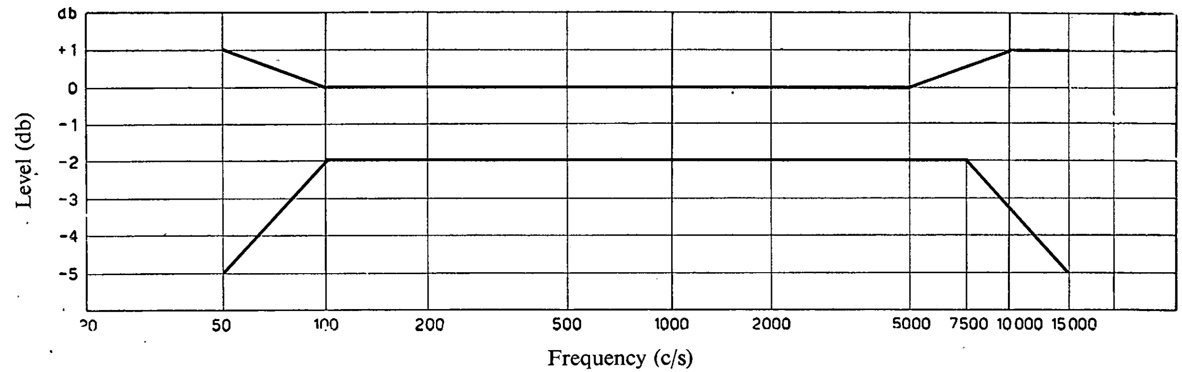


FIGURE 8

Recording tolerance for the speed of 15 and 30 in./s. Limits within which the response should lie when reproduction is carried out on the standard replay chain

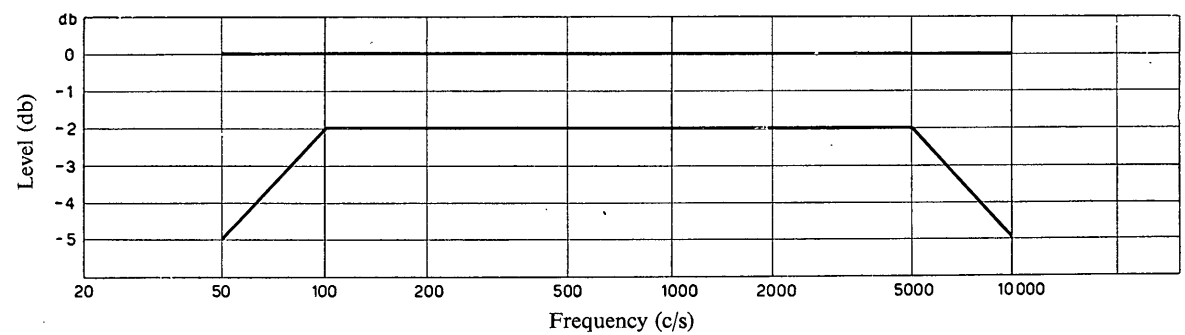


FIGURE 9

Recording tolerance for the speed of 7½ in./s. Limits within which the response should lie when reproduction is carried out on the standard replay chain

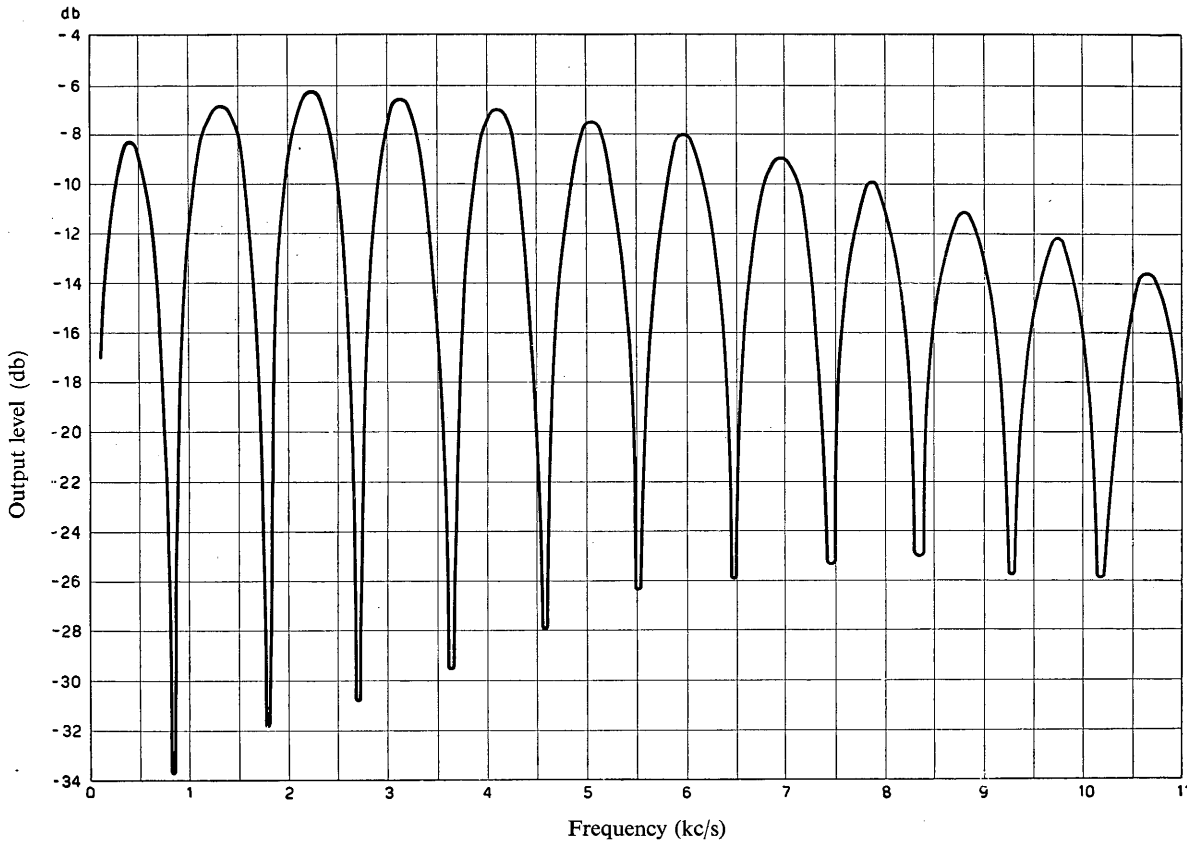


FIGURE 10

Typical response curve of a "long-gap" reproducing head

RECOMMENDATION 264 *

RECORDING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES

(Question 100)

The C.C.I.R., (Warsaw, 1956 — Los Angeles, 1959)

UNANIMOUSLY RECOMMENDS

that the international exchange of recorded television programmes should be effected by means of one of the following:

1. film 35 COMOPT
2. film 16 COMOPT
3. film 16 COMMAG
4. films 16 SEPMAG
5. films 35 SEPMAG

in accordance with the definitions and standards given in Recommendation 265.

Films of types 1, 2, 3 and 4 are primary standards and these films may be exchanged without preliminary advice.

Film type 5 is a secondary standard and cannot be exchanged until there is agreement between the organizations concerned.

RECOMMENDATION 265 **

RECORDING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES

Film recording

(Question 100)

The C.C.I.R., (Warsaw, 1956 — Los Angeles, 1959)

UNANIMOUSLY RECOMMENDS

that the films used for the international exchange of television programmes should meet the following definitions and standards:

1. Definitions

The types of films are designated by code words defined below. The code words should be placed on the identification leader of any film used for programme exchange and should also be used for any correspondence concerning these films.

Any form of picture and sound recording is specified by a number (or numbers), in conjunction with a two- or three-syllable code word: for example, 35 COMOPT.

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* This Recommendation, together with Recommendation 265, replaces Recommendation 211. Report 294 states that additions and amendments to this Recommendation have been under discussion at the Xth Plenary Assembly and will be on the agenda of the next meeting of Study Group X.

** This Recommendation, together with Recommendation 264, replaces Recommendation 211. Report 294 states that additions and amendments to this Recommendation have been under discussion at the Xth Plenary Assembly and will be on the agenda of the next meeting of Study Group X.

The number, usually 16 or 35, indicates the gauge of the film in millimetres. The first syllable of the code word indicates either a combined sound and picture recording by the letters COM or separate sound and picture by the letters SEP. The second syllable of the code word indicates whether the sound recording is magnetic or optical by the letters MAG or OPT. Thus,

— 35-mm film with an optical sound track is 35 COMOPT
— 16-mm film with a magnetic stripe is 16 COMMAG
— 35-mm film with separate (" unmarried ") magnetic sound is 35 SEPMAG.

1.1 If the sound and picture films are of the same gauge, this is indicated by a single number. If not, then two numbers separated by a stroke are used, the first indicating the gauge of the picture film. For example:

— 35-mm picture film with magnetic sound track on 16-mm film is 35/16 SEPMAG
— 16-mm picture film with optical sound track on 35-mm film is 16/35 SEPOPT

If the sound is carried on a ¼ in. (unperforated) tape, the second gauge number is replaced by the letter T. Thus,

— 16-mm picture film with sound or magnetic tape is 16/T SEPMAG

1.2 If the sound is on a separate film using two, three or four tracks, then the syllable DU for two tracks, TRI for three tracks or QUAD for four tracks is inserted between the two code-word syllables. Thus,

— 16-mm film with magnetic stripe is 16 COMMAG
— 16-mm picture film with single magnetic sound track on a separate 16-mm film is 16 SEPMAG
— 16-mm picture film with two magnetic sound tracks on a separate 16-mm film is 16 SEPDUMAG
— 16-mm picture film with three magnetic sound tracks on a separate 35-mm film is 16/35 SEPTRIMAG
— 35-mm picture film with four magnetic sound tracks on a separate 35-mm film is 35 SEPQUADMAG

1.3 For picture film without sound, the designation is 16 MUTE or 35 MUTE.

2. Standards common to all films

2.1 Safety film should be used.

2.2 The film should normally be photographic positive.

2.3 The picture (frame) frequency should be either 25 or 24 pictures (frames) per second.

2.4 Splicing of the film should be carried out according to ASA PH 22.24 for 16 mm.

2.5 The leader attached to a film sent to another organization should end in a frame line of the general form indicated in Fig. 1.

When joined on to a combined sound and picture film, the leader should be spliced-on, so that the dotted line is one frame ahead of picture start or sound start, whichever is the earlier in time sequence.

When used with separate sound and picture films, the dotted frame line of one leader should be joined one frame ahead of picture or sound start, whichever is the earlier in time sequence; the other leader should be joined to the other film, so that the dotted line indicates a point that is synchronous with the dotted frame line on the first, a blank length of film being inserted if necessary.

2.6 The minimum length of the protection and identification leader should be 3 m.

2.7 The minimum information given on the identification leader should be as follows:

— Name of sending organization

— Code word (see § 1)
— Picture frequency
— Title of film
— Number of reel

2.8 The films should be either on flanged reels as described in ASA specification PH 22.11 for the 16-mm films, or on flangeless hubs as described in ASA specification PH 22.37 for the 35-mm films and ASA specification PH 22.38 for the 16-mm film.*

2.9 Flanges and hubs for films with magnetic sound recording should be of non-magnetic material.

2.10 The diameter of a flanged reel or the outer diameter of the film on a flangeless hub should not exceed 15 in. (380 mm).

3. Special standards for certain types of film

3.1 35 COMOPT

ASA specifications:	PH 22.36	PH 22.58
	PH 22.59	PH 22.40

3.2 16 COMOPT

ASA specifications:	PH 22.12	Z 22.8
	Z 22.7	Z 22.41

3.3 16 COMMAG

3.3.1 The dimensions and position of the magnetic stripe should be as given in Fig. 2.

3.3.2 The sound record should be in advance of the picture by 28 ± ½ frames.

3.3.3 The magnetic stripe should be on the side of the film that faces the light source of a projector arranged for direct projection on to a reflecting type screen.

3.3.4 The maximum additional thickness due to the magnetic stripe should be 0·0008 in. (20 microns).

3.3.5 If a balancing magnetic stripe is used outside the sprocket holes, it should have the same composition and thickness as the main magnetic stripe. The dimensions and position of the magnetic stripe should be as given in Fig. 2.

3.3.6 No recording should be made on the balancing stripe.

3.3.7 The recording characteristic should be that standardized by the C.C.I.R. for magnetic tape for a tape speed of 7½ in./s (19·05 cm/s) (Recommendation 261).

3.4 16 SEPMAG

3.4.1 The second film should be a standard 16-mm film with single perforation intended to run at the same mean speed as the picture film.**

3.4.2 Either one or two sound tracks may be provided. Track No. 1 is nominally 0·2 in. (5 mm) wide and in the centre of the film; track No. 2 is nominally 0·1 in. (2·5 mm) wide at the unperforated edge. See Fig. 3.

3.4.3 If there is only one sound track, it should be in the centre (track No. 1).

3.4.4 If two tracks are used, they should be placed synchronously on the film.

3.4.5 The COM and SEP forms should not be combined, that is to say, if a sound track or tracks are provided on a separate film, only these tracks should be used for reproduction.

* It should be noted that occasionally film coming from France may be received on a hub of different design.

** It is to be noted in this connection that France may send out double-perforated film for some time.

3.4.6 The code word 16 SEPMAG or 16 SEPDUMAG should always be marked on the identification leaders of both films to indicate whether one or two sound tracks are provided.

3.4.7 The recording characteristic should be that standardized by the C.C.I.R. for magnetic tape for a tape speed of 7½ in./s (19·05 cm/s) (Recommendation 261).

3.5 35 SEPMAG

3.5.1 The second film should be a standard 35-mm double-perforated film intended to run at the same mean speed as the picture film.

3.5.2 Up to three sound tracks may be provided, their positions and dimensions being as described in ASA specification PH 22.86, i.e. three tracks nominally 0·2 in. (5 mm) wide. See Fig. 4.

3.5.3 The tracks should be designated as follows: Track No. 1 is the left-hand track, No. 2 the central track and No. 3 the right-hand track as seen on a film hanging vertically with the start end downwards and with the magnetic coating towards the observer.

3.5.4 If only one sound track is used, it should be track No. 1.

3.5.5 If a second track is used, it should be track No. 2.

3.5.6 If two or three sound tracks are provided, they should be placed synchronously on the film.

3.5.7 The COM and SEP forms should not be combined, that is to say, if one or more sound tracks are provided on a separate film, only these tracks should be used for reproduction.

3.5.8 The code word 35 SEPMAG, 35 SEPDUMAG, or 35 SEPTRIMAG should always be marked on the leaders of both films to indicate whether one, two or three sound tracks are provided.

3.5.9 The recording characteristic should be that standardized by the C.C.I.R. for magnetic tape for a tape speed of 15 in./s (38·1 cm/s) (Recommendation 261).

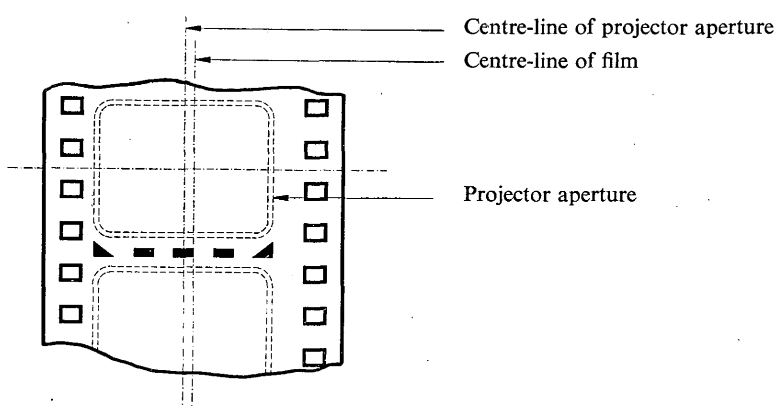
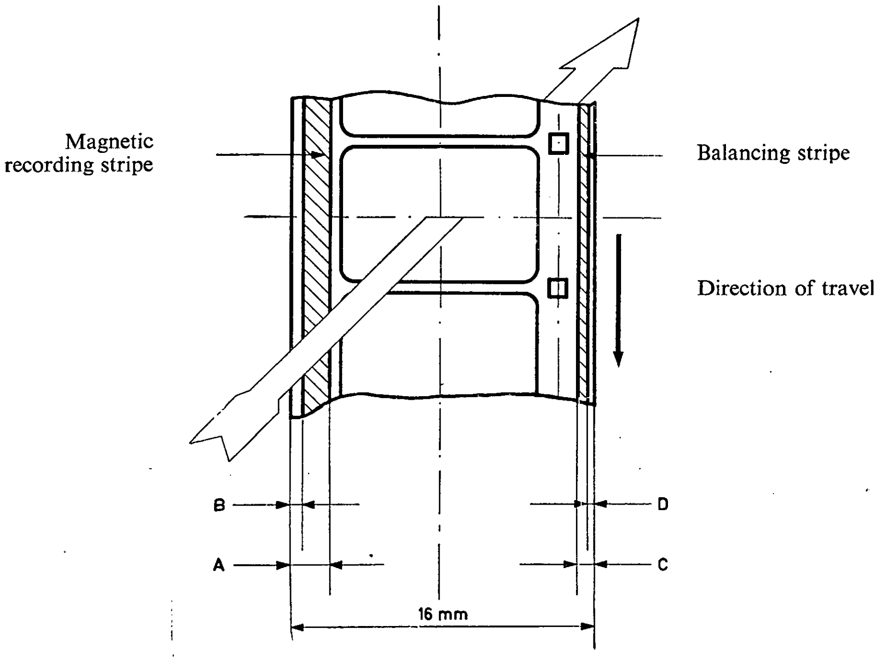


FIGURE 1

End of the identification leader

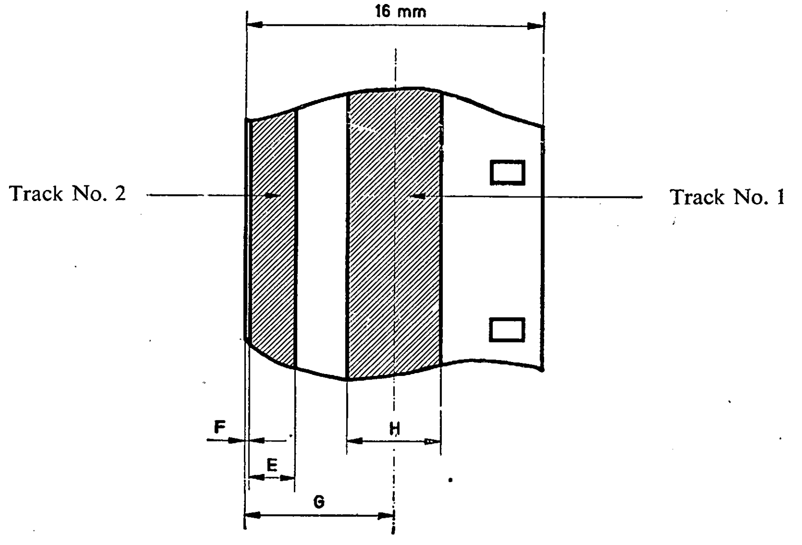


Dimensions

	Inches	Millimetres
A	0·100 $^{+0·004}_{-0·002}$	2·5 $^{+0·15}_{-0}$
B	0·005 max.	0·15 max.
C	0·031 $^{+0}_{-0·005}$	0·8 $^{+0}_{-0·1}$
D	0·002 max.	0·05 max.

FIGURE 2

Sound recording on film type 16 COMMAG

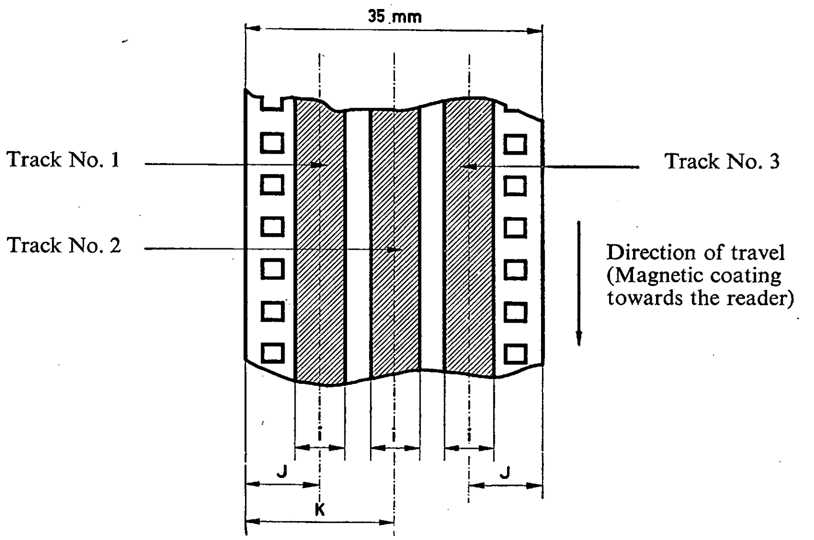


Dimensions

	Inches		Millimetres	
E	0·100	+0·005 −0	2·54	+0·127 −0
F	0·005	+0 −0·005	0·127	+0 −0·127
G	0·315	±0·004	8·00	±0·10
H	0·200	±0·002	5·08	±0·05

FIGURE 3

Sound recording on film type 16 SEPDUMAG



Dimensions

	Inches	Millimetres
i	0·200 ± 0·002	5·08 ± 0·05
J	0·339 ± 0·004	8·61 ± 0·10
K	0·689 ± 0·004	17·50 ± 0·10

FIGURE 4

Sound recording on film type 35 SEPTRIMAG

RECOMMENDATION 407 *

SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Questions 42 and 63)

(Geneva, 1951 — London, 1953 — Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

The C.C.I.R.,

UNANIMOUSLY RECOMMENDS

that the international exchange of recorded sound programmes between broadcasting organizations should be by means of:

1. single-track magnetic recording on tape as specified in Recommendation 261;
2. two-track magnetic recording of stereo signals as specified in Recommendation 408;
3. discs as specified in I.E.C. (Publication 98).

RECOMMENDATION 408

STANDARDS FOR STEREOPHONIC RECORDING ON 6.25 mm (1/4 in.) TWO-TRACK TAPE FOR THE INTERNATIONAL EXCHANGE OF BROADCAST PROGRAMMES

(Question 200 (X) and Report 293)

The C.C.I.R., (Geneva, 1963)

UNANIMOUSLY RECOMMENDS

that, for the international exchange of sound-broadcast programmes, stereophonic recordings on 6·25 mm (¼ in.) magnetic tape should conform to the following characteristics:

1. only the following tape speeds should be used: 38·1 cm/s (15 in./s) and 19·05 cm/s (7½ in./s);
2. the signals should be recorded on two tracks only. Tracks Nos. 1 and 2 should carry the signals to be applied to the left-hand (Signal *A*) and right-hand (Signal *B*) loudspeakers respectively.** The unrecorded space between these two tracks, centred on the centre line of the tape, should have a minimum width of 0·75 mm (0·03 in.) ***;
3. the sum $(A + B)$ of the left-hand and right-hand channels is a compatible signal, that is to say, the reproduction of a stereophonic tape by monophonic equipment should re-combine $(A + B)$; conversely, the reproduction of a monophonic tape by stereophonic equipment should give two signals, the sum of which should equal the monophonic signal. Stereophonic recordings should be compatible in this sense. They should therefore be made with the head gaps aligned to a high degree of accuracy. A high degree of uniformity of tape tension should

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* This Recommendation replaces Recommendation 260.

** In conformity with I.E.C. Publication 94, tracks Nos. 1 and 2 are defined as follows: if the tape moves from left to right with the coated side facing away from the observer, and with the leader to the right, the top track is designated No. 1 track, the lower track is designated No. 2 track.

*** In France, an unrecorded space of 2 mm is used.

also be preserved. The equipment should be such that reproduction of a full-width tape recording produces sound pressures equal and in-phase at the two loudspeakers;

4. recording of the signals should not produce a degradation of reproduction likely to affect the high quality required of a stereophonic programme. The technical performance of stereophonic tape recorders should therefore be within the admissible tolerances for an audio frequency chain.

RECOMMENDATION 409 *

MEASUREMENT OF WOW AND FLUTTER IN RECORDING EQUIPMENT AND IN SOUND REPRODUCTION

(Study Programme 161(X))

The C.C.I.R., (Warsaw, 1956—Geneva, 1963)

UNANIMOUSLY RECOMMENDS

1. that two methods, one giving the peak value and the other giving the r.m.s. value, may be used for the measurement of wow and flutter in sound recording equipment;

2. that these measurements should, preferably, be performed at a frequency of 3000 c/s;

3. that the measurements made, with or without the appropriate weighting, should include all flutter and wow frequencies in the range 0·2 c/s to at least 200 c/s;

4. that indications should always be given as to whether the peak, or the r.m.s. value was measured, and if the weighting network was, or was not, in use;

5. that, when measuring the peak value, the following specifications should be complied with:

5.1 frequency of measurement: 3000 c/s ; **

5.2 response curve:

— a flat frequency-response curve between 0·2 and 200 c/s should enable an overall measurement to be made;

— a weighted response curve, as specified in the attached Table I and Fig. 1, gives a value which corresponds closely to the subjective impression.

5.3 *Dynamic characteristics:*

For unidirectional pulses of duration *A*, the meter should indicate the percentage *B* of the reading obtained with a 100 ms pulse:

A — duration of impulse (ms)	10	30	60	100
B — indication (%)	21 ± 3	62 ± 6	90 ± 6	100 ± 4

* This Recommendation replaces Recommendation 210 and Report 116.

** A frequencyof 3150 c/s, corresponding to the proposed I.S.O. Recommendation 402, could also be used.

The return time should be such that, when applying pulses of 100 ms duration with a repetition rate of 1 c/s, the meter should read (40 ± 10) % between the pulses.

5.4 The value indicated should be referred to a sinusoidal modulation. The scale should indicate the wow in ± . . . % (‰), with the figure corresponding to one half the peak-to-peak value.

Note. — For the measurement of the r.m.s. value, further technical specifications, as necessary for comparable results, are under discussion *.

TABLE I

Frequency response curve for weighting network

Frequency (c/s)	Attenuation (db)	Tolerances on attenuation (db)
0·2	−30·6	At 0 p.d.a. 2 c/s : + 10; −4
0·315 0·4	−19·7 −15·0	From 0·315 to 0·5 c/s : ± 4
0·63 0·8 1·0 1·6 2·0	− 8·4 − 6·0 − 4·2 − 1·8 − 0·9	From 0·5 to < 4 c/s : ± 2
4·0	0	At 4 c/s : 0
6·3 10 20 40	− 0·9 − 2·1 − 5·9 −10·4	From > 4 to 50 c/s : ± 2
63 100 200	−14·2 −17·3 −23	From 50 to 200 c/s : ± 4

* In Japan, the following technical specifications are complied with when measuring r.m.s. values:
— frequency of measurement: 3000 c/s
— response curve: same as specified in § 5.2
— dynamic characteristic: exponent of the rectifier used 2 ± 0·2;
integration time of the circuit: more than 5 s.

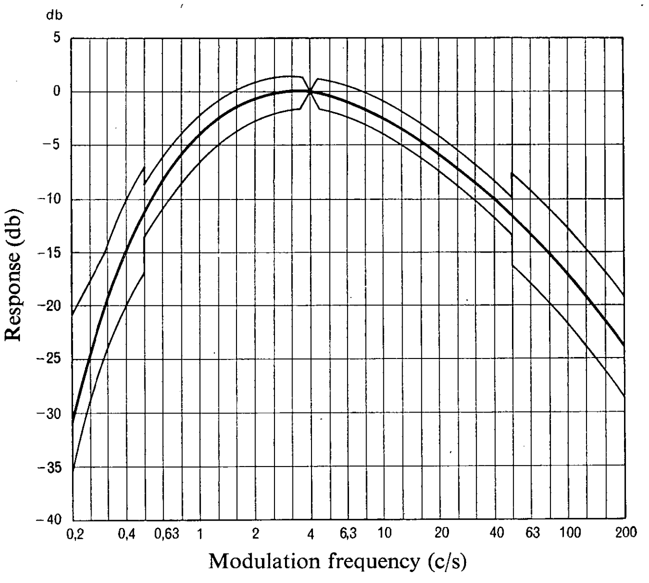


FIGURE 1

Frequency-response curve of weighting network

E. 2 – Radio frequency

RECOMMENDATION 80

HIGH-FREQUENCY BROADCASTING

Directional antennae

(Question 23 (X))

The C.C.I.R., (Geneva, 1951)

CONSIDERING

(a) 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;

(b) 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 differ materially from the frequency for which an array is designed;

(c) 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 design performance :

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 1 kW of power supplied to the antenna *.

RECOMMENDATION 136

SINGLE-SIDEBAND SOUND BROADCASTING

(Question 62)

The C.C.I.R., (London, 1953)

CONSIDERING

(a) that the results of a series of laboratory experiments (see Doc. 305 of London, 1953), on the use of single-sideband (SSB) or asymmetrical sideband (ASB) transmissions for HF (decametric) broadcasting indicate that:

— with present types of HF (decametric) broadcast receivers, no economy in the radio-frequency spectrum can be obtained by changing from double-sideband (DSB) to SSB or ASB transmission;

— a relatively small saving (about 7%) might be obtained by the use of SSB transmissions if substantial improvements were made in the selectivity of receivers, but the modifications could not be applied to receivers already manufactured;

* 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. 24 of Washington as reproduced in Geneva, 1951.

— a greater saving (about 14%) might be obtained by the use of SSB with a " tête-bêche " system of channelling, but this would necessitate elaboration in the design of receivers, which could not be applied to receivers already manufactured;

— closer carrier spacing might be possible if low-pass audio-frequency filters could be added to present receivers, but this would be almost equally true whether applied to the reception of SSB or of DSB transmissions;

(b) that the use of SSB or ASB transmissions for medium-frequency broadcasting would also necessitate considerable modifications to the receivers and, in addition, would reduce the range obtainable for an acceptable distortion from a transmitter of given power:

UNANIMOUSLY RECOMMENDS

that these results should be accepted as a conclusive answer to Question 62.

RECOMMENDATION 205 *

HIGH-FREQUENCY BROADCASTING

Use of synchronized transmitters

The C.C.I.R., (London, 1953 — Warsaw, 1956)

UNANIMOUSLY RECOMMENDS

that two synchronized transmitters at the same site, driven by a common oscillator and modulated by the same programme in the correct phase, may be considered not to introduce any appreciable deterioration in reception:

1. for non-overlapping service areas;

2. for overlapping service areas, provided that due consideration is given to:
— the shape and size of the reception area;
— the availability of suitable antennae with similar transmission characteristics;
— the propagation conditions over the two transmission paths, corresponding to the two antennae.

These considerations become more critical as the transmission distance increases.

RECOMMENDATION 262

HIG-HFREQUENCY BROADCASTING

Effects of closer spacing between carriers

(Question 262 (X))

The C.C.I.R., (Los Angeles, 1959)

UNANIMOUSLY RECOMMENDS

that at least with the majority of receivers in use, the ratio of the wanted-to-unwanted field-strengths to give satisfactory reception (see Note), when two transmitters use carrier fre-

* This Recommendation replaces Recommendation 137.

quencies 5 kc/s apart, should not be considered to be less than when the transmitters use the same frequency (within 50 c/s).

Note. — Satisfactory reception is defined here as a condition when the interference from the unwanted signal can be deemed tolerable.

RECOMMENDATION 410 *

HIGH-FREQUENCY BROADCASTING

Use of more than one frequency per programme

(Question 37)

The C.C.I.R., (Geneva, 1963)

CONSIDERING

that Article 10, No. 643, of the Radio Regulations, Geneva, 1959, states: "... their number (of frequencies) should be the minimum necessary to provide satisfactory reception of the particular programme in each of the areas for which it is intended ...";

UNANIMOUSLY RECOMMENDS

1. that, wherever possible, only one frequency should be used to radiate a particular programme to a given reception area;

2. that in certain special circumstances, namely:

- over certain paths, e.g. very long paths, those passing through the auroral zone, or paths over which the FOT is changing rapidly;
- areas where the depth of the area extending outwards from the transmitter is too great to be served by a single frequency;
- when highly directional antennae are used to maintain satisfactory signal-to-noise ratios, thereby limiting the geographical area covered by such antennae;

it may be found necessary to use more than one frequency per programme;

3. that the decision to use more than one frequency per programme should be made on the merits of the particular case concerned.

RECOMMENDATION 411 **

HIGH-FREQUENCY BROADCASTING

Conditions for satisfactory reception

(Question 39)

The C.C.I.R., (Geneva, 1963)

CONSIDERING

that the International High Frequency Broadcasting Conference, Mexico City, 1948, requested the C.C.I.R. to study certain questions relating to the conditions for satisfactory reception in high-frequency broadcasting:

* This Recommendation replaces Report 118.

** This Recommendation replaces Report 119 and terminates the study of Question 39.

UNANIMOUSLY RECOMMENDS

that the values given in the Table below should be used for the fading factors necessary to ensure a satisfactory signal-to-interference ratio for given percentages of the time.

Ratio (db)	*a*	*b*	*c*	*d*
Wanted-to-unwanted signal	10	13	23	16
Wanted signal-to-atmospheric noise	6	16	22	17
Wanted signal-to-industrial noise	6	10	16	12

Column a : the short-term fading allowance which must be made to ensure that the steady-state ratio is attained for 90% of any given hour.

Column b : 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 c : the sum of the values in columns *a* and *b*, and is the overall variability allowance which must be made to ensure that the steady-state ratio is attained for 90% of any one 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 d : the square root of the sum of the squares of the values (in db) given in columns *a* and *b* and is the overall variability allowance which must be made to ensure that the steady-state ratio is attained for 90% of the time.

Note. — The figures in the above table, relating to the time availability of service, were selected on a theoretical basis and on experience derived principally from medium-wave broadcasting.

RECOMMENDATION 412 *

STANDARDS FOR FREQUENCY-MODULATION SOUND BROADCASTING IN THE VHF (METRIC) BAND

(Question 150)

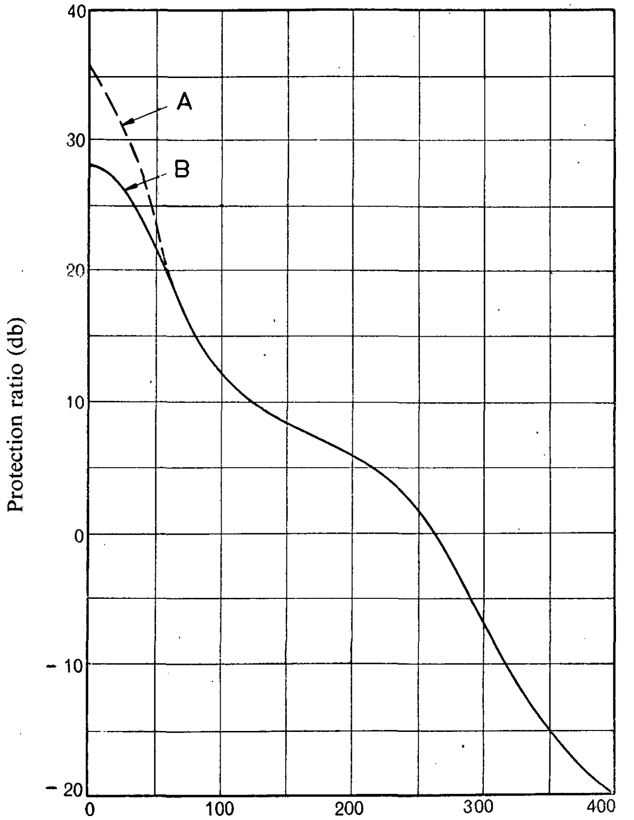
The C.C.I.R., (Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

UNANIMOUSLY RECOMMENDS

that for frequency-modulation sound broadcasting in the VHF (metric) band:

1. the maximum frequency deviation should be either ± 75 kc/s or ± 50 kc/s;
2. the pre-emphasis characteristic should be defined as a curve rising with frequency in conformity with the admittance of a parallel combination of a capacitance and a resistance having a time constant of either 50 or 75 μs;

* This Recommendation replaces Recommendation 263 and terminates the study of Question 150.



Frequency difference between wanted and interfering transmitters (kc/s)

FIGURE 1

Protection ratios required by VHF broadcasting services at frequencies between 87·5 Mc/s and 108 Mc/s using a maximum frequency deviation of ±75 kc/s

Curve A: steady interference — Curve B: tropospheric interference (99% of the time)

3. in the absence of interference from industrial and domestic equipment, a field strength * of at least 50 μV/m can be considered to give an acceptable service;

4. in the presence of interference from industrial and domestic equipment, a satisfactory service requires a median field-strength * of at least:

   — 0·25 mV/m in rural areas,
   — 1 mV/m in urban areas,
   — 3 mV/m in large cities;

5. the protection ratios required to give satisfactory reception for 99% of the time, in systems using a maximum frequency deviation of ± 75 kc/s, are those given by the continuous curve in Fig. 1. For steady interference, it is desirable to provide the higher degree of protection, shown by the dashed curve in Fig. 1.

   The corresponding values for systems using a maximum frequency deviation of ±50 kc/s are given in Fig. 2.

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* Measured 10 m above ground level.

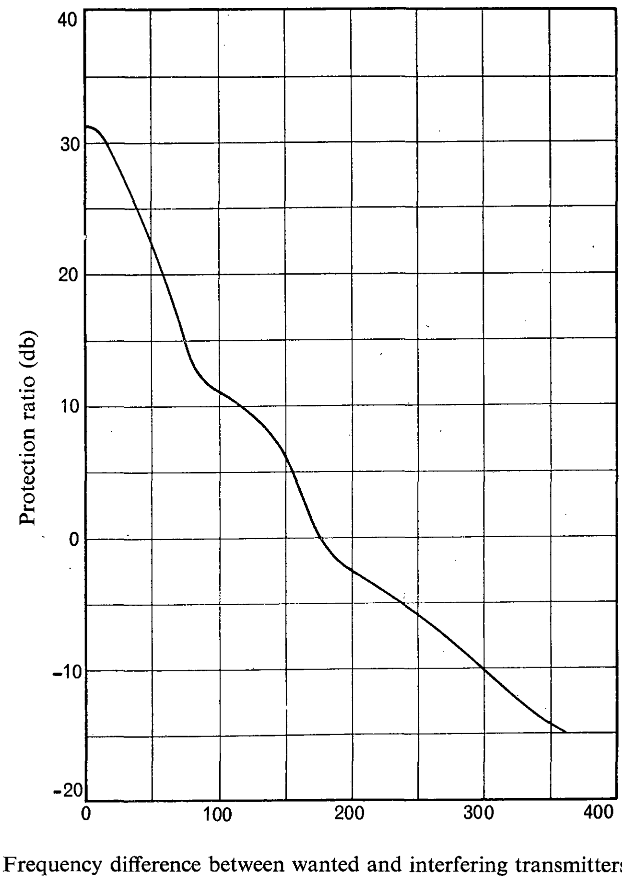

FIGURE 2

Protection ratios required by VHF-FM sound broadcasting services at frequencies below 87·5 Mc/s using a maximum frequency deviation of ±50 kc/s (Tropospheric interference, 99% of the time)

RECOMMENDATION 413

PRESENTATION OF THE RESULTS OF SUBJECTIVE MEASUREMENTS OF PROTECTION RATIOS FOR AMPLITUDE-MODULATION SOUND BROADCASTING

(Question 262 (X) and Question 263 (X))

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that the value of protection ratio, determined as the results of a series of subjective measurements, depends on a large number of parameters;

(b) that, if valid comparisons are to be made between values of protection ratios established by different workers, it is essential that as many as possible of these parameters be standardized:

UNANIMOUSLY RECOMMENDS

1. that, whenever possible, the results of measurements of the protection ratio between two stable amplitude-modulation broadcast signals, should be presented in terms of the following parameters:
   - separation, Δf, between the carrier-frequencies (kc/s) (Δf should lie between 0 and at least 10 kc/s),
   - modulation index, k, of both signals,
   - occupied bandwidth, b,
   - nature of the wanted and the unwanted signals,
   - radio-frequency input voltage of the wanted signal (*RF*),
   - passband of the receiver before demodulation, Δ *RF*,
   - overall response curve of the receiver, including the loudspeaker at audio-frequencies,
   - the grade of listener satisfaction aimed at and the statistical distribution of such grades;

2. that, if all the results cannot be presented as a function of the above parameters, at least some of the results should be presented with respect to the following values:

Δf (kc/s)	k	b	Programmes (wanted and unwanted)	RF input voltage of the wanted signal	ΔRF	Overall frequency response	Listener satisfaction
0 (1) 5 9 10	0·8	±10 kc/s	Light music	0·1–1 mV (2)	5 kc/s at the 6 db points	Flat within ±3 db up to 2·5 kc/s	50%

(1) Within ±20 c/s.

(2) The radio-frequency input voltage should be chosen in such a way that the protection ratios are not significantly affected by non-linearities within the radio-frequency and intermediate-frequency stages of the receiver.

RECOMMENDATION 414

DIRECTIONAL ANTENNAE

Presentation of antenna diagrams

(Question 23 (X))

The C.C.I.R., (Geneva, 1963)

UNANIMOUSLY RECOMMENDS

1. that the new diagrams to be published in the C.C.I.R. Book of Antenna Diagrams be presented in the same form as at present, but that the curves of equal field-strength be expressed in db referred to the maximum instead of in percentages of power;

2. that the curves of equal field-strength be determined by the following values (in db below the maximum):

   0, 1, 2, 3, 4, 6, 8, 10, 13, 16, 20, 25, 30, 40 and ∞

   or at least for some of these values, preferably:

   0, 3, 6, 10, 20, 40 and ∞.

E. 3 – Tropical broadcasting

RECOMMENDATION 48

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

(Question 102 (XII))

The C.C.I.R., (Geneva, 1951)

CONSIDERING

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

(b) that the minimum tolerable ratio of the wanted-to-unwanted signal field-strengths 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, however, mid-spaced frequencies are not assigned it is desirable that the same frequencies should 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, Col. 3, of the Radio Regulations, Geneva, 1959. 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 49

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

(Question 102 (XII))

The C.C.I.R., (Geneva, 1951)

CONSIDERING

(a) the provisions of Art. 14, No. 695, of the Radio Regulations, Geneva, 1959;

(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 antennae 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 139

DESIGN OF TRANSMITTING ANTENNAE FOR TROPICAL BROADCASTING

(Question 70, § 1)

The C.C.I.R., (London, 1953)

CONSIDERING

(a) that it is desirable to use transmitting antennae for tropical broadcasting that cause a minimum of interference outside the service area;

(b) that the antennae should be economical in design and simple in operation;

(c) that Report 301 gives the principles on which antennae for tropical broadcasting should be designed and constructed;

(d) that it is desirable to obtain as much operational data as possible on tropical broadcasting using antennae designed on these principles:

RECOMMENDS

1. that Administrations and organizations operating tropical broadcasting services should use antenna systems so designed that:
   - the power radiated is as large as possible at the high angles of elevation required for the needs of the service area,
   - a sufficient value of radiation should be maintained at angles of elevation necessary to serve the fringe of the service area,
   - the power radiated at angles of elevation lower than those used to serve the fringe of the service area is as low as possible;

2. that Administrations and organizations should forward to the C.C.I.R. reports on the operation of such antennae so that an addendum can be issued to Report 301 giving practical operational data concerning these antennae. The data and information should be forwarded in the following form:
   - type of antenna system used and its physical dimensions in relation to the frequency of operation;
   - electrical characteristics—polar diagram in the vertical and the horizontal planes;
   - power radiated by the antenna;
   - siting of the antenna with respect to the geographical configuration of the area to be served and the orientation of the antenna with respect to North;

— hourly averages of field strength measured, whenever practicable, every 100 or 200 km, up to a maximum distance of 2000 km in all directions;
— fading characteristics of the received signal;
— influence, if any, of the orientation of the antenna with respect to the magnetic meridian;
— ground conductivity in the vicinity of the antenna system;
— any other information considered useful in respect of this Recommendation.

RECOMMENDATION 140

DESIGN OF RECEIVING ANTENNAE FOR TROPICAL BROADCASTING

(Question 70, § 3)

The C.C.I.R., (London, 1953)

CONSIDERING

(a) that only simple antennae are practicable for the great majority of domestic tropical broadcast listeners;

(b) that the antenna has to be both cheap and simple to install and that it has to be used on a number of frequencies with fields at varying angles of incidence:

RECOMMENDS

1. that the directivity of receiving antennae cannot be relied upon to improve the signal-to-noise ratio;

2. that it appears reasonable to assume that the antenna of the average listener cannot be better than that given in the Report of the Geneva Planning Committee (1948), which consisted of an " L " type antenna with horizontal and vertical limbs, each 16 feet in length (4·90 metres).

RECOMMENDATION 214 *

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

(Question 102 (XII))

The C.C.I.R., (Geneva, 1951 — Warsaw, 1956)

CONSIDERING

(a) that the power of transmitters for radio services in the tropical zone, operating within the bands shared with tropical broadcasting (Art. 7, No. 425 of the Radio Regulations, Geneva, 1959), should be determined 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;

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* This Recommendation replaces Recommendation 47.

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

(d) that Recommendation 215 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 216 read in conjunction with Report 302;

(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 should be imposed on the power of radiotelegraph stations operating within the shared bands other than those necessary to comply with the provisions of Section I, Art. 14 of the Radio Regulations, Geneva, 1959;

2. that, for the general case involving the 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.

RECOMMENDATION 215 **

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

(Questions 27 and 102(XII), Study Programme 112(XII), Recommendation 214)

The C.C.I.R., (Warsaw, 1956)

CONSIDERING

(a) that the prolonged observations and studies which have been carried out confirm the existence of high noise levels in tropical zones;

(b) that good quality service pre-supposes the maintenance of a satisfactory value of signal-to-noise ratio in the entire service zone, which the provisional power limits mentioned in Recommendation 84 cannot ensure, with appropriate coverage up to 800 km;

(c) that the high value of noise level observed in tropical regions during certain hours of the day and certain periods of the year, together with the need for signal-to-noise ratios such as to ensure a satisfactory service for practically all listeners within the specified service area, tends to suggest the use of a high transmitter-power for tropical broadcasting services. It is therefore advisable, when evaluating the powers to be used, to assume reasonable values for

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* See P.F.B. Doc. 712, dated 14th February, 1950.

** This Recommendation replaces Recommendation 84. France, the United Kingdom (for § 1.3), the Overseas Territories of the French Republic, Turkey (for § 1.3) and the Republic of South Africa reserved their opinions on this Recommendation.

*** As defined in the " considerings " of Question 27, given in the Annex to Study Programme 112(XII), for this service.

the average noise level and signal-to-noise ratio to reach practical values of transmitter powers, ensuring acceptable conditions of reception for a suitable percentage of transmission time at the limit of the service area;

(d) that, when the service zone is limited to 400 km, vertical incidence antennae may be used effectively to concentrate the energy in the service zone and to reduce radiation beyond this zone;

(e) that, for greater distances, it appears necessary to use types of antenna with low gain, such as a simple dipole, to obtain the required field strength at a distance of 800 km. Nevertheless, this type of antenna radiates at low angles of elevation and may give rise to interference at great distances;

(f) that it is advisable to make a judicious choice of transmitting frequencies which, for a tropical broadcasting programme, may be located in the shared bands the upper limit of which is 5060 kc/s and in the HF (decametric) broadcast bands above 5060 kc/s:

RECOMMENDS

1. that the upper power limit for the unmodulated carrier wave of short-distance high-frequency broadcasting transmitters employing double-sideband emission, operating in the tropical zones should be determined as follows;

1.1 for a service area limited to 400 km, the nominal power of the transmitter should not exceed 10 kW;

1.2 for a service area limited to 800 km, the nominal power of the transmitter should not exceed 30 kW;

the powers mentioned in § 1.1 and 1.2 are for frequencies below 5060 kc/s used in tropical broadcasting for such ranges;

1.3 for frequencies above 5060 kc/s, where tropical broadcasting services use the same frequency bands as the high-frequency broadcasting services, the same power limit as recommended by the Mexico City Conference (1949) shall apply;

2. that, within the above limits, Administrations should use, as far as possible, lower powers, if these will assure satisfactory service throughout the reception area;

3. 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 bands), to provide as good a received signal-to-noise ratio as possible;

4. that, in conformity with the provisions of Recommendation 139, and to make the best possible use of the frequency bands which have been allocated, Administrations should use appropriate antennae, so that radiations at low angles be reduced to a minimum, to avoid all harmful interference outside the service zone.

RECOMMENDATION 216 *

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

(Question 102 (XII))

The C.C.I.R., (Geneva, 1951 — London, 1953 — Warsaw, 1956)

CONSIDERING

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

(b) that the 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 strength 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. 7, No. 423, of the Radio Regulations, Geneva, 1959;

RECOMMENDS

1. that, for the present and wherever practicable in the tropical zone, the ratio of median wanted broadcasting carrier to median unwanted carrier shall be 40 db, to provide a signal-to-interference ratio of not less than 23 db for 90% of the hours and 90% of the days (ref: Doc. 635, § 13 of Mexico City, 1948/49) ***;

2. that the protection ratio thus defined should be measured at the output of a receiver provided with a filter 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 μV/m 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. 117, § 5, of the Radio Regulations, Geneva, 1959.

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* This Recommendation replaces Recommendation 138.

** See Report 302.

*** Doc. 43 of Washington, 1950, refers in particular to the effect of long and short term fading.

**** Pratical consideration of the frequency separation of adjacent channels requires the use of an audio-frequency cut-off of 5 kc/s in the measurement in preference to 6 · 4 kc/s, appropriate corrections being applied, if considered necessary, to correspond to an audio-frequency cut-off of 6 · 4 kc/s.

RECOMMENDATION 415

PERFORMANCE SPECIFICATIONS FOR LOW-COST SOUND BROADCASTING RECEIVERS

(Study Programme 170(XII))

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) Recommendation No. 7 of the Administrative Radio Conference, Geneva, 1959;

(b) that the advantages of broadcasting should be made more easily available to the populations of the countries where, at present, the density of receivers is particularly low due to economic, geographic or technical reasons;

(c) that to this end, it is desirable that efficient broadcasting receivers should be available at prices low enough to secure their wide distribution in those countries;

(d) that general agreement on the performance of suitable broadcasting receivers would prove most useful to radio receiver manufacturers by assisting them to produce suitable receivers, having an agreed adequate standard of performance, at the lowest possible cost:

UNANIMOUSLY RECOMMENDS

that the minimum performance specifications, contained in the Annex, be used to assist in the design and development of low-cost sound broadcasting receivers suitable for production in large quantities.

ANNEX

These specifications apply to the following types of receivers:

Type A: a low sensitivity MF receiver,

Type B: a combined MF/HF receiver,

Type C: a medium sensitivity VHF–FM receiver.

1. General

1.1 Each of the three types of receivers should be available for either mains or battery operation. For battery operation, all three types of receivers should be fully transistorized to ensure economy of power consumption. For mains operation, either valves or transistors may be used, considerations of cost being the guiding factor.

1.2 For battery operated receivers, the minimum performance specifications listed in this Recommendation should be achieved for the nominal battery voltage less 30% as specified in the relevant I.E.C. publication.

1.3 The methods of measurement employed should be those recommended in the relevant I.E.C. publications for amplitude-modulation receivers and frequency-modulation receivers.*

1.4 The receivers should be simple, robust and well protected against dust. Those intended for use in regions of high temperature and humidity should be treated so that they can be used under the climatic conditions laid down by the Administration concerned. The appropriate tests required by the Administration procuring such receivers should comply with the relevant I.E.C. publications.

* See Recommendation 237.

1.5 If national regulations prescribe methods of measurement or tests differing from the standard I.E.C. methods, Administrations will, where necessary, draw attention to this.

2. Specification for Type A receivers

2.1 Frequency coverage: 525–1605 kc/s

2.2 Sensitivity for 50 mW output 30% modulation at 400 c/s: 5 mV/m **

2.3	Signal/noise ratio for input as under § 2.2	20 db (mains-operated tube receivers) 26 db (transistor receivers)
2.4	Power output, for less than 10% distortion	not less than 0·1 W
2.5	Overall selectivity	
	at – 6 db points	passband not less than ± 3 kc/s
	at – 20 db points	passband not greater than ± 10 kc/s
2.6	Image, intermediate frequency and spurious response ratio	not less than 30 db
2.7	Overall fidelity including acoustic response of loudspeaker	250–3150 c/s, within 18 db limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–4000 c/s within 12 db limits (in a graphical presentation 400 c/s should be taken as the reference 0 db level)

3. Specification for Type B receiver (the two types differing only in frequency range)

3.1	Frequency coverage	B1 } 0·525–1·605; 2·3–16 ** Mc/s B2 } 0·525–1·605; 2·3–21·75 ** Mc/s
3.2	Sensitivity for 50 mW output 30% modulation at 400 c/s	not worse than 150 μV
3.3	Signal-to-noise ratio, for input as under § 3.2	20 db (mains-operated tube receivers) 26 db (transistor receivers)
3.4	Power output, for less than 10% distortion	not less than 0·1 W
3.5	Overall selectivity	
	at – 6 db points	passband not less than ± 3 kc/s
	at – 20 db points	passband not greater than ± 10 kc/s
	at – 40 db points	passband not greater than ± 20 kc/s
3.6	Image, intermediate frequency and spurious response ratio	MF — not less than 30 db
	Intermediate frequency and spurious response ratio	HF — not less than 12 db
	Image response ratio	HF — not less than 5 db

* Assumes a built-in antenna with facilities for using an external antenna.

** The receiver shall be provided with adequate mechanical and/or electrical means for easy tuning.

3.7	Overall fidelity including acoustic response of loudspeaker	250–3150 c/s within 18 db limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be	100–4000 c/s within 12 db limits (in a graphical presentation 400 c/s should be taken as the reference 0 db level)
3.8	A.g.c. performance: change in output when the input is reduced by 30 db from 0·1 V	not greater than 10 db
3.9	Frequency stability	must be such that the receiver does not require frequent retuning

4. Specification for Type C receivers

4.1	Frequency coverage	87·5–108 Mc/s
4.2	Signal-to-noise ratio	30 db
4.3	Sensitivity (noise limited)	− 75 db rel. 1 mW (at a signal-to-noise ratio of 30 db and 50 mW output power)
4.4	Intermediate frequency	10·7 Mc/s
4.5	AM suppression ratio	20 db
4.6	Power output	not less than 0·1 W
4.7	Overall selectivity	− 30 db at ± 300 kc/s
4.8	Overall fidelity including acoustic response of loudspeaker	200–5000 c/s, within 18 db limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–5000 c/s within 6 db limits (in a graphical presentation 400 c/s should be taken as the reference 0 db level)
4.9	Radiation	The local oscillator radiation should be less than the limits specified by C.I.S.P.R. However, where national regulations exist, the radiation should be less than the limits specified therein.
4.10	Distortion	The distortion should be less than 5% for a frequency deviation varying between ± 15 kc/s and ± 75 kc/s with a modulation frequency of 400 c/s and an output power of 50 mW
4.11	Frequency stability	Must be such that the receiver does not require frequent retuning.

RECOMMENDATION 416

PERFORMANCE SPECIFICATIONS FOR LOW-COST SOUND BROADCASTING RECEIVERS FOR COMMUNITY LISTENING

(Study Programme 170 (XII))

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) Recommendation No. 7 of the Administrative Radio Conference, Geneva, 1959;

(b) that community receivers provide the easiest method of making broadcasting available to the populations of those countries where, at present, the density of receivers is particularly low due to economic, geographical or technical reasons:

UNANIMOUSLY RECOMMENDS

that the minimum performance specifications, contained in the Annex, be used to assist in the design and development of low-cost community receivers.

ANNEX

1. General

1.1 The receiver should be simple, robust and well protected against dust. It should also be strong enough to withstand transport and handling by unskilled persons.

1.2 The pre-set tuning controls should be available only to authorized persons. The controls should be robust and include a channel selection switch, a fine tuning control to facilitate accurate tuning and compensate for any frequency drift during operation, and a volume control.

1.3 Each of the two types of receivers considered in § 2 and 3 should be available for either mains or battery operation. For battery operation, the receivers should be fully transistorized to ensure economy of power consumption. For mains operation, either valves or transistors may be used, considerations of cost being the guiding factor.

1.4 For battery-operated receivers, the minimum performance specifications listed in this Recommendation should be achieved for the nominal battery voltage less 30% as specified in the relevant I.E.C. publication.

1.5 The methods of measurement employed should be those recommended in the relevant I.E.C. publications for amplitude-modulation and frequency-modulation receivers.*

1.6 The receivers, which are intended for use in regions of high temperature and humidity, should be treated so that they can be used under the climatic conditions laid down by the Administration concerned. The appropriate tests required by the Administration procuring such receivers should comply with the relevant I.E.C. publication.

1.7 If national regulations prescribe measuring methods or tests different from the standard I.E.C. methods, the Administrations will, where necessary, draw attention to this.

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* See Recommendation 237.

2. Specification for MF/HF community receiver

(Two types, differing only in frequency range)

2.1	Frequency coverage in Mc/s	*(a)* 0·525–1·605; 2·3–21·75; *(b)* 0·525–1·605; 2·3– 9·775;

2.1.1 Receiver tuning may be fully bandspread on the broadcast bands appropriate to the requirements of any Administration or the receiver should be capable of being coarse pre-tuned to any spot frequency in;

— the medium frequency band and

— each of the high-frequency bands;

with the provision that a limited number of spot frequencies (e.g. three), selected from the high frequency bands, are made available for ready selection at any time, by the operator.

2.2	Sensitivity for 50 mW output 30% modulation at 400 c/s	not worse than 150 μV
2.3	Signal/noise ratio for input as under § 2.2	26 db
2.4	Power output for less than 10% distortion	not less than 900 mW (at nominal mains or battery voltage) and not less than 400 (at the nominal battery voltage less 30%)
2.5	Overall selectivity	
	at — 6 db points	passband not less than ± 3 kc/s
	at — 20 db points	passband not greater than ± 10 kc/s
	at — 40 db points	passband not greater than ± 20 kc/s
2.6	Image, intermediate frequency and spurious response ratio	MF — not less than 30 db
	Intermediate frequency and spurious response ratio	HF — not less than 12 db
	Image response ratio	not less than 10 db (HF up to 10 Mc/s)
	Image response ratio	not less than 5 db (HF up to 21·75 Mc/s)
2.7	Overall fidelity including acoustic response of loudspeaker	250–3150 c/s, within 18 db limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–4000 c/s within 12 db limits (in a graphical presentation 400 c/s should be taken as the reference 0 db level)
2.8	A.g.c. performance: change in output when the input is reduced by 30 db from 0·1 V	not greater than 10 db
2.9	Frequency stability	must be such that the receiver does not require frequent retuning

3. Specification for VHF community receiver

3.1	Frequency coverage	87·5–108 Mc/s *
3.2	Signal-to-noise ratio	30 db
3.3	Sensitivity (noise limited)	– 85 db rel. 1 mW (at a signal-to-noise ratio of 30 db and 50 mW output power)
3.4	Intermediate frequency	10·7 Mc/s
3.5	AM suppression ratio	24 db
3.6	Power output	Not less than 900 mW (at nominal mains or battery voltage) and not less than 400 (at the nominal battery voltage less 30%)
3.7	Overall selectivity	– 30 db at ± 300 kc/s
3.8	Overall fidelity including acoustic response of loudspeaker	200–5000 c/s, within 18 db limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–5000 c/s within 6 db limits (in a graphical presentation 400 c/s should be taken as the reference 0 db level)
3.9	Radiation	The local oscillator radiation should be less than the limits specified by C.I.S.P.R. However, where national regulations exist, the radiation should be less than the limits specified therein
3.10	Distortion	The distortion should be less than 5% for a frequency deviation varying between ± 15 kc/s and ± 75 kc/s with a modulation frequency of 400 c/s and an output power of 50 mW
3.11	Frequency stability	Must be such that the receiver does not require frequent retuning.

* Provision must be made for one or more channels to be pre-selected.

E. 4 – Television

RECOMMENDATION 212 *

TELEVISION STANDARDS

The C.C.I.R., (Geneva, 1951 — Warsaw, 1956)

CONSIDERING

that, at its Vth Plenary Assembly, the C.C.I.R. recommended a study of television standards to facilitate the interchange of programmes and to co-ordinate the design of receivers:

UNANIMOUSLY 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-sideband 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—sideband, 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 sideband 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 the gamma characteristic of the radiated signal should be lower than unity, to take account of the signal/brightness characteristic of the average receiving picture tube;

12. 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 §§ 8 and 9 of this Recommendation may be implemented for these transmitters, taking into account any modifications that might be necessary to existing receivers.

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* This Recommendation replaces Recommendation 82.

RECOMMENDATION 266

PHASE CORRECTION OF TELEVISION TRANSMITTERS NECESSITATED BY THE USE OF VESTIGIAL-SIDEBAND TRANSMISSION

The C.C.I.R., (Los Angeles, 1959)

CONSIDERING

(a) that the transmission of television signals using vestigial-sideband techniques gives rise to distortion;

(b) that this distortion consists of linear distortions (in-phase errors) and non-linear distortions (quadrature errors);

(c) that with average pictures, the depths of modulation are low and thus the non-linear distortion is less visible than the linear distortion;

(d) that these linear distortions arise partly from the transmitter and partly in the receiver;

(e) that due regard has to be paid for future design and development of television receivers as well as to the differing degrees of phase errors in existing receivers:

UNANIMOUSLY RECOMMENDS

1. that linear pre-correction shall be introduced into the television picture transmitter, so as to compensate for that part of the linear distortion arising from the errors in the radiated signal;

2. that the television picture transmitter may also introduce a correction to compensate for linear distortions arising in the receiver, but this correction shall not exceed one half of that necessary to compensate a receiver using normal minimum phase shift networks and with an amplitude characteristic corresponding to the television standard concerned;

3. that the pre-correction allowed in § 2, applies only to frequencies between zero and up to approximately half the video bandwidth.

RECOMMENDATION 417

MINIMUM FIELD STRENGTHS FOR WHICH PROTECTION MAY BE SOUGHT IN PLANNING A TELEVISION SERVICE

The C.C.I.R. (Geneva, 1963)

UNANIMOUSLY RECOMMENDS

1. that *when planning a television service* in bands I, III, IV or V the median field strength for which protection against interference is planned should never be lower than:

Band	I	III	IV	V
db rel. 1 μV/m	+ 48	+ 55	+ 65 *	+ 70 *

* The figures shown for bands IV and V should be increased by 2 db for the 625-line (I.B.T.O.) system.

2. that the percentage of time for which the protection may be sought should lie between 90 and 99.

Note 1.—In arriving at these figures, it has been assumed that, in the absence of interference from other television transmissions and man-made noise, the minimum field strengths at the receiving antenna, that will give a satisfactory grade of picture, taking into consideration receiver noise, cosmic noise, antenna gain and feeder loss, are + 47 db relative to 1 μV/m in band I, + 53 db in band III, + 62 * db in band IV and + 67 * db in band V.

Note 2.—In a practical plan, because of interference from other television transmissions, the field strengths that can be protected will generally be higher than those quoted in § 1 and the exact values to be used in the boundary areas between any two countries should be agreed between the Administrations concerned.

RECOMMENDATION 418 **

RATIO OF THE WANTED-TO-UNWANTED SIGNAL IN MONOCHROME TELEVISION

(Question 267 (XI))

The C.C.I.R. (Geneva, 1963)

UNANIMOUSLY RECOMMENDS

that the protection ratios given in the Annex should be used for planning purposes.

ANNEX

1. Introduction

The protection ratios quoted are considered to be acceptable for planning purposes for a small percentage of the time, not precisely defined, but assumed to be between 1% and 10%. Protection ratios for just perceptible interference would be some 10 to 20 db higher.

When making use of the protection ratios in planning, suitable allowance for fading is made by using field strength curves appropriate to the percentage of time for which protection is desired, it being assumed that fading of the wanted signal is small, compared with that of the unwanted signal.

The protection ratios quoted refer in all cases to the ratios at the input to the receiver, no account having been taken of the effect of using directional receiving antennae or of the advantage that can be obtained by using different polarization for transmission of the wanted and unwanted signals.

The amplitude of a vision-modulated signal is defined as the r.m.s. value of the carrier at peaks of the modulation envelope, while that of a sound-modulated signal is the r.m.s. value of the unmodulated carrier, both for amplitude-modulation and for frequency-modulation.

All the protection ratios quoted in this Annex refer to interference from a single interfering source.

The full advantage of offset operation can only be obtained if the carrier frequencies of the transmitters concerned are within ± 500 c/s of their nominal values.

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* The figures shown for bands IV and V should be increased by 2 db for the 625-line, I.B.T.O. system.

** This Recommendation replaces Report 125.

2. Interference within the same channel

2.1 *Protection ratio when the wanted and unwanted signals have the same line freqency*

2.1.1 *Carriers separated by less than 1000 c/s, but not synchronized :*
Protection ratio: 45 db.*

2.1.2 *Carriers separated by less than 50 c/s, but not synchronized :*
Protection ratio reduced by 5 to 10 db, relative to the preceding case.

2.1.3 *Nominal carrier frequencies separated by 1/3, 2/3, 4/3 or 5/3 of the line frequency :*

Protection ratio: — for 405-line system: 35 db;
— for 525-line system: 28 db;
— for 625- and 819-line systems: 30 db.

These values may be reduced to 28 db, 20 db and 20 db respectively, if a carrier separation equal to an appropriate multiple of the frame frequency can be maintained; the line frequency should be kept constant to within 5×10^{-6} and each transmitter should have a frequency tolerance of not more than $\pm 2 \cdot 5$ c/s.

The 20 db value is at present valid for the 525- and 625-line systems when there is one unwanted transmitter. Under these conditions, the ratio between the wanted and unwanted sound signals will also be 20 db, and this is permissible only if the offset is at least 5/3 of the line frequency for frequency-modulated sound (see § 6.1), or above the audio-frequency range for amplitude-modulation sound (see § 6.2).

2.1.4 *Nominal carrier frequencies separated by 1/2 or 3/2 of the line frequency*

Protection ratio: — for 405-line system: 31 db;
— for 525-, 625- and 819-line systems: 27 db.

2.2 *Protection ratio for the picture signal when the wanted and unwanted signals have different line frequencies*

2.2.1 *Carriers separated by less than 1000 c/s, but not synchronized :*
Protection ratio: 45 db.

2.2.2 *Carriers separated by less than 50 c/s, but not synchronized :*
Protection ratio reduced by 5 to 10 db relative to the preceding case.

2.2.3 *Nominal carrier frequencies separated by 6·3 kc/s :*

Protection ratio between a 625-line system and an 819-line system: 30 db.

3. Adjacent-channel interference

Throughout this section, fairly conservative values have been chosen to take account of the divergence in performance between different types of television receivers and to allow for the possible introduction of colour.

3.1 *Lower ** adjacent-channel interference — bands I and III*

The worst interference on the picture signal from another signal using the same standard results from the sound signal in the lower ** adjacent channel. The figures below relate to the cases where the separation between the wanted vision carrier frequency and the unwanted

* This value may be reduced by about 20 db for the 525-line system, if a carrier separation of a few hundred cycles per second is maintained at an appropriate multiple of the frame frequency with a variation in carrier frequency difference less than 1½ cycles per second.

** Upper, for the 405-line standard, since the vestigial sideband lies above the vision carrier frequency.

sound carrier frequency is 1·5 Mc/s and the ratio between the unwanted vision and unwanted sound powers is 7 db. The ratios are expressed in terms of the wanted and unwanted vision signals.

Protection ratio: — for frequency-modulated sound carrier: – 6 db;
— for amplitude-modulated sound carrier: – 2 db.

3.2 *Lower adjacent-channel interference — Bands IV and V*

Protection ratio: — for the 525-line system in a 6 Mc/s channel: – 6 db.

For the various 625-line systems proposed for use in 8 Mc/s channels in bands IV and V, the following table gives the protection required by a signal on any system against a lower adjacent-channel signal of the same or any of the other standards. The protection ratios quoted are those to be applied between the wanted and unwanted vision signal levels.

Interfering signal standard *	Protection ratio (db) for a wanted-signal standard:					Vision/sound power ratio (db) for interfering signal
	G	*H*	*I*	*K* (1)	*L*	
G	– 6	– 6	– 6	– 6	– 6	7
H	– 6	– 6	– 6	– 6	– 6	7
I	– 6	– 6	– 6(2)	– 6	+ 3(2)	7
K	– 6	+ 16	+ 16	– 6	+ 16	7
L	– 4	+ 18	+ 18	– 4	+ 18	9

(1) Administrations using system *K* in bands I and III are studying the possibility of broadening the vestigial sideband to 1·25 Mc/s for use in bands IV and V without changing the other parameters of the systems. In this case, the protection ratios required for system K would be the same as those quoted for the 625-line system L.

(2) The values for systems *I* and *L* are different in this case, because receivers for system *I* will contain a sound trap giving additional rejection at the frequency of the interference.

Note : When an interfering frequency-modulated sound signal is offset, during quiescent periods, erlative to the wanted vision signal by a frequency equal to a multiple of the line frequency plus or minus about one-third line frequency, the protection ratio may be reduced by 6 db. For an interfering amplitude-modulated sound signal with the carrier offset in a similar way the reduction may be greater.

3.3 *Upper ** adjacent-channel interference — bands I, III, IV and V*

Protection ratio:

— for system *K*: 4 db;

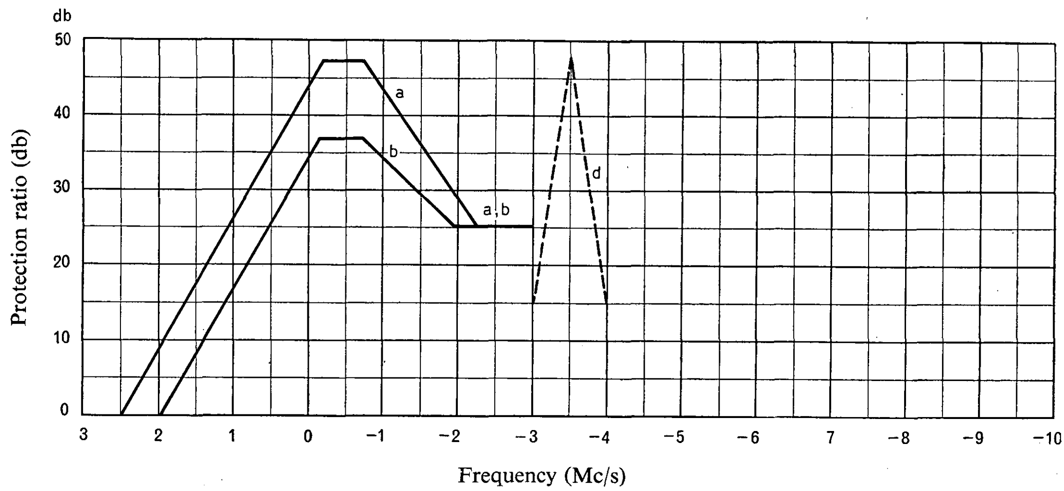
— for all other systems: – 12 db.

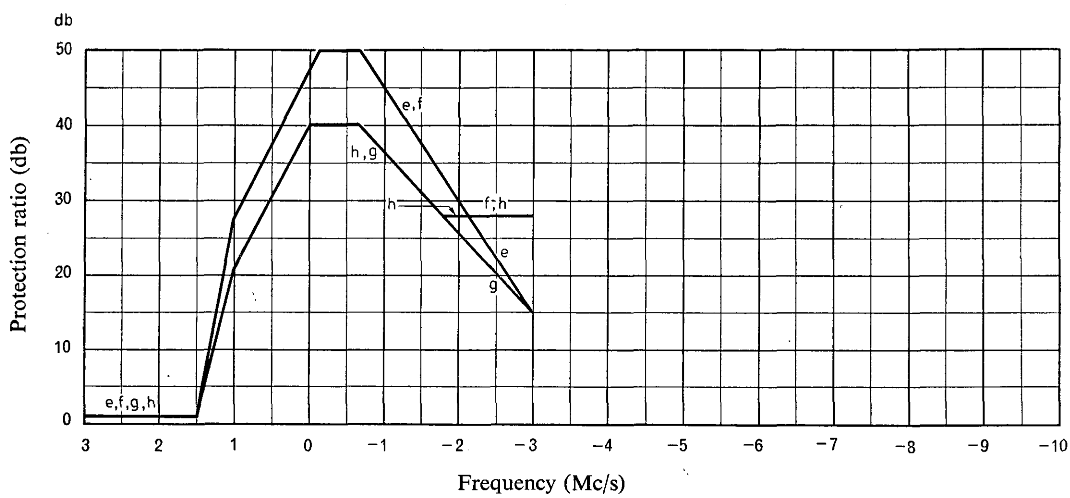
4. Overlapping-channel interference

Fig. 1 to 9 give protection ratios for the 405, 525, 625 and 819-line systems when a CW signal or the carrier of an interfering sound or vision signal lies within the channel of the wanted transmission.

* See Report 308.

** Lower, for system *A* in bands I and III.


db
50
40
30
20
10
0
Protection ratio (db)
a
b
a, b
d
3
2
1
0
−1
−2
−3
−4
−5
−6
7
−8
−9
−10
Frequency (Mc/s)


db
50
40
30
20
10
0
Protection ratio (db)
e, f
h, g
h
f; h
e
g
e, f, g, h
3
2
1
0
−1
−2
−3
−4
−5
−6
−7
−8
−9
−10
Frequency (Mc/s)

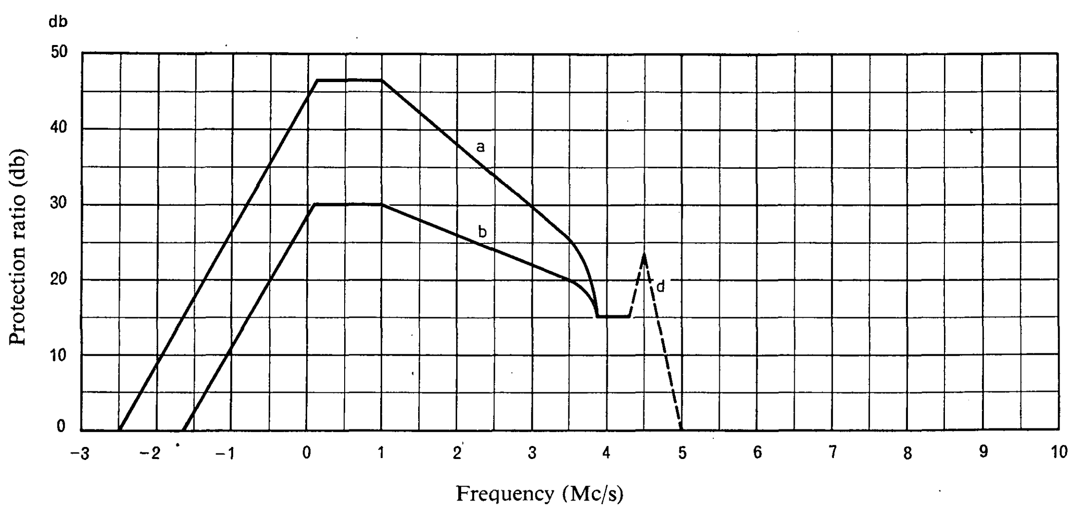

db
50
40
30
20
10
0
Protection ratio (db)
a
b
d
−3
−2
−1
0
1
2
3
4
5
6
7
8
9
10
Frequency (Mc/s)

FIGURE 1

System A. Protection from vision signal interference

In all cases in this figure, the ratios quoted are those between the wanted and the unwanted vision evels.

Curve *a* — Interference to vision from a 405-, 625-, or 819-line vision signal with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

Curve *b* — Interference to vision from a 405-, 625-, or 819-line vision signal when the nominal frequency difference between the carriers of the wanted and unwanted signals is a multiple of the line frequency (10·125 kc/s) plus or minus 3 to 5 kc/s. If the nominal frequency difference is 1/2 or 3/2 of the line frequency, a protection ratio of 31 db may be accepted (see § 2.1.4).

Curve *d* — Interference to sound signal from a 405-, 625-, or 819-line vision signal.

FIGURE 2

System A. Protection from CW or sound-signal interference

In all cases in this figure, the ratios quoted are those between the wanted vision and the unwanted sound levels.

Curve *e* — Interference to vision from a CW or frequency-modulated sound signal with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

Curve *f* — Interference to vision from an amplitude-modulated sound signal with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

Curve *g* — Interference to vision from a frequency-modulated sound signal when the nominal frequency difference between the wanted-signal carrier and the interfering-sound carrier, during quiescent periods, is an odd multiple of half the line-frequency (5·0625 kc/s).

Curve *h* — Interference to vision from an amplitude-modulated sound signal when the nominal frequency difference between the carriers of the wanted and unwanted signals is an odd multiple of half the line-frequency (5·0625 kc/s).

FIGURE 3

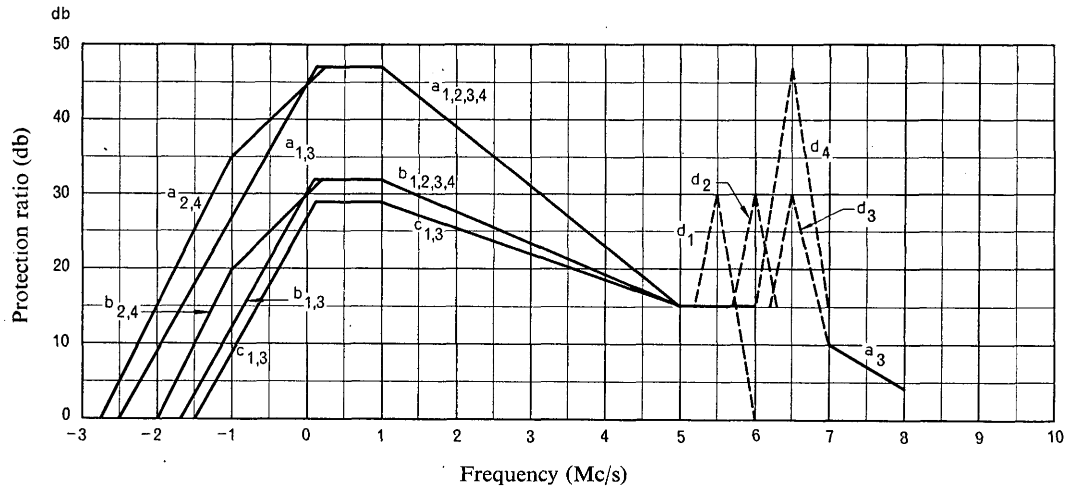
System M. Protection from vision signal interference

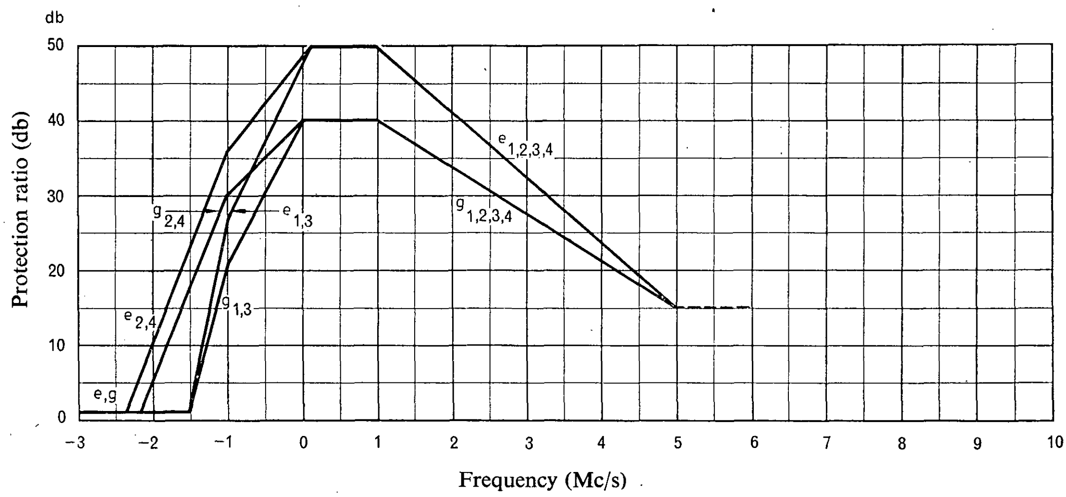
In all cases in this figure, the ratios quoted are those between the wanted and the unwanted vision signals.

Curve *a* — Interference to vision from another 525-line vision signal with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

Curve *b* — Interference to vision from another 525-line vision signal when the nominal frequency difference between the carriers of the wanted and unwanted signals is a multiple of the line frequency (15·75 kc/s) plus or minus one-third of the line frequency (5·25 kc/s).

Curve *d* — Interference to sound signal from a 525-line vision signal.


db
Protection ratio (db)
Frequency (Mc/s)
a 1,2,3,4
a 1,3
a 2,4
b 1,2,3,4
b 1,3
b 2,4
c 1,3
d 1
d 2
d 3
d 4
a 3


db
Protection ratio (db)
Frequency (Mc/s)
e 1,2,3,4
g 1,2,3,4
g 2,4
e 1,3
e 2,4
g 1,3
e,g

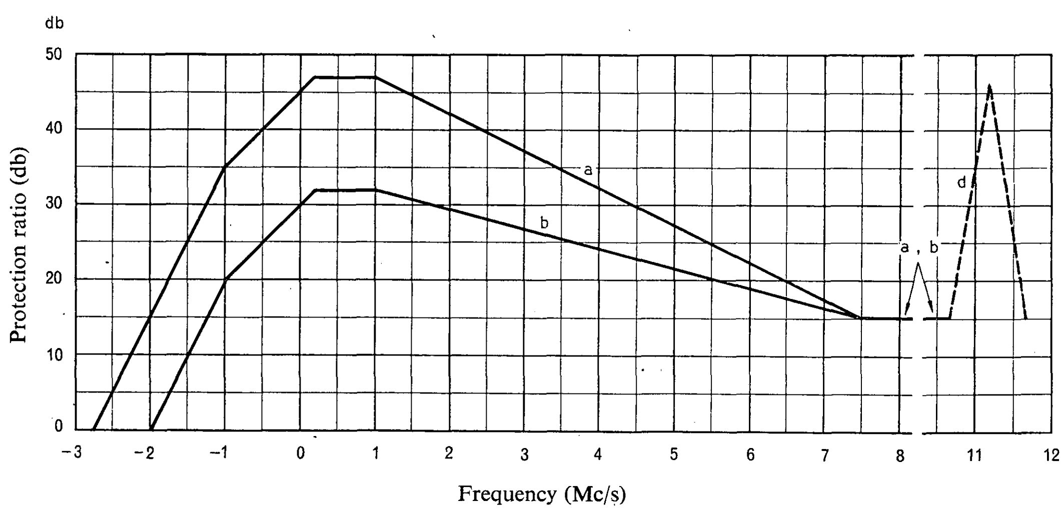

db
Protection ratio (db)
Frequency (Mc/s)
a
b
a , b
d

FIGURE 4

625-line system. Protection from vision-signal interference

In all cases in this figure, the levels quoted are those between the wanted and unwanted vision levels. The subscript numbers used on the curves indicate the various applications of the 625-line system:

1 — 625 lines; 2 — system *I*; 3 — system *K* *; 4 — system *L*.

Curve *a* — Interference to vision from 405-, 625-, or 819-line systems vision signal, with no special control of the nominal frequency-difference between the carriers of the wanted and unwanted signals.

Curve *b* — Interference to vision from a 625-line vision signal when the nominal frequency difference between the carriers of the wanted and unwanted signals is a multiple of the line-frequency (15·625 kc/s), plus or minus one-third of the line-frequency (5·208 kc/s).

Curve *c* — Interference to vision from a 625-line vision signal when the nominal frequency difference between the carriers of the wanted and unwanted signals is an odd multiple of half the line-frequency (7·8125 kc/s).

Curve *d* — Interference to sound from a 625-line vision signal.

* If a vestigial sideband of 1·25 Mc/s is used in system *K*, curves a_4 and b_4 should be used instead of curves a_3 and b_3 and curve c_3 is no longer valid.

FIGURE 5

625-line system. Protection from CW or sound-signal interference

In both cases in this figure, the ratios quoted are those between the wanted vision and the unwanted sound levels.

The subscript numbers are used on the curves to indicate the variations applicable to the various 625-line systems as follows:

1 — 625 lines; 2 — system *I*; 3 — system *K* *; 4 — system *L*.

Curve *e* — Interference to vision from a CW or frequency-modulated sound signal, with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals. For amplitude-modulation of the interfering sound signal, the protection ratios should be increased by 4 db.

Curve *g* — Interference to vision from a frequency-modulated sound signal, when the nominal frequency difference between the wanted signal carrier and the sound carrier during quiescent periods is an odd multiple of half the line-frequency (7·8125 kc/s).

* If a vestigial sideband of 1.25 Mc/s is used in system *K*, curves e_4 and g_4 should be used instead of curves e_3 and g_3.

FIGURE 6

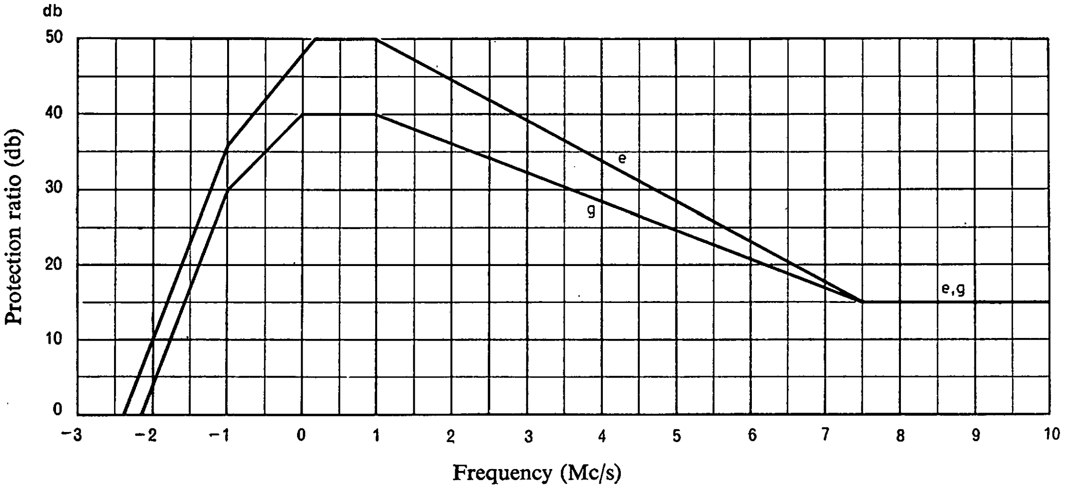
System E. Protection from vision-signal interference

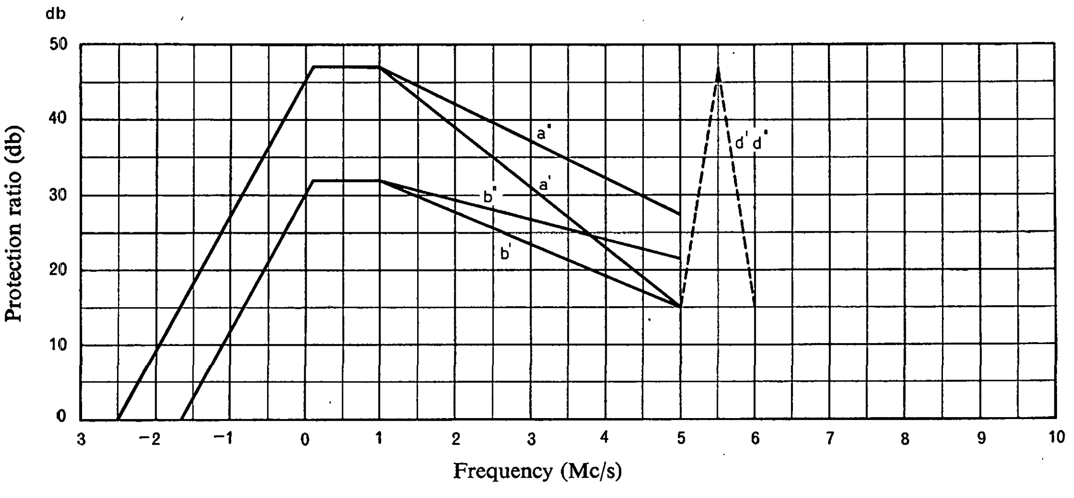
In all cases in this figure, the ratios quoted are those between the wanted and unwanted vision levels.

Curve *a* — Interference to vision from a 405-, 625-, or 819-line vision signal with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

Curve *b* — Interference to vision from an 819-line vision signal, when the nominal frequency difference between the wanted and unwanted signal carriers is a multiple of the line-frequency (20·475 kc/s), plus or minus one-third of the line frequency (6·825 kc/s).

Curve *d* — Interference to the sound signal from a 405-, 625-, or 819-line vision signal.


db
50
40
30
20
10
0
Protection ratio (db)
e
g
e,g
−3
−2
−1
0
1
2
3
4
5
6
7
8
9
10
Frequency (Mc/s)


db
50
40
30
20
10
0
Protection ratio (db)
a"
a'
b"
b'
d' d"
3
−2
−1
0
1
2
3
4
5
6
7
8
9
10
Frequency (Mc/s)

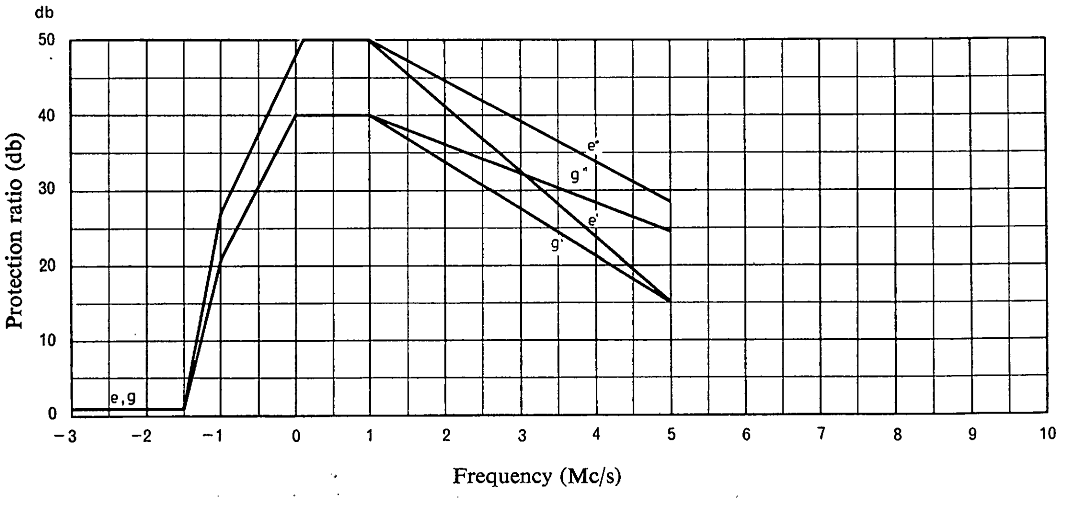

db
50
40
30
20
10
0
Protection ratio (db)
e"
g"
e'
g'
e,g
−3
−2
−1
0
1
2
3
4
5
6
7
8
9
10
Frequency (Mc/s)

FIGURE 7

System E. Protection from CW or sound-signal interference

In both cases in this figure, the ratios quoted are those between the wanted vision and unwanted sound levels.

Curve *e* — Interference to vision from a CW or frequency-modulated sound signal, with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals. For amplitude modulation of the interfering sound signal, the protection ratios should be increased by 4 db.

Curve *g* — Interference to vision from a frequency-modulated sound signal, when the nominal frequency difference between the wanted signal carrier and the sound carrier during quiescent periods, is an odd multiple of half the line-frequency (10·2375 kc/s).

FIGURE 8

Systems C and F. Protection from vision-signal interference

In all cases in this figure, the ratios quoted are those between the wanted levels of the vision and unwanted vision signals.

Letters with a single prime are used for curves applying to System *C.* Letters with double primes are used for curves applying to System *F.*

Curve *a* — Interference to vision from a 405-, 625-, or 819-line vision signal, with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

Curve *b* — Interference to vision from a vision signal, having the same number of lines when the nominal frequency difference between the carriers of the wanted and unwanted signals is a multiple of the line frequency (15·625 or 20·475 kc/s), plus or minus one-third of the line-frequency (5·208 or 6·825 kc/s).

Curve *d* — Interference to the sound signal from a 405-, 625-, or 819-line vision signal.

FIGURE 9

Systems C and F. Protection from CW and sound-signal interference

In all cases in this figure, the ratios quoted are those between the levels of the wanted vision and the unwanted sound signals.

Letters with a single prime are used for curves applying to System *C.* Letters with double primes are used for curves applying to System *F.*

Curve *e* — Interference to vision signal from a CW or frequency-modulated sound signal, with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals. When the interfering sound signal is amplitude-modulated, the protection ratios should be increased by 4 db.

Curve *g* — Interference to vision signal from a CW or frequency-modulated sound signal, when the nominal frequency difference between the carrier of the wanted signal and the sound carrier, during quiescent periods, is an odd multiple of half the line-frequency (7·8125 or 10·2375 kc/s).

When the difference between the carrier-frequencies of the wanted and unwanted signals is large and it is desired to use offset to reduce the necessary protection ratio, the line-frequency of the wanted signal must be controlled to within 5 parts in 10^6.

Where it affects the result, the ratio of vision power to sound power is assumed to be 9 db for system *L*, 3 db for system *M* and 7 db for the other systems.

5. Second channel (image channel) interference

The protection ratio required depends upon the intermediate frequency used and upon the second channel rejection of the receiver. For the purposes of planning it may be assumed that the second channel rejection of receivers will not be less than 40 db except in receivers for the I.B.T.O. systems *D* and *K* when it will not be less than 30 db.

6. Protection ratios between sound signals

(The ratios quoted are those between wanted and unwanted sound signals)

6.1 *Wanted and unwanted sound signals frequency-modulated*

Protection ratio:

— for carriers separated by less than 1000 c/s: 28 db

— for carriers separated by 5/3 of the line-frequency: 20 db

6.2 *Wanted and unwanted sound signals amplitude-modulated*

Protection ratio:

— for carriers separated by frequency below the audio range: 30 db

— for carriers separated by frequency within the audio range: 40 db

— for carriers separated by frequency above the audio range: 15 db

6.3 *Wanted-sound signal amplitude-modulated, unwanted-sound signal frequency-modulated*

Protection ratio:

— for carriers separated by frequency below 1000 c/s: 40 db

— for carriers separated by 25 kc/s: 30 db

— for carriers separated by 50 kc/s: 12 db

6.4 *Wanted-sound signal frequency-modulated, unwanted-sound signal amplitude-modulated*

Protection ratio: 30 db.

RECOMMENDATION 419

DIRECTIVITY OF ANTENNAE IN THE RECEPTION OF BROADCAST SOUND AND TELEVISION

The C.C.I.R. (Geneva, 1963)

UNANIMOUSLY RECOMMENDS

that the characteristics of directivity of the receiving antennae of Fig. 1, can be used for planning broadcast sound or television service in bands I to V.

Note 1 : It is considered that the discrimination shown will be available at the majority of antenna locations in built-up areas. At clear sites in open country, slightly higher values will be obtained.

Note 2 : The curves in Fig. 1 are valid for signals of vertical or horizontal polarization, when both the wanted and the unwanted signal have the same polarization.

Note 3 : The Special Regional Conference, Geneva, 1960, and the European VHF/UHF Broadcasting Conference, Stockholm, 1961, did not take the directional characteristics of antennae into consideration for sound broadcasting.

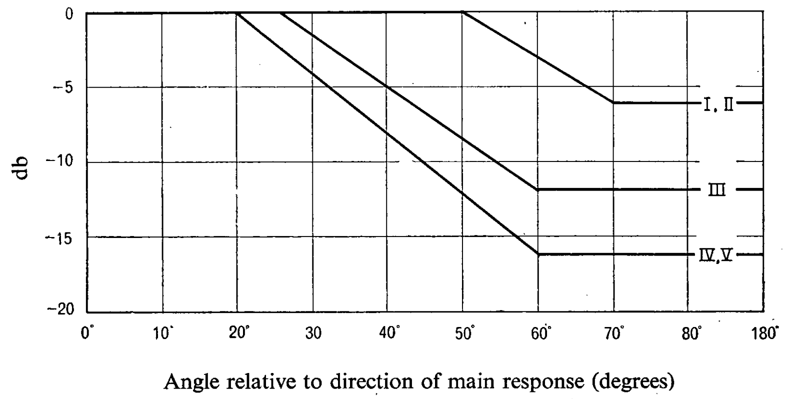


FIGURE 1

Discrimination obtained by the use of directional receiving antennae in broadcasting

(The number of the broadcasting band is shown on the curve)

RECOMMENDATION 420

INSERTION OF SPECIAL SIGNALS IN THE FIELD-BLANKING INTERVAL OF A 625-LINE TELEVISION SIGNAL

(Question 121(XI) and Study Programme 177(XI))

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that, for transmissions over international television circuits, it is advantageous to be able to exercise constant supervision of the overall equivalent (insertion gain);

(b) that such supervision could be effected by the insertion of a special signal in the field blanking interval;

(c) that, for special signals for other uses, which are used in very different ways in different countries, an international standardization does not seem possible at present, but should take place in future:

UNANIMOUSLY RECOMMENDS

1. that for the international transmission of 625-line television signals, a special signal, with the following characteristics, be inserted in the field-blanking interval:

— amplitude: peak white (0·7 V ± 0·007 V)

— duration: 10 μs
— rise and fall times 0·1 μs

The shape of the signal is illustrated in Fig. 1;

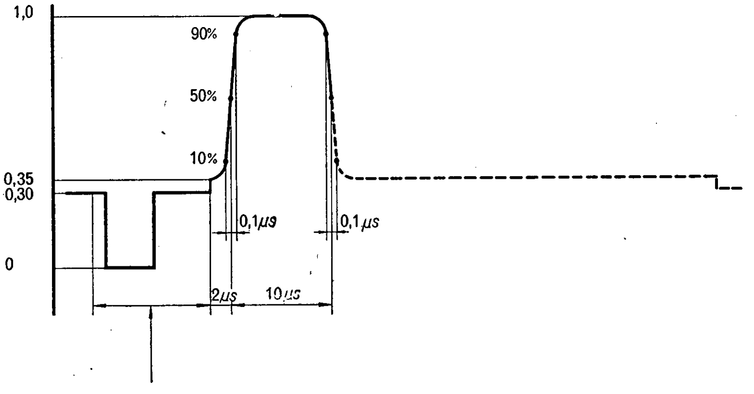


FIGURE 1

Line blanking

2. that this signal be inserted in lines 17 and 330. The numbering of the lines is as follows: line 1 is the one starting at the instant indicated by O_v in Fig. 1 *b* of Report 308; at this instant, the front edge of the line synchronization pulse coincides with the beginning of the sequence of field synchronization pulses. The lines are numbered according to their arrival in time, so that the first field comprises lines 1 to 312 as well as the first half of line 313, whereas the second field comprises the second half of line 313 and lines 314 to 625;

3. that this signal can only be removed or replaced by the broadcasting authority situated at the lower end of the broadcasting chain;

4. that any additional national signals which may be inserted, be removed prior to the sending of the television signal over an international circuit, if such a removal is requested by the broadcasting authority situated at the lower end. Exception is made for the triggering pulse when used by some organizations; in this case, such a pulse must be inserted at the beginning of lines 16 and 329 and its duration should not exceed 2 μs.

RECOMMENDATION 421 *

REQUIREMENTS FOR THE TRANSMISSION OF MONOCHROME TELEVISION SIGNALS OVER LONG DISTANCES

The C.C.I.R., (Los Angeles, 1959 — Geneva, 1963)

CONSIDERING

the agreement reached by the Joint C.C.I.R./C.C.I.T.T. Committee for television transmissions (C.M.T.T.), on a draft Recommendation concerning monochrome television transmissions over long distances, common to the C.C.I.R. and the C.C.I.T.T.,

* This Recommendation replaces Recommendation 267.

UNANIMOUSLY RECOMMENDS

that, taking account of the definitions in § 1, monochrome television transmissions over long distances should satisfy the requirements laid down in §§ 2 and 3 and their Annexes.

1. Definitions

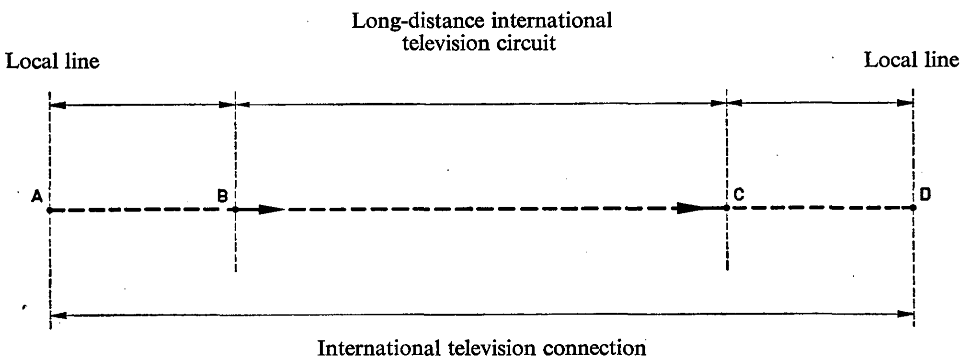


FIGURE 1

1.1 *Definition of a long-distance international television connection (see Fig. 1)*

1.1.1 Point *A*, to be considered as the sending end of the international television connection, may be the point at which the programme originates (studio or outside location), a switching centre or the location of a standards converter.

1.1.2 Point *D*, to be considered as the receiving end of the international television connection, may be a programme mixing or recording centre, a broadcasting station, a switching centre or the location of a standards converter.

1.1.3 The local line *AB* connects point *A* to the sending terminal station, point *B*, of the international television circuit.

1.1.4 The long-distance international television circuit, *BC*, comprises a chain of national and international television links. The precise locations (e.g. within buildings), to be regarded as the points *B* and *C*, will be nominated by the authorities concerned.

1.1.5 The local line *CD* connects point *C*, the receiving terminal station of the long distance international television circuit, to the point *D*.

1.1.6 The combination *AD*, of the long-distance international television circuit, *BC*, and the local lines *AB* and *CD*, constitutes the *international television connection.*

The requirements given in §§ 2 and 3 refer to the performance of long-distance international television circuits only; no requirements have been laid down for the local lines, *AB* and *CD.*

1.2 *Definition of the hypothetical reference circuit*

The main features of the television hypothetical reference circuit, which is an example of a long-distance international television circuit (BC in Fig. 1) and which may be of either radio or coaxial-cable type, are:

— the overall length between video terminal points is 2500 km (about 1600 miles),

— two intermediate video points divide the circuit into three sections of equal length,

— the three sections are lined up individually and then interconnected without any form of overall adjustment or correction,

— the circuit does not contain a standards converter or a synchronizing-pulse regenerator.

Note 1 : The concept of the hypothetical reference circuit serves to provide a basis for the planning and design of transmission systems. Such a circuit has a length which is reasonably but not excessively long and, for a television circuit, a defined number of video-to-video sections. It is appreciated, that at the present time, international television circuits usually contain more than three video-to-video links in a length of 2500 km, but it is expected that the number will be reduced in the course of time. Annex V gives a provisional indication of the characteristics of circuits shorter or longer than the hypothetical reference circuit.

Note 2 : In Canada and the U.S.A., objectives are normally specified for circuits 6400 km long. The limits given in this Recommendation for 2500-km circuits for the 525-line system in Canada and the U.S.A., are therefore chosen to give an adequate performance in a portion 2500 km long of a 6400-km circuit.

2. Requirements at video interconnection points

In this section the requirements apply at the video terminals of any long-distance television circuit, whatever its length.

2.1 *Impedance*

At video interconnection points, the input and output impedance of each circuit should be unbalanced to earth, with a nominal value of 75 Ω resistive and a return loss of at least 24 db relative to 75 Ω.*

Note : In Canada and the U.S.A., the impedance at video interconnection points should be either 124 Ω balanced to earth or 75 Ω unbalanced to earth, with a return loss of at least 30 db.

2.2 *Polarity and d.c. component*

At video interconnection points, the polarity of the signal should be *positive*, i.e. such that black-to-white transitions are positive-going.

The useful d.c. component, which is related to the average luminance of the picture, may or may not be contained in the video signal and need not be transmitted, or delivered at the output.

Any non-useful d.c. component unrelated to the video signal (e.g. the component due to d.c. valve supplies) should not cause more than 0·5 W to be dissipated in the 75 Ω load impedance. If the load impedance is disconnected, the voltage of this component should not exceed 60 V.

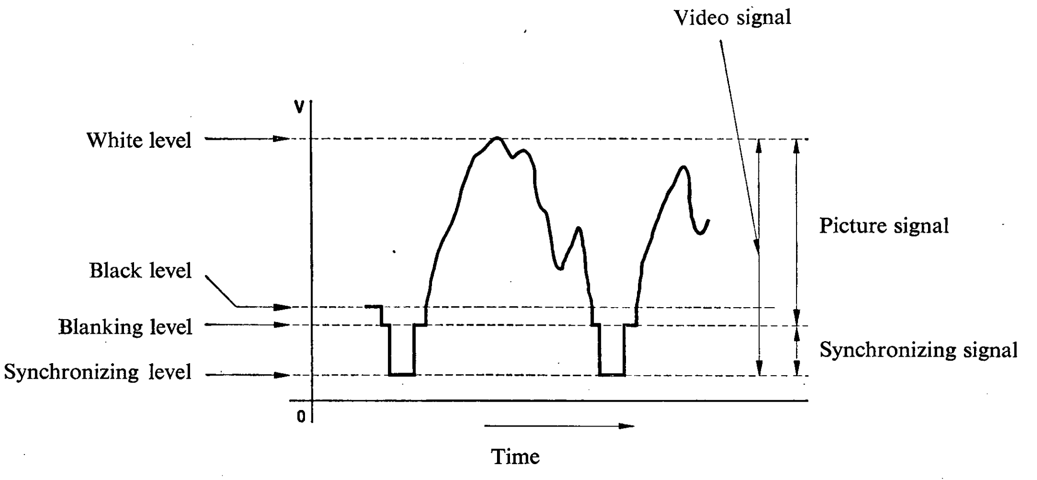
2.3 *Signal amplitude*

At video interconnection points, the blanking level taken as the reference level, the nominal amplitude of the picture signal, measured from the blanking level to the white level should be 0·7 V (0·714 V in Canada and the U.S.A.), while the nominal amplitude of the synchronizing signal, measured from the blanking level to the tips of the synchronizing pulses should be 0·3 V (0·286 V in Canada and the U.S.A.), so that the nominal peak-to-peak amplitude of the video signal should be 1·0 V (see Fig. 2).

---

* The return loss, relative to 75 Ω, of an impedance Z is

$$20 \log_{10} \left| \frac{75 + Z}{75 - Z} \right| \text{ (db)}$$



$V =$ Difference in potential between the terminal (not at earth potential) of the input (or output) impedance and earth (difference of potential positive in an upward direction).

FIGURE 2

Theoretically, the amplitude should be measured with the useful d.c. component of the video signal restored, but in practice this is not necessary.

Note : In the design of equipment, account should be taken of the losses in interconnecting cables when the video interconnection points are at some distance from the terminals of the modulating and demodulating equipment.

3. Transmission performance of the hypothetical reference circuit

In this section, the performance requirements are to be taken as design objectives applying to the hypothetical reference circuit as defined in § 1.2.

It should be emphasized, that the material of this section constitutes only a first step towards the solution of the general problem of determining methods of measuring and specifying the performance of television circuits of any length or degree of complexity.

3.1 *Insertion gain*

A long-distance international circuit, having the form of the hypothetical reference circuit should, at the time of setting up, have an insertion gain of 0 db $\pm$ 1 db ($\pm$ 0·5 db in Canada and the U.S.A.).

The insertion gain should be measured, using Test Signal No. 2 (described in Annex I) and is defined as the ratio, in decibels, of the amplitude of the bar (from black level to white level) at the output to the nominal amplitude of the bar at the input.

The measurement should be made under the following conditions:

A generator producing Test Signal No. 2, with an internal impedance of 75 Ω (resistive), is adjusted so that, if connected directly to a 75 Ω resistance, it would produce a line-synchronizing signal of 0·3 V combined with a picture signal of 0·7 V which may include 0·05 V of pedestal. At the receiving end, the voltage between the black level and the white level (bar amplitude) is measured, using an oscilloscope connected across a resistance of 75 Ω. The ratio of this voltage to 0·65 V if pedestal is used, or 0·7 V if it is not (in decibels) is the insertion gain of the television circuit.

Note : In Canada and the U.S.A. somewhat different methods are used, but similar results are obtained.

3.2 *Variations of insertion gain*

The variations of insertion gain with time in the hypothetical reference circuit should not exceed the following limits:

— short-period (e.g. 1 s) variations: ± 0·3 db (± 0·2 db in Canada and the U.S.A.),

— medium-period (e.g. 1 hr) variations: ± 1·0 db

3.3 *Noise*

3.3.1 *Continuous random noise*

The signal-to-noise ratio for continuous random noise is defined as the ratio, in decibels, of the peak-to-peak amplitude of the picture signal (see Fig. 2) to the r.m.s.* amplitude of the noise, within the range between 10 kc/s and the nominal upper limit of the video frequency band of the system, f_c. The purpose of the lower frequency limit is to enable power supply hum and microphonic noise to be excluded from practical measurements.

TABLE I

System	Number of lines	405	525	625	625	819	819
	Nominal upper limit of video frequency band f_c (Mc/s)	3	4	5	6	5	10
Signal-to-weighted-noise ratio X (db) . .		50	52 (Japan) 56 (Canada) and U.S.A.)	52	57	52	50

For the hypothetical reference circuit, the signal-to-noise ratio should be not less than the values X given in Table I when measured with the appropriate low-pass filter, described in Annex I, the appropriate weighting network described in Annex III, and an instrument having an " effective time constant " or " integrating time " in terms of power of 1 s (0·4 s in Canada and the U.S.A.).

Note 1 : To obtain satisfactory transmission performance, television specialists believe that the signal-to-weighted-noise ratio should neither fall below X db for more than 1% of any month, nor below $(X - 8)$ db for more than 0·1% of any month.

Note 2 : For the routine measurement of signal-to-noise ratio on real circuits, the noise can be measured with sufficient accuracy in the absence of the video signal. The error introduced by this method will not, in general, exceed 2 db. More accurate devices and methods for measuring signal-to-weighted-noise ratio when transmitting test signals, are described in Doc. XI/25 of Moscow, 1958, CMTT/23 of Monte Carlo, 1958, and CMTT/3 of Paris, 1962, presented by the U.S.S.R.

3.3.2 *Periodic noise*

The signal-to-noise ratio for periodic noise is defined as the ratio, in decibels, of the peak-to-peak amplitude of the picture signal (see Fig. 2), to the peak-to-peak amplitude of the noise.

Note : This definition has so far been used in specification clauses dealing with single-frequency noise and with power-supply hum (including the fundamental frequency and lower-order harmonics), but it may also prove to be useful for any case in which two or more sinusoidal components are in harmonic relationship.

* Administrations measuring the quasi-peak-to-peak amplitude of the noise are asked to establish the crest factor appropriate to their method of measurement and to express the results in terms of r.m.s. amplitude.

The signal-to-noise ratio in the hypothetical reference circuit should not be less than the value given in Table II:

TABLE II

System								
	Number of lines	405	525 Canada and U.S.A.	525 Japan	625	625	819	819
	Nominal upper limit of video frequency band f_c (Mc/s)	3	4	4	5	6	5	10
Signal-to-noise ratio (db) for power-supply hum (including the fundamental frequency and lower-order harmonics) (1)		30	35	30	30	30	30	30
Signal-to-noise ratio (db) for single-frequency noise between 1 kc/s and 1 Mc/s		50	59 (2)	50	50	50	50	50 (3)
Value (db) to which the signal-to-noise ratio for single-frequency noise may decrease linearly between 1 Mc/s and f_c . . .		25	43 (4)	30	30	30	30	30 (5)

(1) These figures apply only to hum added to the signal and not to hum which in transmission has modulated the amplitude of the signal and cannot be removed by clamping. The measurement should be made without clamping.

(2) This limit applies between 1 kc/s and 2 Mc/s.

(3) For the 819-line system (10 Mc/s video bandwidth) for frequencies below 1 kc/s excluding power-supply hum (including both the fundamental frequency and lower-order harmonics), the signal-to-noise ratio may decrease linearly between the values 50 db at 1 kc/s and 45 db at 100 c/s, and between the values 45 db at 100 c/s and 30 db at 50 c/s.

(4) Value to which the signal-to-noise ratio may decrease, according to a linear function on a chart having a linear decibel scale and a logarithmic frequency scale, for frequencies between 2 Mc/s and f_c.

(5) For the 819-line (10 Mc/s video bandwidth) system, this figure is reached at a frequency of 7 Mc/s and remains constant between 7 Mc/s and f_c (10 Mc/s).

3.3.3 *Impulsive noise*

The signal-to-noise ratio for impulsive noise is defined as the ratio, in decibels, of the peak-to-peak amplitude of the picture signal (see Fig. 2), to the peak-to-peak amplitude of the noise.

Provisionally, for the hypothetical reference circuit, a minimum signal-to-noise ratio of 25 db for impulsive noise of a sporadic or infrequently occurring nature has been proposed for all systems, except the 525-line system in Canada and the U.S.A., for which the requirement is 11 db.

3.4 *Non-linearity distortion*

Non-linearity distortion effects both the picture signal and the synchronizing signal.

Non-linearity distortions of the picture signal may be classified under three headings *, namely:

— field-time non-linearity distortion,
— line-time non-linearity distortion,
— short-time non-linearity distortion.

3.4.1 *Field-time non-linearity distortion of the picture signal*

This matter is still under study.

* The corresponding terms in French are respectively: " distortion non-linéaire aux fréquences très basses, aux fréquences moyennes, aux fréquences élevées. "

3.4.2 *Line-time non-linearity distortion of the picture signal*

Non-linearity of the picture signal is measured with Test Signal No. 3 (described in Annex I)*, using a superimposed sine-wave at a frequency $0 \cdot 2 f_c$.

The magnitude of the distortion is indicated by the ratio of the minimum peak-to-peak amplitude of the sine-wave to the maximum amplitude along the saw-tooth.

The sine-wave may be displayed on an oscilloscope with the time base running at line frequency by using a band-pass filter to separate the sine-wave from the rest of the signal. The display then has the form indicated in Fig. 3 and the line-time non-linearity distortion is indicated by changes in amplitude across the display.

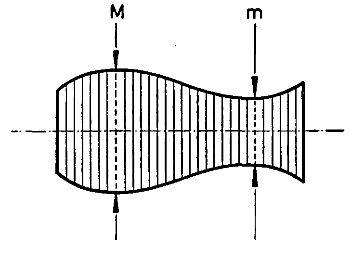


FIGURE 3

The non-linearity distortion should be expressed as a percentage, in the form $(1 - m/M) \times 100$ and should not be more than 20% for the hypothetical reference circuit. Alternatively, the result may, if desired, be expressed in db.

In Canada and the U.S.A., the non-linearity distortion is measured with a superimposed sine-wave at 3.6 Mc/s and the results are expressed either as a percentage or in db and should not be more than 13% or 1·2 db respectively.

3.4.3 *Short-time non-linearity distortion of the picture signal*

This matter is still under study **.

In Canada and the U.S.A., the short-time non-linearity distortion requirement is covered by the non-linearity distortion requirement given in § 3.4.2.

3.4.4 *Non-linearity distortion of the synchronizing signal*

For the hypothetical reference circuit, when the gain of the circuit is 0 db, the amplitude, S, of the line-synchronizing signal, measured with Test Signal No. 3, should lie between the limits of 0·21 V and 0·33 V (0·26 V and 0·31 V for Canada and the U.S.A.), irrespective of whether the intermediate lines are at black level, S_a, or at white level, S_b.

3.5 *Linear waveform distortion*

3.5.1 *Field-time waveform distortion*

3.5.1.1 *405-line, 625-line and 819-line systems*

For the hypothetical reference circuit, using Test Signal No. 1 (described in Annex I) the received waveform displayed on an oscilloscope should lie within the limits *** of the mask shown in Fig. 4, provided that the oscilloscope is adjusted so that the half-amplitude points of the bar transitions coincide with M_1 and M_2, and the mid-points of the " black " and " white " portions coincide with A and B respectively.

---

* Although this signal is agreed for international use, the United Kingdom uses a " staircase " signal for testing its national television links. The method is described in Doc. C.M.T.T./3 of Monte Carlo, 1958.

** In several countries, such measurements are at present being made using Test Signal No. 3 with a higher value than $0 \cdot 2 f_c$ for the frequency of the superimposed sine-wave (See Doc .C.M.T.T./41 of Monte Carlo, 1958—(Chairman's report)).

*** For the 405-line system, these limits correspond to a rating factor, K, of 5% ($K = 0 \cdot 05$) as defined in Annex IV.

3.5.1.2 *525-line systems*

In Canada and the U.S.A., with Test Signal No. 1, the variations about the level *B* should not exceed ± 5 % when the signal is unclamped, or 1 % when the signal is clamped.

In Japan, with Test Signal No. 1, the tolerances are the same as for the 405-, 625- and 819-line systems.

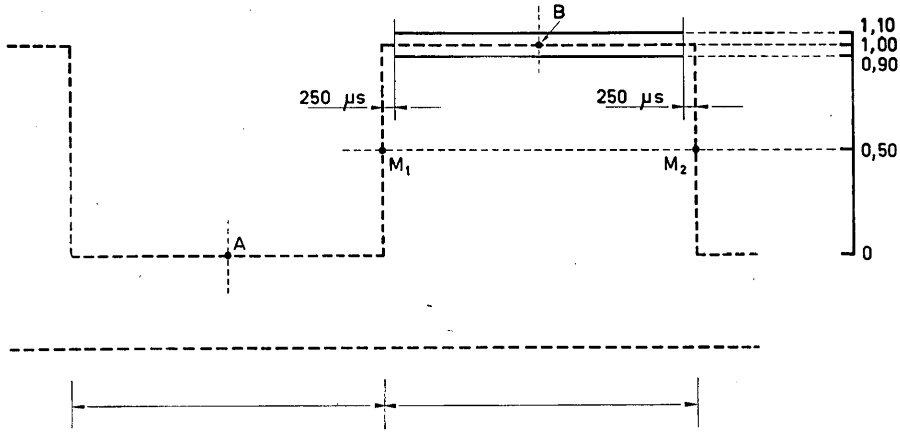


FIGURE 4 — *Waveform response to Test Signal No. 1*

3.5.2 *Line-time waveform distortion*

3.5.2.1 *405-line system*

For the hypothetical reference circuit, using Test Signal No. 2 (described in Annex I), with a rise time of $2\,T$ (0·33 μs) and with an interval of 0·1 H between the bar and the succeeding synchronizing pulse, the received waveform displayed on an oscilloscope should lie within the limits * of the corresponding mask shown in Fig. 5 provided that the oscilloscope is adjusted so that the half-amplitude points of the bar transitions coincide with M_1 and M_2, and the mid-points of the "black" and "white" portions coincide with A and B respectively.

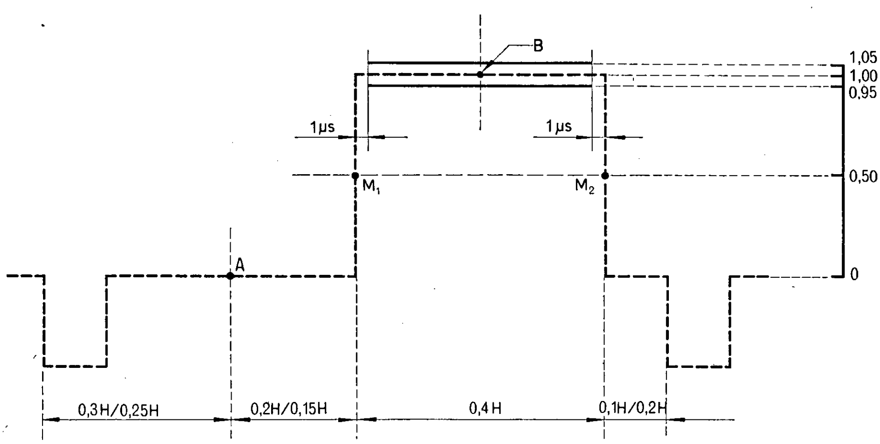


FIGURE 5 — *Waveform response to Test Signal No. 2*

* For the 405-line system, these limits correspond to a rating factor, K, of 5 % ($K = 0{\cdot}05$) as defined in Annex IV.

3.5.2.2 *525-line systems*

In Canada and the U.S.A., for the hypothetical reference circuit, using Test Signal No. 2 (described in Annex I), with a rise-time of $2T$ (0·25 μs), the received waveforms displayed on an oscilloscope should lie within the limits of the corresponding mask, similar to that shown in Fig. 5, but with a permitted variation about the level B of ± 1%, provided that the oscilloscope is adjusted so that the half-amplitude points of the bar transitions coincide with M_1 and M_2, and the mid-points of the " black " and " white " portions coincide with A and B respectively.

In Japan, the conditions described below for the 625- and 819-line systems apply.

3.5.2.3 *625-line and 819-line systems*

For the hypothetical reference circuit, using Test Signal No. 2 (described in Annex I), with a rise time of T*, the received waveform displayed on an oscilloscope should lie within the limits of the mask shown in Fig. 5, provided that the oscilloscope is adjusted so that the half-amplitude points of the bar transitions coincide with M_1 and M_2, and the mid-points of the " black " and " white " portions coincide with A and B respectively.

3.5.3 *Short-time waveform distortion*

3.5.3.1 *405-line system*

For the hypothetical reference circuit, the rating factor K, as defined in Annex IV, should not exceed 5% (K = 0·05). For this measurement, Test Signal No. 2 (described in Annex I) should be used with an interval of 0·1 H between the bar and the succeeding synchronizing pulse and with a sine-squared pulse of half-amplitude duration T (0·17 μs) inserted in the interval A.

μs	Upper limit	Lower limit
0.12	120	90
0.35	109	91
> 1	105	95

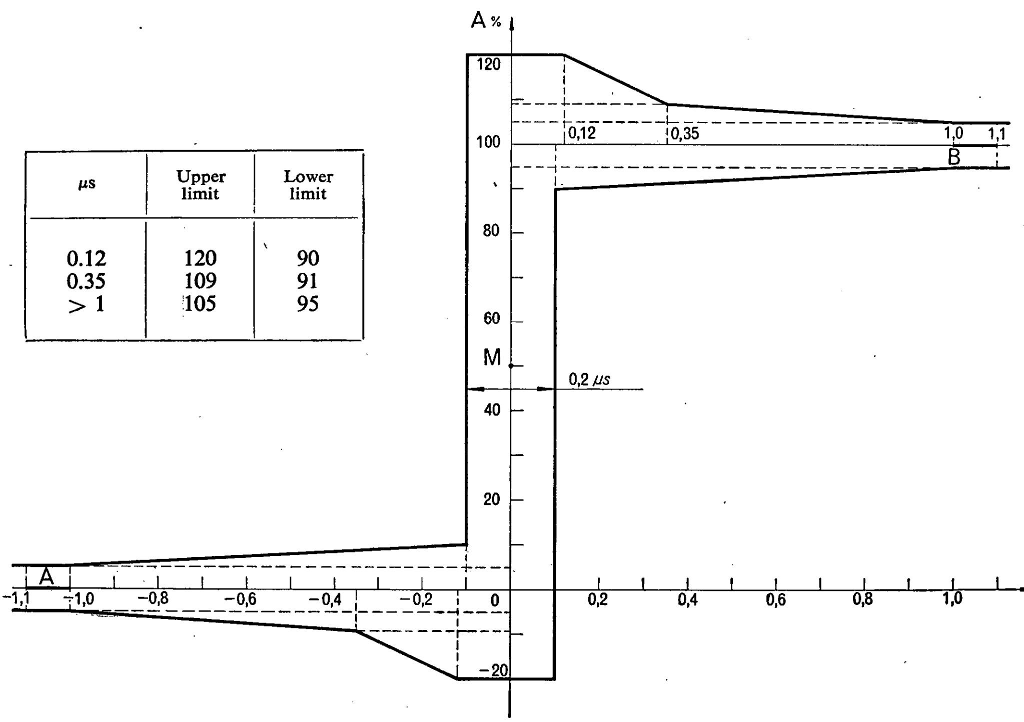


FIGURE 6 — *Mask for waveform response to Test Signal No. 2 for the 525-line system (Japan)*

* It may be necessary to use a rise time of $2T$ for circuits which cut off sharply close to the nominal upper video frequency limt.

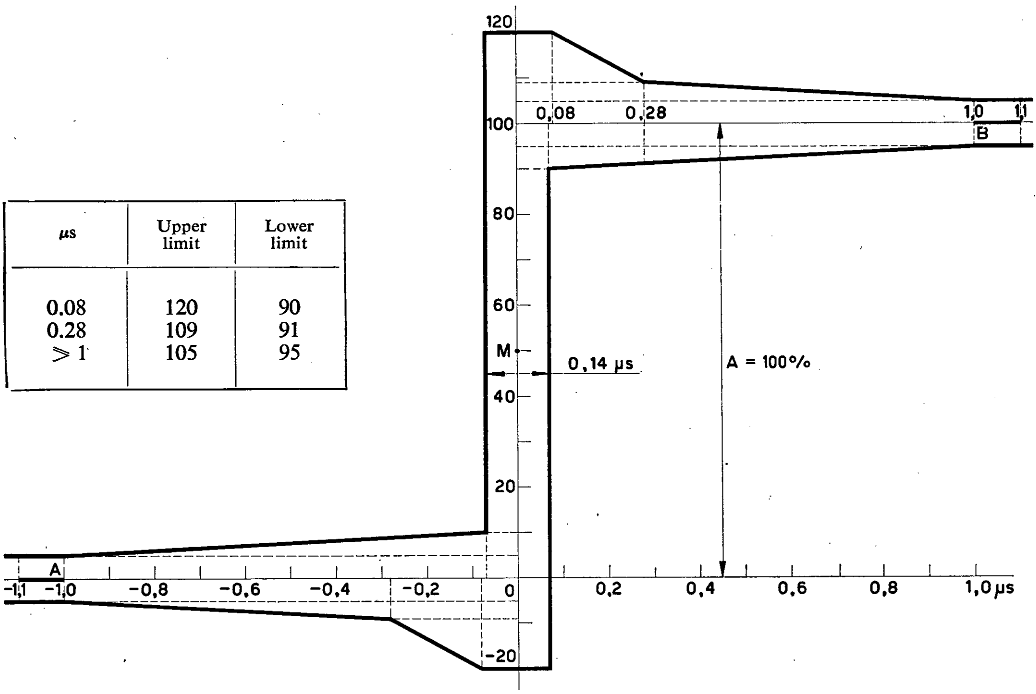
3.5.3.2 *525-line systems*

In Canada and the U.S.A., where a test signal comprising a sine-squared pulse of half-amplitude duration $1/(2\ f_c)$s is used, the output signal should have a first-lobe amplitude (negative), leading or trailing, not greater than 13% of the peak amplitude of the pulse.

In Japan, the test procedure is the same as that described for the 625- and 819-line systems, the response being observed by means of the mask shown in Fig. 6.

3.5.3.3 *625-line systems and 819-line systems*

Test Signal No. 2 is used, with a rise-time of $T = 1/(2f_c)$.



µs	Upper limit	Lower limit
0.08	120	90
0.28	109	91
> 1	105	95

FIGURE 7

Provisional mask for waveform response to Test Signal No. 2 for the 625-line systems (f_c = 6 Mc/s) other than System L

The response is observed by means of one of the masks shown in Figs. 7 and 8, the oscilloscope being adjusted so that *M* coincides with the middle of the rise, and the black and white levels coincide with the segments *A* and *B*.

If ringing is present in the regions *A* and *B*, the peaks of the oscillations should be set symmetrically with respect to *A* and *B*.

For the hypothetical reference circuit, the response should lie within the limits of the appropriate mask as follows:

— Fig. 7 for the 625-line systems (f_c = 6 Mc/s) other than system *L* (Note 1).

— Fig. 8 for the other 625-line systems (f_c = 5 Mc/s) and the 819-line system (f_c = 5 Mc/s and f_c = 10 Mc/s) (Note 1).

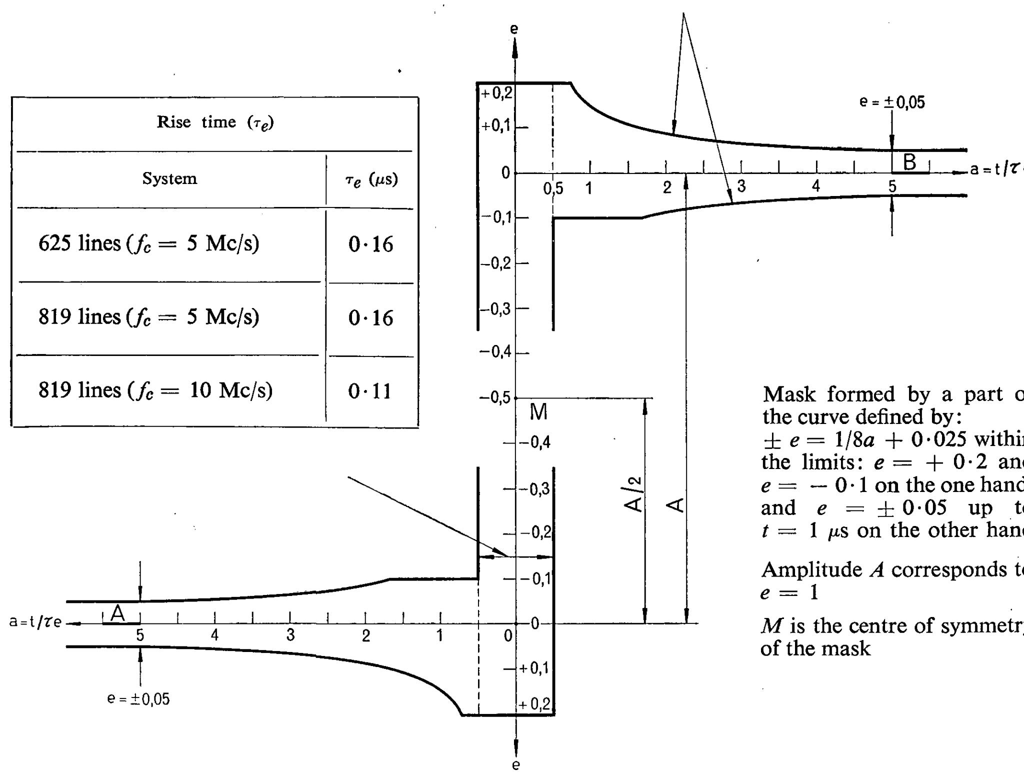
Note 1 : For the 625-line system *L* as used in France, the mask for the waveform response to Test Signal No. 2 is provisionally the mask of Fig. 8 corresponding to the 819-line system *E* (f_c = 10 Mc/s).

3.6 *Steady-state characteristics*

3.6.1 *405-line system*

As a precaution against possible overloading effects, the insertion gain in the hypothetical reference circuit, at any frequency between the field-repetition frequency (50 c/s) and the nominal upper limit of the video-frequency band (3 Mc/s), should not exceed the gain at the line-repetition frequency (10 kc/s) by more than 5 db.

Rise time (τ_e)	
System	τ_e (μs)
625 lines (f_c = 5 Mc/s)	0·16
819 lines (f_c = 5 Mc/s)	0·16
819 lines (f_c = 10 Mc/s)	0·11



Mask formed by a part of the curve defined by: $\pm e = 1/8a + 0{\cdot}025$ within the limits: $e = +0{\cdot}2$ and $e = -0{\cdot}1$ on the one hand, and $e = \pm 0{\cdot}05$ up to $t = 1$ μs on the other hand

Amplitude *A* corresponds to $e = 1$

M is the centre of symmetry of the mask

FIGURE 8

Mask for waveform response to Test Signal No. 2 of the 625-line (f_c = 5 Mc/s) and 819-line (f_c = 5 and 10 Mc/s) systems

3.6.2 *525-line systems*

In Canada and the U.S.A., the design-objective limits are shown by the lines B in Figs. 9 and 10, the lowest frequency to which these limits apply being $0{\cdot}0025\,f_c$.

In Japan the limits are, as indicated below, for the 625-line and 819-line systems, the appropriate value of f_c being 4 Mc/s.

3.6.3 *625-line and 819-line systems*

For the hypothetical reference circuit, the limits of the attenuation/frequency and envelope-delay/frequency characteristics given in Figs. 9 and 10 may be found useful by designers. In these figures, the abscissae show a single parameter which is the ratio between the frequency and the nominal upper video frequency, f_c, of the system considered (normalized frequency).

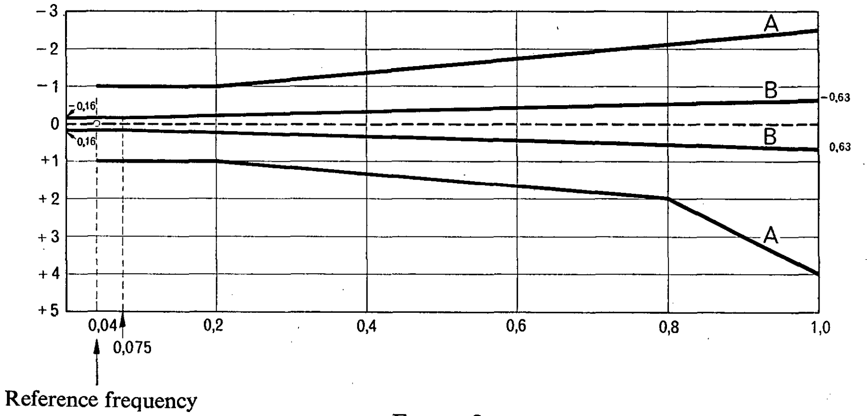


FIGURE 9

Limits for the attenuation/normalized-frequency characteristic for television systems

A: With nominal upper limits of the video frequency band f_c = 4 (except in Canada and the U.S.A.), 5, 6 and 10 Mc/s.

B: With nominal upper limit of the video frequency band f_c = 4 Mc/s, as used in Canada and the U.S.A.

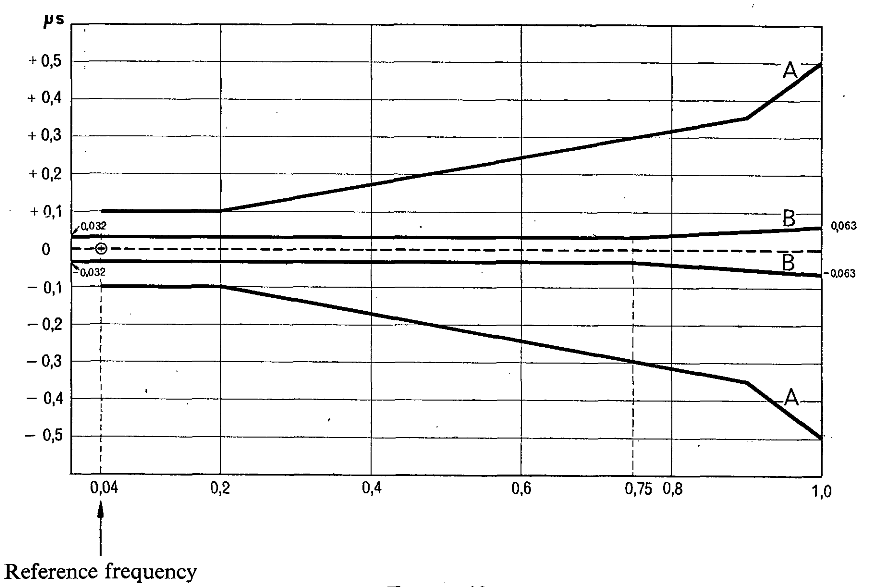


FIGURE 10

Limits for the envelope-delay/normalized-frequency characteristic for television systems

A: With nominal upper limits of the video frequency band f_c = 4 (except in Canada and the U.S.A.), 5, 6 and 10 Mc/s.

B: With nominal upper limit of the video frequency band f_c = 4 Mc/s, as used in Canada and the U.S.A.

ANNEX I

TEST SIGNALS

1. Test Signal No. 1

Test Signal No. 1 is used in the measurement of field-time waveform distortion. As shown in Fig. 11 below, it comprises a square wave of field frequency superimposed upon line-synchronized and blanking pulses. If desired, a field-synchronizing signal may be included and the pedestal may be omitted.

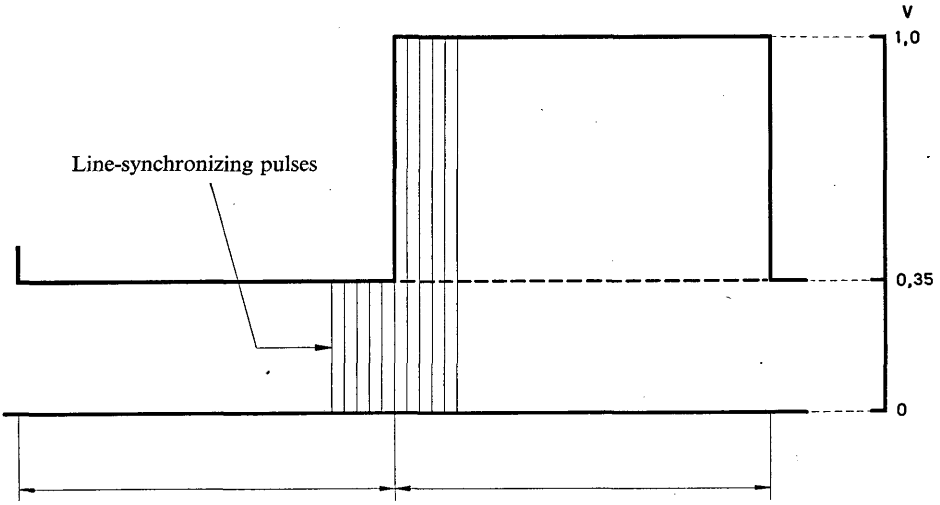


FIGURE 11

Test Signal No. 1

2. Test Signal No. 2 *

Test Signal No. 2 is used in the measurement of insertion gain, line-time waveform distortion and short-time waveform distortion. As shown in Fig. 12, it comprises a half-line bar associated with line-synchronizing pulses. If desired, a field-synchronizing signal may be included. The interval between the half-line bar and the succeeding synchronizing pulse may be either 0.1 H or 0.2 H, where H is the line period. The pedestal may be omitted if desired.

The precise shape and rise-time of each transition of the half-line bar may be determined by means of a shaping network, the design of which is based on " Solution 3 " in a paper by W. E. Thomson (Proc. I.E.E., Part III, **99**, 373 (1952)). Two alternative networks may be used giving rise-times of T and $2T$, where $T = 1/(2 f_c)$, and f_c is the nominal upper video-frequency limit of the system. (Design details of suitable networks are given in Annex IV).

If desired, an additional feature such as a sine-squared pulse, of shape and half-amplitude duration determined by the above-mentioned shaping networks, or a high-frequency burst, can be added in the space marked A.

* Considerable errors in measurement occur when using Test Signals Nos. 2 and 3, if the signal-to-noise ratio is less than 30 db (see Doc. CMTT/2 of Paris, 1962),

3. Test Signal No. 3 *

Test Signal No. 3 is used in the measurement of non-linearity distortion. As shown in Fig. 13, it is a signal in which the " picture " portion of every fourth line consists of a

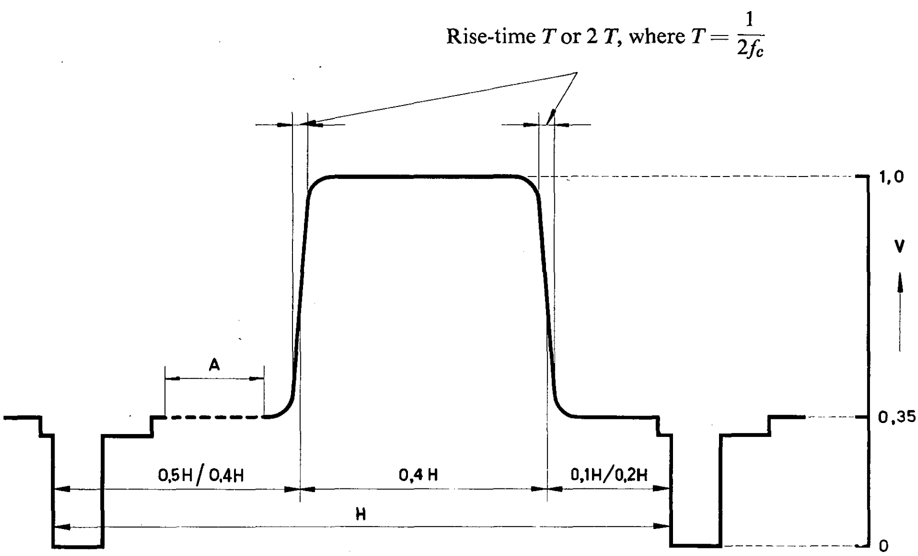
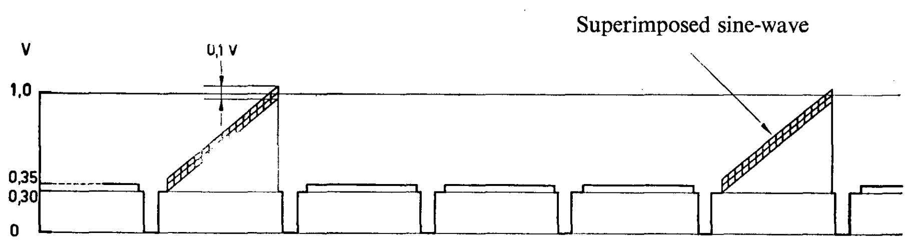
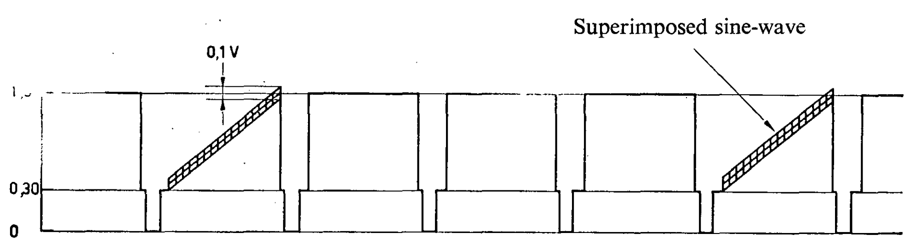


FIGURE 12

Test Signal No. 2



(a) Intermediate lines at black level



(b) Intermediate lines at white level

FIGURE 13

Test Signal No. 3

* Considerable errors in measurement occur when using Test Signals Nos. 2 and 3, if the signal-to-noise ratio is less than 30 db (see Doc. CMTT/2 of Paris, 1962).

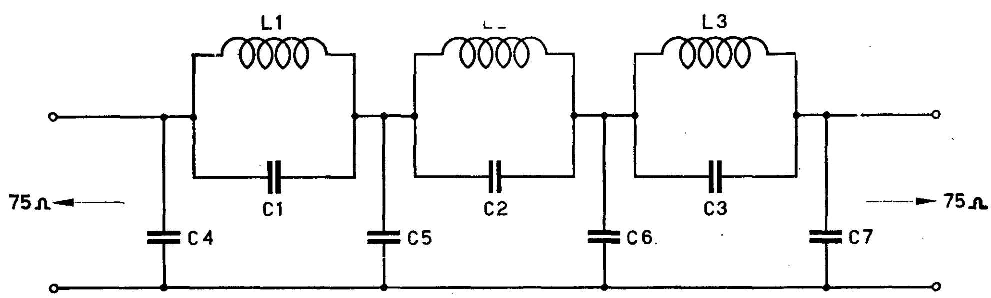
sine-wave of 0·1 V peak-to-peak amplitude superimposed on a sawtooth, the three intermediate lines being set either to black level or to white level by means of a switch at the sending end. If desired, a field-synchronizing signal may be included and the pedestal may be omitted.

For measuring line-time non-linearity distortion, the frequency of the superimposed sine-wave is $0 \cdot 2\, f_c$.

At the receiving end of a circuit, any variation of the sine-wave amplitude over the duration of the sawtooth is taken as indicative of non-linearity distortion.

ANNEX II

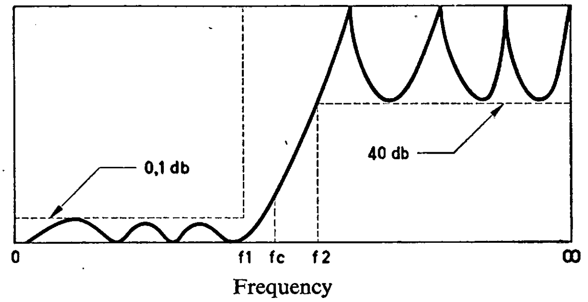
LOW-PASS FILTER FOR USE IN MEASUREMENTS OF CONTINUOUS RANDOM NOISE



	Nominal upper video-frequency limit: f_c (Mc/s) *		
	L (μH)	C (pF)	f (Mc/s)
1	$14 \cdot 38/f_c$	$497 \cdot 6/f_c$	$1 \cdot 8816\, f_c$
2	$7 \cdot 673/f_c$	$2723/f_c$	$1 \cdot 1011\, f_c$
3	$8 \cdot 600/f_c$	$1950/f_c$	$1 \cdot 2290\, f_c$
4		$2139/f_c$	
5		$2815/f_c$	
6		$2315/f_c$	
7		$1297/f_c$	

* In Canada and the U.S.A., a value of $f_c = 4 \cdot 2$ Mc/s is adopted for the design of the low-pass filter used for noise measurements.

f/f_c	db	f/f_c	db
0·98	0·1	1·04	14·8
0·99	0·5	1·05	18·8
1·00	1·8	1·06	23·0
1·01	4·2	1·07	27·7
1·02	7·3	1·08	33·3
1·03	10·9	1·09	41·0



Theoretical insertion loss
$f_1 = 0{\cdot}9\, f_2$ by design.

Ringing frequency $= f_c$ by design.
$f_1 = 0{\cdot}9807\, f_c$
$f_2 = 1{\cdot}0897\, f_c$

Note 1 : Each capacitance quoted is the total value, including all relevant stray capacitances, and should be correct to $\pm$ 2%.

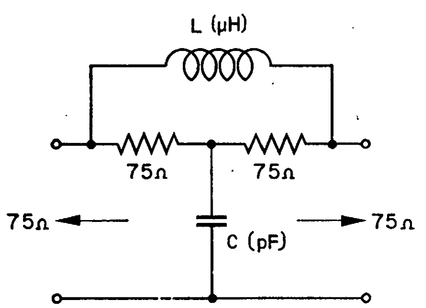
Note 2 : Each inductor should be adjusted to make the insertion loss a maximum at the appropriate indicated frequency, f (Mc/s).

Note 3 : The Q of each inductor measured at the frequency f_c should be between 80 and 125.

Note 4 : Limits for the insertion-loss/frequency characteristic are specified indirectly by the indicated tolerances on the component values.

ANNEX III

CONTINUOUS-RANDOM-NOISE WEIGHTING NETWORKS



L (μH) $= 75\,\tau$ (μs); C (pF) $= [\tau$ (μs)/75$] \times 10^6$

Insertion loss (db) $= 10 \log_{10} [1 + (2\,\pi\tau f)^2]$

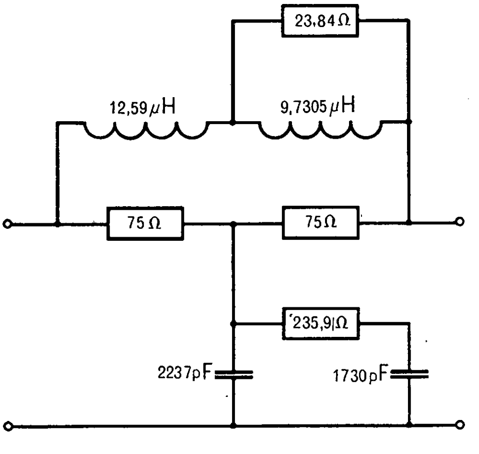
Number of lines	f_c(1) (Mc/s)	τ (μs)	τf_c	Theoretical weighting (db), for:	
				" White " noise	" Triangular " noise
405	3	0·33	1·0	6·5	12·3
525 (Canada and U.S.A.)	see Note			6·1	10·2
525 (Japan)	4	0·415	1·66	8·5	16·3
625	5	0·33	1·66	8·5	16·3
625	6	0·33	2·0	9·3	17·8
819	5	0·33	1·66	8·5	16·3
819	10	0·166	1·66	8·5	16·3

(1) f_c is the nominal upper video-frequency limit of the system (Mc/s).

Note : In Canada and the U.S.A., the following weighting characteristic is used:

Frequency (Mc/s)	0·01	0·05	0·10	0·50	1·00	2·00	3·00	4·00
Weighting (insertion loss) (db)	0	0	0.3	2.8	4.7	8.1	10.8	13.0

A weighting network, such as that shown below, may be used:



$$\text{Insertion loss (db)} = 10 \log \{[1 + (f/f_1)^2]\,[1 + (f/f_2)^2]/[1 + (f/f_3)^2]\}$$

where: $f_1 = 0{\cdot}270$ Mc/s, $f_2 = 1{\cdot}37$ Mc/s and $f_3 = 0{\cdot}390$ Mc/s

ANNEX IV

SPECIFICATION OF LINEAR WAVEFORM-TRANSMISSION PERFORMANCE FOR THE 405-LINE SYSTEM

1. Scope

This Annex describes two complementary methods of specifying the linear waveform-transmission performance, between video input and output terminals, of television links and equipment intended for use with the 405-line 3 Mc/s monochrome system.

2. General

The present limitations of available waveform-measuring equipment make it necessary to distinguish two complementary methods of testing performance. The first, or " routine test " method, is rapid but less precise, because it relies on direct oscilloscopic observations of the responses to prescribed test signals, and because the spectrum of one of these signals unavoidably extends beyond the 3 Mc/s limit of interest. The second, or " acceptance-test " method, is slow but more precise, because a computational process applied to a series of waveform ordinates (measured by travelling microscope on a photographic record, or by other means) enables irrelevant information to be eliminated and certain measuring-equipment errors to be corrected.

The routine-test method may be used for:

— checking the performance of a batch of items, when type-approval has been given after a full acceptance test on one item;

— detecting gross distortion during the initial tests of a new item;

— checking the performance of temporary links and similar items, when conditions do not permit a full acceptance test.

The performance limits are given in terms of a rating factor K, for which numerical values are assigned in the individual specifications for links and equipment. Rating factors may range from several per cent for a complex system down to less than ½% ($K = 0{\cdot}005$) for a single video amplifier. The basis of reference of the rating-factor method is distortion, consisting only of a single long-term echo, the rating factor then being numerically equal to the relative amplitude of the echo.

3. Test signal waveforms

3.1 *Pulse-and-bar test signal*

The composite pulse-and-bar test signal consists of a sine-squared pulse and a smoothed half-line bar associated with line-synchronizing pulses as shown in Fig. 14.

The sine-squared pulse should have alternative half-amplitude durations of 0·17 μs (a half-period of 3 Mc/s) and 0.33 μs (a whole period of 3 Mc/s), distinguished by the terms " *T*-pulse " and " 2*T*-pulse " respectively. The *T*-pulse is used in both the routine-test and acceptance-test methods, but the 2*T*-pulse is used only in the routine-test method. The precise shapes and durations of the pulses are determined by the pulse-shaping networks detailed in Fig. 19, operated under the indicated conditions or their equivalent.

For both the routine-test and acceptance-test methods, each of the bar transitions should have an integrated sine-squared shape with a 10–90% rise-time of 0·33 μs. These transitions are determined by a pulse-shaping network identical with that used for the 2*T*-pulse

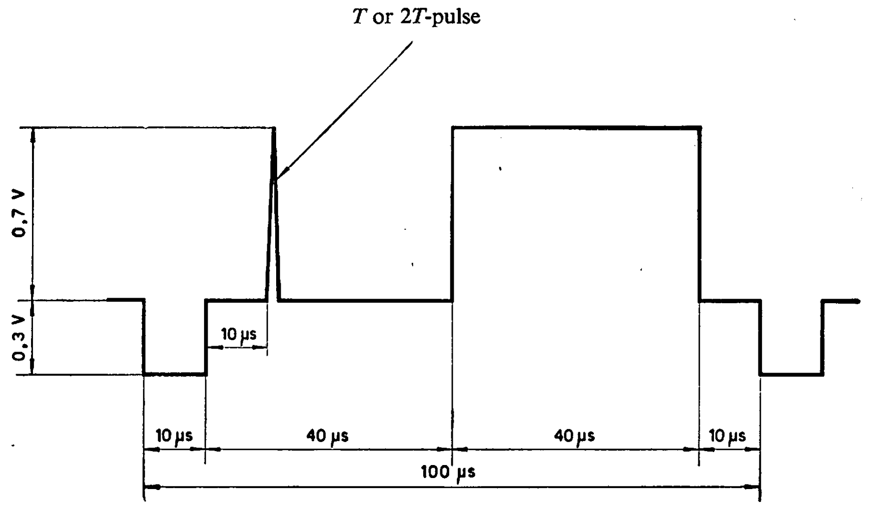


FIGURE 14

Pulse-and-bar test signal

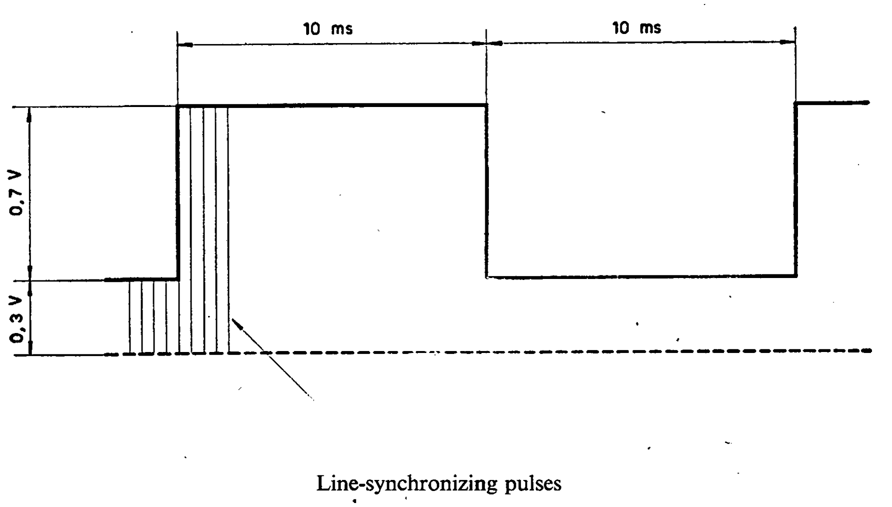


FIGURE 15

50 c/s square-wave test signal

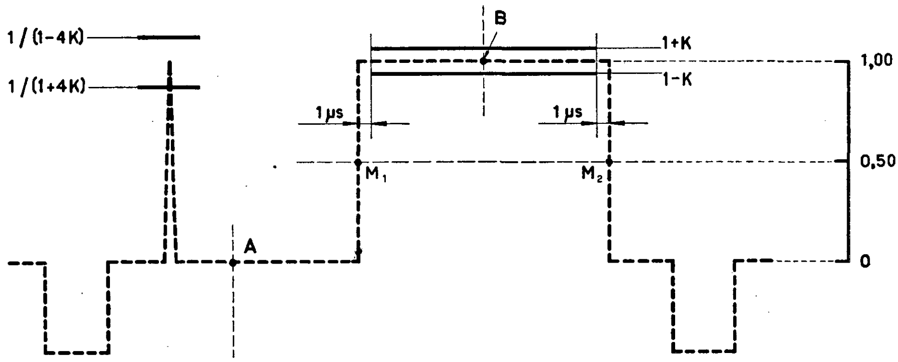
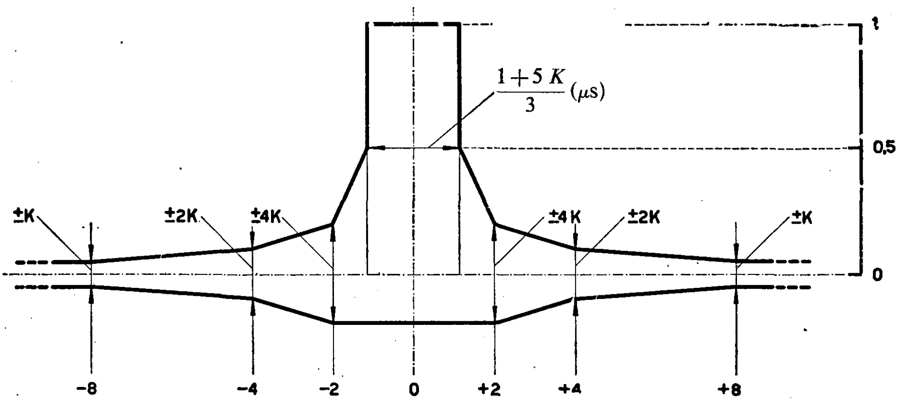


FIGURE 16

Limits of bar response



Unit interval = 1/6 μs

FIGURE 17

Limits of 2T-pulse response

the input waveform being specified to have transitions with 10–90% rise times not exceeding 0·07 μs.

3.2 *50 c/s square-wave test signal*

This consists of a 50 c/s square wave associated with line-synchronizing pulses as shown in Fig. 15.

4. Routine-test method

To meet a specified rating factor K, the responses to the test signals should fall within the limits stated in the following sub-sections.

4.1 *Bar response*

The limits are indicated by the oscilloscope mask shown in Fig. 16. The oscilloscope is to be adjusted so that the half-amplitude points of the bar transitions coincide with M_1

and M_2, and the mid-points of the 40 μs " black " and " white " portions coincide with A and B respectively. The response should then fall within the $\pm K$ limits indicated by the full lines, which extend to 1 μs from each transition.

4.2 *2T-pulse response*

The limits are indicated by the oscilloscope mask shown in Fig. 17. The oscilloscope is to be adjusted so that:

— the sweep velocity corresponds with the time scale indicated;

— the " black " level of the response coincides with the horizontal axis;

— the peak of the response falls on the unit amplitude line;

— the half-amplitude points of the response are symmetrically disposed about the vertical axis.

4.3 *Bar-to-pulse ratio*

The ratio of the amplitude of the bar response to the amplitude of the 2T-pulse response should fall within the limits ($1 \pm 4\,K$). The amplitude of the bar is taken as the amplitude difference between the points A and B already defined; the amplitude of the pulse is the difference between the " black " level and the peak of the response. These limits are also shown in Fig. 16.

4.4 *T-pulse response*

Irrespective of the assigned rating factor, the T-pulse response of any link should not show appreciable ringing at a frequency lower than 3.0 Mc/s. Apart from this, rigid limits cannot be specified, because the T-pulse has a frequency spectrum which extends far beyond 3 Mc/s, so that some irrelevant information must be present in the response of every normal link.

For some types of link, a partial solution is found in the use of a " 3·2 Mc/s link filter ". This is a member of a series of delay-equalized low-pass filters designed to have good waveform responses. In steady-state terms, its insertion loss is substantially constant up to 3·0 Mc/s, thence rises by about 3 db at 3·2 Mc/s (the ring frequency) and 20 db at 3·5 Mc/s. In the manufacture of these filters, the final adjustments are made with the aid of a sensitive waveform comparator and a standard filter, so that a high degree of uniformity of waveform response is achieved.

For any normal link the T-pulse response of which either rings at a frequency higher than 3·2 Mc/s, or shows no appreciable ringing, a 3·2 Mc/s link filter may be inserted between the link and the oscilloscope, to attenuate the irrelevant components of the response. Assuming, then, that the filter is dominant in determining the overall upper cut-off characteristic, the pulse-to-bar ratio of the overall response is a useful feature for measurement; it is closely related to the ratio which forms the basis of the third condition in the acceptance-test method (see § 5.2.3 of this Annex).

Under the conditions stated, it has been found empirically that, to meet a given rating factor, K, the T-pulse-to- bar ratio of the link plus filter should fall within the limits given by $0{\cdot}84/(1 \pm 6\,K)$. Thus, for a rating factor of 1%, the ratio should be between 79% and 89%. As the formula indicates, a ratio of 84% is given by the filter alone.

Other features of interest in the T-pulse response of the link plus filter are the lobes of ringing immediately before and after the main lobe of the response. The following is a rough guide to the maximum amplitude to be expected under normal conditions.

Lobe	Upper limit of lobe amplitude (percentage of bar amplitude)	
	$K = 1\%$	$K = 5\%$
First lobe (negative), leading or trailing	12	20
Second lobe (positive), leading or trailing	8	12

Although the amplitudes of other lobes may be of importance in some cases, it is not possible to offer further general guidance at present.

4.5 *50 c/s square-wave response*

The limits are indicated by the oscilloscope mask shown in Fig. 18. As for the bar response, the oscilloscope is to be adjusted so that the waveform passes through the four marked points, the synchronizing pulses being ignored.

5. Acceptance-test method

5.1 *Bar response*

The limits are identical with those given in § 4.1 for the routine-test method.

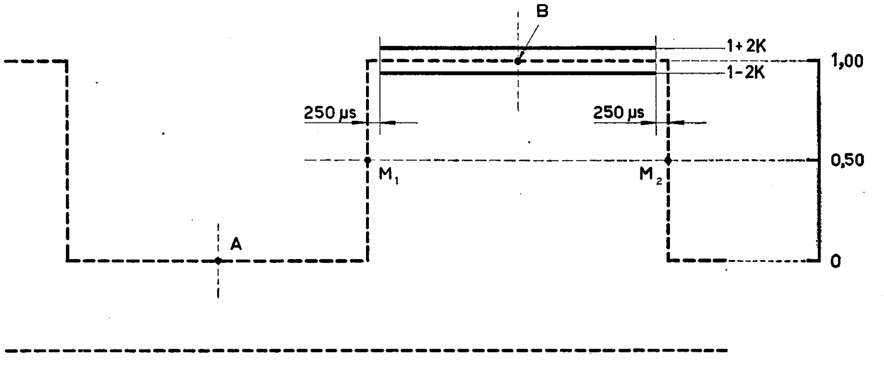


FIGURE 18

Limits of 50 c/s square-wave response

5.2 *T-pulse response*

From the measured *T*-pulse response and the measured or assumed responses of the measuring equipment itself, the " filtered impulse response " is derived and expressed in the form of a normalized time series. The " main " term of this series represents the ideal or non-distorting part of the transmission properties of the item under test, while the " echo " terms represent the distorting part. To meet a specified rating factor, *K*, the amplitudes of the echo terms should be such that each of the following four conditions is met.

Let the time series representing the filtered impulse response be

$$B(rt) = \dots\dots\; B_{-r} \;\dots\dots\; B_{-1}\, B_0\, B_1 \;\dots\dots\; B_r \;\dots\dots$$

and assume that this has already been normalized so that $B_0 = 1$.

Let the serial product of $B(rT)$ and the series (½, 1, ½) be

$$C(rT) = \dots\dots\; C_{-r} \;\dots\dots\; C_{-1}\, C_0\, C_1 \;\dots\dots\; C_r \;\dots\dots$$

where $C_r = \tfrac{1}{2}B_{(r-1)} + B_r + \tfrac{1}{2}B_{(r+1)}$

5.2.1 *The first condition is :*

$$\frac{1}{8}\left|\frac{C_r}{C_o} - \frac{1}{2}\right| \leqslant K \qquad r = \pm$$

and

$$\frac{1}{8}\left|r\frac{C_r}{C_o}\right| \leqslant K \qquad \begin{cases} -8 \leqslant r \leqslant -2 \\ +2 \leqslant r \leqslant +8 \end{cases}$$

and

$$\left|\frac{C_r}{C_o}\right| \leqslant K \qquad \begin{cases} r \leqslant -8 \\ +8 \leqslant r \end{cases}$$

5.2.2 *The second condition is :*

$$\frac{1}{4}\left|\frac{1}{C_o}\left|\sum_{-8}^{+8} B_r\right| - 1\right| \leqslant K$$

5.2.3 *The third condition is :*

$$\frac{1}{6}\left|\left(\sum_{-8}^{+8} B_r\right) - 1\right| \leqslant K$$

5.2.4 *The fourth condition is :*

$$\frac{1}{20}\left(\sum_{-8}^{+8}|B_r| - 1\right) \leqslant K$$

The series $C(rT)$ represents fairly closely the response to a $2T$-pulse. The first condition corresponds approximately to the limits indicated in Fig. 17 for the $2T$ response in the routine-test method. The second condition corresponds to the limits placed on the bar-to-pulse ratio in the routine-test method. The third condition corresponds to limits placed on the bar-to-pulse ratio of the response to a hypothetical pulse-and-bar test signal in which the pulse is an ideal filtered impulse. The fourth condition is an upper limit placed on the average amplitude, ignoring signs, of the 16 central echo terms.

5.3 *50 c/s square-wave response*

The limits are identical with those given in § 4.5 for the routine-test method.

Sine-squared pulse-shaping network

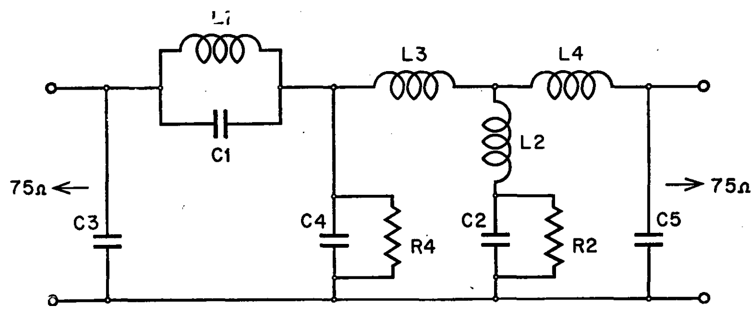


FIGURE 19

Component	Value (Note 7) Half-amplitude duration (μs) 1/6	1/3	Tolerance (± %)	Q (Note 3)
L_1	1·580	3·159	1	⩾ 70
L_2	0·308	0·617	(Note 2)	⩾ 50
L_3	3·091	6·182	1	⩾ 100
L_4	3·035	6·069	1	⩾ 100
C_1	79·22	158·4	2	
C_2	2168	4335	0·5	
C_3	75·92	151·8	2	
C_4	566·4	1133	0·5	
C_5	166·4	332·9	2	
R_2	1300	1300	5	
R_4	5100	5100	5	

Note 1. — Inductances are given in μH, capacitances in pF, resistances in ohms.

Note 2. — Inductor L_2 should be adjusted to make the insertion loss a maximum at 6·156 Mc/s for the 1/6 μs network, and at 3·078 Mc/s for the 1/3 μs network.

Note 3. — The values of Q should be measured at 4 Mc/s for the 1/6 μs network, and at 2 Mc/s for the 1/3 μs network.

Note 4. — The network should, if necessary, be connected between masking pads designed to present impedances of 75 $\Omega \pm 1\%$ to the network under operating conditions.

Note 5. — An allowance for stray capacitance should be made in the value of any capacitor.

Note 6. — The design is from " solution 3 " given by W. E. Thomson: " The synthesis of a network to have a sine-squared impulse response ". Proc. I.E.E., **99**, part III, 373 (1952).

Note 7. — The half-amplitude durations of the input pulses should not exceed 0·035 μs and 0·07 μs for the 1/6 μs and 1/3 μs networks respectively.

ANNEX V

INDICATION OF THE CHARACTERISTICS OF CIRCUITS SHORTER OR LONGER THAN THE HYPOTHETICAL REFERENCE CIRCUIT

1. Introduction

The purpose of this Annex is to give some indication of what may be expected for the characteristics of average circuits shorter or longer than the hypothetical reference circuit. The figures which can be calculated using Table II give only an indication of the value, as the actual statistical laws of addition for distortion and noise are not completely known, and should not be used directly when considering specifications.

2. Laws of addition

If D_3 = distortion (expressed and measured as given in this Recommendation), permitted in the hypothetical reference circuit (consisting of 3 sections defined in § 1.2 of this Recommendation), or the parameter derived therefrom and indicated in Table II,

and D_n = distortion (or the parameter mentioned above) permitted in n sections

then $D_n = D_3 \cdot (n/3)^{1/p}$

where p should have the value 1, 3/2 or 2 in accordance with Table II; $p = 1$ gives linear addition, $p = 3/2$ gives the " three-halves power " law of addition; $p = 2$ gives r.s.s. or quadratic addition.

Values of $(n/3)^{1/p}$ are calculated in Table I below.

TABLE I

n	$(n/3)^{1/p}$ for		
	$p = 1$	$p = 3/2$	$p = 2$
1	0·33	0·48	0·58
2	0·67	0·76	0·82
3	1·00	1·00	1·00
4	1·33	1·21	1·15
5	1·67	1·41	1·29
6	2·00	1·59	1·41
7	2·33	1·76	1·53
8	2·67	1·92	1·63
9	3·00	2·08	1·73

3. Examples of the use of Tables I and II

3.1 In the hypothetical reference circuit, if the tolerance on gain is ± 1 db, the tolerance on gain for a video section will (with $p = 2$) be:

$$D_1 = D_3 \sqrt{1/3} = D_3 \times 0 \cdot 58 = \pm\, 0 \cdot 58 \text{ db.}$$

3.2 In the hypothetical reference circuit, if the tolerance on the signal-to-noise ratio is 50 db, the tolerance on the signal-to-noise ratio for a 9-section circuit will be calculated as follows (with $p = 2$):

TABLE II

Relevant section of this Recommendation	Characteristic	D_s expressed in	p	Note
3.1	*Insertion gain* (tolerance)	db	2	
3.2	*Insertion gain variation*			
	short period	db	2	
	medium period	db	2	
3.3.1	*Continuous random noise*			
	signal-to-noise ratio			1
3.3.2	*Periodic noise*			
	signal-to-noise ratio	amplitude of noise		
	power-supply hum		2	2
	1 kc/s to 1 Mc/s		2	3
	1 Mc/s to f_c		2	3
3.3.3	*Impulsive noise*	amplitude of noise		4
3.4	*Non-linearity distortion*			
3.4.2	Picture signal	$(1-m/M)\times 100\%$	3/2	
3.4.4	Synchronizing signal	%	3/2	
3.5	*Linear waveform distortion*			
3.5.1	Field-time	%	1	
3.5.2	Line-time	%	2	5
3.5.3	Short-time			
	Overshoot and ringing	mask	2	5
	Rise-time	μs	no law	5
3.6	*Steady-state characteristics*			
	Attenuation/frequency	db	3/2	6
	Envelope-delay/frequency	μs	3/2	6

Note 1.— For circuits on coaxial cables, the law $p = 2$ is applicable to the r.m.s. amplitude of the noise;
for circuits on radio links, see Recommendation 289.

Note 2.— As there could be in-phase addition of noise due to power supplies, it may be advisable to put $p = 1$ for systems much shorter than the hypothetical reference circuit or when the power supply stations feeding all the repeaters are not interconnected.

Note 3.— Periodic noise may comprise many discrete frequencies between the limits indicated. Where the interfering waves on different sections are very close in frequency, arithmetic addition ($p = 1$) should be used.

Note 4.— When impulsive noise causes interference during a small percentage of the time (less than 0·1% for example), an arithmetic addition of the time will apply.

Note 5.— For these parameters, the Administration of the United Kingdom will use the method described in Annex IV to this Recommendation for the 405-line system. The three-halves power law ($p = 3/2$) has been found to apply to the rating factor K.

Note 6.— In Canada and U.S.A., the practice is to use $p = 2$.

noise amplitude for the hypothetical reference circuit: D_3;

noise amplitude for the 9-section circuit:

$$D_9 = D_3 \sqrt{9/3} = D_3 \times 1 \cdot 73$$

signal-to-noise ratio for the 9-section circuit:

$$\frac{S}{D_9} = \frac{S}{D_3} \times \frac{1}{1 \cdot 73} \text{ or, in db;}$$

$$\left[\frac{S}{D_9} \right] \text{db} = 50 - 4 \cdot 8, \text{ i.e. about 45 db.}$$

3.3 In the hypothetical reference circuit, if the tolerance on non-linearity is 20%, the tolerance on non-linearity for a video section will be (with $p = 3/2$):

$$D_1 = D_3 \, (1/3)^{2/3} = D_3 \times 0.48$$

$$D_1 = 20 \times 0 \cdot 48 = 9 \cdot 6\%$$

REPORT OF SECTION E: SOUND BROADCASTING AND TELEVISION

E. 1 — Audio-frequency and recording

REPORT 79 *

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Study Programme 161(X))

(Warsaw, 1956)

In conformity with the recommendation appearing in § 3 of Study Programme 161(X), exchanges of test tapes have taken place during 1954 and 1955 between a number of broadcasting organizations. The results obtained have been reported in: Doc. 198 (France), Doc. 235 (United Kingdom), Doc. 292 (E.B.U.), Doc. 374 (Japan) (including comments from Denmark, France, Federal Republic of Germany and Switzerland) of Warsaw, 1956.

The results obtained have made it possible to assess the practical validity of the measuring methods described in Recommendation 261 and its Annex. Thus, it is now possible to exchange programmes recorded on magnetic tape at tape speeds of 15 and 7·5 in./s, with the assurance that the technical quality will correspond to the standard indicated in § 9 of Recommendation 261.

In the course of these exchanges, however, certain discrepancies have been observed for the extreme frequencies. These discrepancies are more systematic at low frequencies and seem to be due to the method of measurement.

A study of these discrepancies has shown that they can all be attributed to a difficulty in applying the definition of the " ideal head ", as it appears in § 9 of Recommendation 261.

Since an ideal reproducing head is defined as a ferromagnetic reproducing head, the losses of which are negligible, it is important to know precisely the losses of heads normally used to construct a reproducing system equivalent to an ideal head.

Recommendation 261, mentions explicitly two types of losses:

— those dependent on frequency,

— those due to the gap length,

and in the Annex to Recommendation 261, practical methods are given for measuring these.

During the exchange of test tapes, it was found that in certain cases, attention should be given to other losses, for example, those due to the imperfect contact between the tape and the head, and those due to the dimensions of the core of the ferromagnetic head.**

It is not impossible that, in the future, new causes of losses may be discovered.

For these reasons it will be necessary in the future to decide on a new wording that will eliminate the concept of the ideal head and will define only the state of magnetization of the tape, and indicate methods for measuring this for all frequencies.

It appears that the study of these problems is not yet sufficiently advanced to permit this change to be made now. It has, therefore, been considered preferable to leave the Recommendation in its present form, adding only a note which describes the nature of the errors likely to be encountered at very low frequencies, and the means of avoiding them.

The study of the problems should be continued.

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* This Report was adopted unanimously.

** These losses, as well as those dependent on frequency, can be negative as well as positive.

REPORT 291 *

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Study Programme 161(X), Recommendations 261 and 265)

(Geneva, 1963)

Further investigations of the technique of sound recording, referred to in Study Programme 161(X), § 4, have led to the decision that a change in Recommendation 261, § 9.1, is desirable. This paragraph specifies the equalization to be used for a reproducing amplifier following an " ideal " head and used for the reproduction of tapes recorded at 19·05 cm/s (7½ in./s).

The current I.E.C. Recommendation (Publication 94, Clause D2) is the same as C.C.I.R. Recommendation 261, but consideration is being given in the I.E.C. National Committees to a revision of the I.E.C. Recommendation. At the same time, consideration is being given in the U.S.A. to a revision of the N.A.B. Recommendation for 19·05 cm/s (7½ in./s) magnetic tape.

To avoid, as far as possible, the publication of conflicting international standards, no change will be made to Recommendation 261 at the present time. After discussion of the various changes of bass and top equalization that have been proposed, it was the view of the C.C.I.R. that, if a change were to be made, the revised characteristic for 19·05 cm/s (7½ in./s) tape speed should be as in Recommendation 261, § 9.1, with only the change of the figure of 100 μs to the figure of 70 μs.

As far as recording on magnetic tracks on 16-mm film is concerned, it is the view of the C.C.I.R., that Recommendation 265 should remain unchanged for the time being, but if the change envisaged above for Recommendation 261 is carried out, it will then be necessary to change the wording of Recommendation 265, §§ 3.3.7 and 3.4.7, so that the curve specified for 16-mm film is not changed by the change in Recommendation 261. The equalization for 16-mm film would, therefore, remain at 100 μs, in conformity with the current Draft Recommendation of ISO TC/36.

REPORT 292 **

MEASUREMENT OF PROGRAMME LEVEL IN SOUND BROADCASTING

(Question 151, Study Programme 109)

(Geneva, 1963)

Question 151 asked " by what methods and by means of what equipment should the programme level be controlled in connection with recording, reproduction, and transmission over lines or radio links ? ".

As far as transmission over lines or radio links is concerned, C.C.I.T.T. Recommendation J. 14 applies and should be respected.

As far as recording and reproduction are concerned, there is no need for special methods of measurement different from those used for general purposes in broadcasting.

* This Report was adopted unanimously.

** This Report, which replaces Reports 33 and 117, and terminates the study of Question 151 and Study Programme 109, was adopted unanimously.

TABLE I

Principal characteristics of the various instruments used for monitoring the volume or peaks during programme transmissions

Type of instrument	Rectifier characteristics (Note 4)	Time to reach 99% of final reading (ms)	Integration time (ms) (Note 5)	Time to return to zero (value and definition)
(1) C.C.I.T.T. — " Speech voltmeter " British type 3 (S.V.3) identical to the speech power meter of the A.R.A.E.N.	2	230	100 (approx.)	equal to the integration time
(2) C.C.I.T.T. — V.U. meter (United States of America) C 16.5 - 1954 A.S.A. (Note 1)	1·0–1·4	300	165 (approx.)	equal to the integration time
(3) C.C.I.T.T. — Speech power meter of the "S.F.E.R.T." volume indicator	2	around 400–650	200	equal to the integration time
(4) C.C.I.T.T. — Peak indicator for programme transmission used by the B.B.C. (B.B.C. Peak Programme Meter) (Note 2)	1	around 12	4	3 seconds for the pointer to fall 26 db
(5) C.C.I.T.T. — Maximum amplitude indicator used by the Federal Republic of Germany (Type U 21)	1	around 80	5 (approx.)	1 or 2 seconds from 100% to 10% of the reading in the steady state
(6) I.B.T.O. — Programme level meter:		for both types:		for both types:
Type A sound meter		less than 300 ms for meters with pointer indication and	10 ± 5	1·5 to 2 seconds from " 0 db " point at 30% of the length of the operational section of the scale
Type B sound meter		less than 150 ms for meters with light indication	60 ± 10	

Methods of measuring programme levels in sound broadcasting have been under consideration by the C.C.I.R. for many years and, as was indicated in Reports 33 and 117, it has not been possible to reach agreement on the use of a single type of meter.

Report 117 noted that it was desirable to retain Question 151, because research was in progress and new information might become available. Since then only one new proposal has emerged, namely, that two meters specified by the I.B.T.O. should be adopted as international standards. These meters, however, are rather similar to the peak-type meters that have hitherto been discussed in the C.C.I.R. and there seems to be little likelihood that they could be universally adopted. It is not possible, therefore, to do more than state the present practices and Table I shows the fundamental characteristics of the meters that are recommended at present by the C.C.I.T.T., together with those recommended by the I.B.T.O.

This Report is, as far as possible, a reply to Question 151, and terminates Study Programme 109.

Nevertheless, it may become desirable, at some time in the future, to establish a new Study Programme for the whole problem of the measurement and control of the dynamic range of sound programmes.

Note 1.—In France, a meter has been standardized similar to that defined in item (2) of Table I.

Note 2.—In the Netherlands, a meter has been standardized (Type N.R.U.—ON301) similar to that defined in item (4) of Table I.

Note 3.—In Italy, a programme meter with the following characteristics is in use:

— Rectifier characteristic: 1 (see Note 4)

— Time to reach 99% of final reading: approx. 20 ms

— Integration time: approx. 1·5 ms

— Time to return to zero: approx. 1·5 s from 100% to 10% of the reading in the steady state.

Note 4.—The number given in the column is the index *n* in the formula $V_{out} = V^n{}_{in}$ applicable for each half-cycle.

Note 5.—The " integration time " was defined by the C.C.I.F. as the " minimum period during which a sinusoidal voltage should be applied to the instrument for the pointer to reach to within 0·2 Neper or nearly 2 db of the deflection which would be obtained if the voltage were applied indefinitely ". A logarithmic ratio of 2 db corresponds to 79.5% and a ratio of 0·2 Neper to 82%.

REPORT 293 *

AUDIO-FREQUENCY PARAMETERS FOR THE STEREOPHONIC REPRODUCTION OF SOUND

(Study Programme 199A(X))

(Geneva, 1963)

1. Introduction

Extensive studies have been carried out in several countries with regard to Study Programme 199A(X), § 6, which is concerned with the study of the subjective aspects of stereophonic sound reproduction.

This Report gives a summary of the results of these studies; the sections below refer respectively to work performed by the E.B.U., in the U.S.A. and in the U.S.S.R.; they deal exclusively with those audio-frequency parameters which are of importance in the reproduction of stereophonic sound.

2. **Doc. X/29 (E.B.U.) of Bad Kreuznach, 1962 and Doc. 206 (E.B.U.) of Geneva, 1963,** deal with the tolerances for faults affecting the quality of listening in stereophonic broadcasting. To determine these tolerances, the E.B.U. carried out investigations in which five European Broadcasting Organizations participated (A.R.D., R.T.F., RAI, N.R.U. and B.B.C.).

The investigations consisted of listening tests on stereophonic recordings into which faults of known values were deliberately introduced. The recordings were appraised by a very large number of listeners, comprising at the same time people professionally interested in stereophony and people without any particular musical education. Listening tests were made on all types of broadcast programme (speech, sound effects, symphonic music, chamber music, light music, opera, piano, etc.).

Values of the tolerances, obtained by statistical analysis of the results of the tests, are given in the Table below. It should be borne in mind that the results are valid for the following experimental conditions:

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* This Report was adopted unanimously.

— the complete transmission chain with the exception of the source equipment supplying the *A* and *B* signals and of the loudspeakers at the receiving end;

— where a single value is given, it indicates the limit of perceptibility of the fault. When the selected radio-frequency transmission system imposes less stringent conditions, a second value is given which is the acceptable limit. This latter limit could sometimes be that imposed by a fault introduced by propagation between the transmitter and receiver. It corresponds, however, to a fault which is not noticeable to the majority of listeners.

TABLE

Tolerances for stereophony
Limits of perceptibility and acceptable limits for faults

Parameters	Signals (1)	Values
Bandwidth	*M*, *A* and *B* *S*	Same bandwidth as for monophony; Same bandwidth (if necessary, attenuation for $f < 100$ c/s and $f > 10$ kc/s)
Crosstalk ratio (2)	*A* and *B*	– 26 db, or if necessary – 20 db from 100 c/s to 5 kc/s – 20 db, or if necessary – 14 db at 10 kc/s (6 db/octave for $f > 5$ kc/s)
Intermodulation (3)	*A* and *B*	– 40 db, or if necessary – 34 db
Harmonic distortion	*A* and *B*	– 40 db, or if necessary – 34 db
Non-linear crosstalk (4)	*A* and *B*	– 40 db, or if necessary – 34 db
Signal-to-noise ratio	*A* and *B*	50 db (desirable value)
Difference in volume (5)	*A* and *B*	1·5 db at all frequencies
Phase difference (6)	*A* and *B*	See Note 6 and Fig. 1

(1) *A* is the " Left " signal and *B* the " Right " signal; *M* is equal to $(A + B)$ and *S* to $(A - B)$.

(2) This concerns the linear crosstalk, introduced unintentionally between the *A* and *B* channels, due to imperfections in the transmission chain.

(3) Intermodulation is here defined as: " the relative level of a signal at the frequency $(f_1 - f_2)$, appearing in the *A* (or *B*) channel. when signals of equal amplitude at frequencies f_1 and f_2 respectively are applied to the *A* and *B* channels ".

(4) Non-linear crosstalk is here defined as: " the relative level of the harmonic of the *A* (or *B*) signal appearing in the *B* (or *A*) channel ".

(5) This concerns the unintentional difference in volume between the *A* and *B* signals.

(6) This concerns the unintentional phase difference between the *A* and *B* signals. The values are defined in a graphical representation having a logarithmic frequency scale, by segments of straight lines joining the following points (See Fig. 1):

— *limit of perceptibility*

Frequency (c/s)	50	200	3750	15 000
Phase difference	90°	30°	30°	90°

— *acceptable limit, if necessary*

Frequency (c/s)	50	200	2500	10 000	15 000
Phase difference	90°	45°	45°	90°	90°

3. **Doc. X/35 (U.S.A.) of Bad Kreuznach, 1962,** refers to the subjective aspects of stereophony, as considered by the United States in adopting standards for stereophonic broadcasting by frequency-modulated sound stations [1].

Testing laboratories, such as those of the Bell Telephone Laboratories [2] and the General Electric Company [3], examined the requirements for frequency response in the *M* and *S* channels and separation between the Left and Right channels. As a result of these examinations, the audio-frequency requirements, which have been standardized in the United States [4] are as follows:

3.1 the compatible signal, *M*, shall have a frequency response which is essentially flat between 50 and 15 000 c/s ;

3.2 the signal, *S*, shall have a frequency response which is essentially flat between 50 and 15 000 c/s;

3.3 the difference in amplitude response between the *M* signal and the *S* signal shall be maintained within 0·3 db over the audio-frequency range from 50 to 15 000 c/s.

3.4 the phase difference between the *M* signal and the *S* signal shall be maintained within 3·0 degrees over the audio-frequency range from 50 to 15 000 c/s.

Note. — The requirements of §§ 3.3 and 3.4 provide a stereophonic separation (crosstalk between *A* and *B*) of 30 db.

4. **Doc. X/45 (U.S.S.R.) of Bad Kreuznach, 1962,** gives the results of an investigation, carried out in the U.S.S.R., on the assessment of distortion and interference in two-channel stereophonic broadcasting systems by subjective statistical methods.

The method used to establish the perceptibility of distortion was that of comparison between a reproduction of a programme free from distortion and a programme into which pre-determined levels of distortion had been introduced. In some instances, preference for stereophonic or monophonic reproduction of the programme was also sought.

The persons who took part in the experiment were:

— qualified experts (sound broadcasting producers);
— ordinary persons, without special musical education and without training in observing distortion.

The results obtained were published in the form of graphs, showing the percentage perceptibility as a function of the degree of distortion or interference introduced.

A large amount of statistical material was used, and the experimental data thus obtained were analyzed by the methods of mathematical statistics.

Doc. X/45 gives the results for the following types of distortion:

— linear distortion of various types,
— non-linear distortion,
— background noise (sinusoidal) of various types,
— white noise,
— unbalance between the levels in the two channels,
— the effects of limitation of bandwidth in the channel carrying the difference signal.

These results may be taken as a basis for the standardization of the parameters of two-channel stereophonic broadcasting systems.

The criteria on which the classification of quality is established were based on the perceptibility of distortion; the following four classes of quality were established for broadcasting transmissions;

Highest class — This corresponds to sound in which distortion and interference were " practically imperceptible " to highly qualified experts and " quite imperceptible " to the remaining experts.

Class I — This corresponds to sound in which the perception of distortion and interference was " uncertain " to highly qualified experts and " practically imperceptible " to the remaining experts, when compared directly with sound of the highest class.

Class II — This corresponds to sound in which the perception of distortion and interference was " certain " to highly qualified experts and " uncertain " to the remaining experts, when compared directly with sound of the highest class.

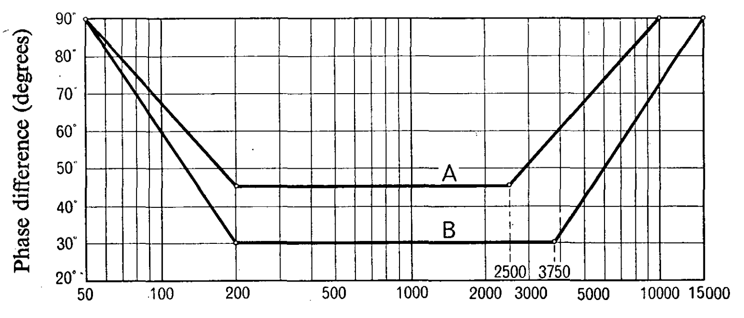
Class III — This corresponds to sound in which perception of distortion and interference are " certain ", when compared directly with sound of the highest class.

Note : " *Quite imperceptible* " means that the given type of distortion or interference was perceptible in less than 15% of the cases; this corresponds to the errors in the observers' assessment caused by the experimental conditions.

" *Practically imperceptible* " means that the given type of distortion or interference was perceptible in 15% to 30% of the cases; this corresponds to conditions in which the majority of the observers did not notice any distortion.

" *Uncertain* " means that the given type of distortion or interference was perceptible in 50% of the cases; in other words, the probability of perceiving this distortion is equal to the probability of not perceiving it.

" *Certain* " means that the given type of distortion or interference was perceived in more than 50% of the cases; on the average, the perceptibility was arbitrarily taken as 75% of the cases.



Frequency (c/s)

FIGURE 1

Phase-difference as a function of frequency

Curve A: acceptable limit, if necessary

Curve B: limit of perceptibility

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REPORT 294 *

RECORDING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES ON FILM

(Question 66(X) and Recommendation 265)

(Geneva, 1963)

Recommendation 265 sets up standards for films to be used for the international exchange of television programmes.

In Doc. 210 of Geneva, 1963, from the I.B.T.O., certain changes in Recommendation 265 are proposed. During the discussions in Study Group X, it became clear that certain changes and additions were desirable.

In Recommendation 265 some standards are defined by reference to ASA specifications. In accordance with Opinion 16 reference should be made to the international standards of the IEC and the ISO, where such standards exist. In other cases, reference may provisionally be made in the form of a footnote to known national standards which cover the case.

Various national and international film standards exist that differ slightly. Although the differences are small and do not seriously impede television programme exchange, it would nevertheless be preferable that a single international standard for 35 mm and 16 mm films be established, and it is suggested that this be brought to the attention of the IEC and the ISO.

It is also suggested that it would be useful to attach labels to the boxes in which the films are being sent. The information on these labels should be the same as that carried on the identification leader. This information should include, in addition to the items given in Recommendation 265, § 2.7, the total number of reels in the programme and the duration or length of film on each reel.

Films of type 16 MUTE and 35 MUTE should also be included in Recommendations 264 and 265.

Further investigations in the technique of photography have led to the decision that supplementary recommendations, referring to the characteristics and dimensions of the picture, would be desirable.

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* This Report was adopted unanimously.

Concerning the characteristics, recommendation of maximum and minimum values for the density of an image, as well as for the most important part of the picture and recommendation of tolerances for the gamma value within the range of densities to be recommended, are desirable. To achieve comparable results, methods of measurement for the density should be recommended as well. Some international or national standards or draft standards exist in this field (I.B.T.O. Doc. 210, SMPTE, ARD).

Concerning the dimensions, a recommendation for size and position of the scanned area seems also to be desirable for television scanning. Recommendations in this field have also been given by some international or national organizations (ISO TC36, W.G. 2; I.B.T.O. Rec. 14, ARD).

At the Xth Plenary Assembly of the C.C.I.R., time did not permit a complete study of these problems. They should therefore be put on the agenda for the next Interim Meeting of Study Group X.

REPORT 295 *

RECORDING OF MONOCHROME TELEVISION SIGNALS ON MAGNETIC TAPE

(Question 266(X))

(Geneva, 1963)

1.

1.1 At present, increasing use is being made of magnetic tape recordings of television programmes and many broadcasting organizations use magnetic tapes for the exchange of recorded programmes.

1.2 Such exchanges cannot be developed in a reliable way, except through adequate standardization of the methods used. However, since the relevant studies are still in progress, final standards for the principal characteristics of the systems used cannot yet be established.

1.3 Docs. X/21 (U.S.A.) and X/27 (E.B.U.) of Bad Kreuznach, 1962, show the basic steps towards standardization which have been made by the users of video tape machines. Examination of these documents reveals that there is already a large measure of agreement among the users. For example, these documents show that exchange of programmes between the 525- and 625-line systems can now be envisaged.

1.4 It is considered that the effort to achieve standardization should be continued and that all information regarding the characteristics of the present systems should be made available. The available data are given for information in the Table in Annex I.

2. Annexes II and III show several of the more important proposed standards and practices intended to facilitate the exchange of programmes.

3.

3.1 A frequency-modulated carrier is normally used for recording of video signals on magnetic tape. The instantaneous frequencies of this signal are located in the range above the highest video-frequencies in accordance with the different standards. Thus, the limits of the deviation range of the FM-signal are given by the upper end of the video band and the resonant frequency of the video heads. The exchange of video tapes takes place at present in accordance with two proposals. The frequencies of the modulated signal corresponding to the basic video levels are:

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* This Report was adopted unanimously.

	Frequency (Mc/s) corresponding to the levels:		
	Sync.	Blanking	White
SMPTE 525-lines	4·3	5·0	6·8
E.B.U. 625-lines	5·0	5·5	6·8

3.2 As far as current performance with the 625-line standards is concerned, it must be stated that bandwidth, transient response and signal-to-noise ratio are not quite satisfactory. These shortcomings are due to the comparatively small deviation range as indicated above. Improvement can be obtained by increasing the frequency excursion in the upward direction. This increase is, however, limited by the resonant frequency of the video head.

4. Docs. X/17 (F.R. of Germany) and X/32 (France) of Bad Kreuznach, 1962, describe recent experiments which show that this can be achieved, either by compensating the influence of the head resonance or by using heads with a higher resonant frequency. The frequency response of the FM channel has been made uniform, up to about 8 Mc/s, by these means.

The extension of the FM-range enables an optimum choice to be made of the basic video frequencies of the recorded signal. In experimental equipments, good results have been obtained with respect to video bandwidth, transient response and signal-to-noise ratio, using the following values:

	Frequency (Mc/s) corresponding to the levels:		
	Sync.	Blanking	White
ARD	5·1	5·8	7·6
RTF	5·7	6·3	7·7

The consideration of a higher upper frequency may, however, lead to possible further improvement in monochrome recording and also enable a common modulation frequency standard to be adopted for both monochrome and colour television recording.

Additional improvements in signal-to-noise ratio of about 6 db may be achieved by including pre- and de-emphasis networks in the FM channel of the recorder.

Further investigations and development work by the manufacturers of video tape recorders will be of great use in obtaining optimum quality of reproduced pictures in 625-line systems for 5 and 6 Mc/s video bandwidths.

5. Because manufacturers, at the present time, are supplying equipment having different video signal pre- and de-emphasis characteristics for the same television systems, there is an urgent need for standardization in this respect. Until this has been achieved, it would be desirable to state the video signal recording characteristic used for international programme exchange.

ANNEX I

System		525 lines (60 c/s)	625 lines (50 c/s)
Characteristics of relative motion between tape and head(s)	Tape speed Speed of rotation of the heads Number of tracks per field Number of tracks per second	38·1 cm/s (15 in./s) 240 r.p.s. 16 960	39·7 cm/s (15 $^5/_8$ in./s) 250 r.p.s. 20 1000
Control track	Control track signal-frequency (sine wave) Frequency of frame pulse Relative amplitude of the pulse in relation to the sine wave signal	240 30 150%	250 25 150%
Recorded frequencies corresponding to the video levels (see § 3)	Sync. level Blanking level White level	4·3 Mc/s 5 Mc/s 6·8 Mc/s	5·0 Mc/s 5·5 Mc/s 6·8 Mc/s
Dimensions of magnetic tape	Width Maximum thickness	50·8 mm (2 in.) 0·038 mm (0·0015 in.)	
Guide radius		26·248 mm (1·0334 in.)	

ANNEX II

OPERATIONAL MEASURES TO FACILITATE THE EXCHANGE OF PROGRAMMES ON 625 LINES

1. Splices

Should comply with SMPTE, VTR 16.4.

2. Cue track

Except by special arrangement, the cue track should always be at the disposal of the receiving organization and should not carry any information the reproduction of which is essential.

3. Arrangement of reels

Recordings of a single programme of up to 90 minutes duration should preferably be on one reel. Separate programmes should always be on separate reels.

4. Tape leaders

Duration (s)	Picture	Sound
10	none	none
60 minimum	alignment signal	audible tone at reference level (1)
15	programme identification (2)	spoken identification
8	either black level or cue	either silence or cue
2	black level	none

(1) Reference level is 9 db below the peak level recorded.
(2) Programme identification may be in picture or in sound or preferably in both.

The synchronizing signal should be continuous for at least 10 s and preferably for 25 s before the beginning of the programme.

At the end of the programme there should be the following:

Duration (s)	Picture	Sound
30	black level	none
10	none	none

ANNEX III

PROPOSED U.S.A. STANDARDS AND SMPTE RECOMMENDED PRACTICES FOR VIDEO TAPE RECORDINGS 525-LINE, 60 C/S

Status of SMPTE video tape standards (as of 21 June 1961)

Number		Status *
VTR 16.1	Dimensions for 2-inch video magnetic tape reels	2
VTR 16.2	Dimensions for 2-inch video magnetic tape	4
VTR 16.3	Specifications for video tape leader	4

* 1. Under consideration by Video Tape Committee.
2. Was published in SMPTE Journal for comment period. Has been revised and is back in the SMPTE Video Tape Recording Committee.
3. Approved by SMPTE/V.T.R. Committee and submitted to SMPTE Standards Committee.
4. Was published in SMPTE Journal.

VTR 16.4	Recommended practice for splices in magnetic video recording tape	4
VTR 16.5	Characteristics of the audio recording for 2-inch video magnetic tape recording	4
VTR 16.6	Dimensions for video, audio and control recording on 2-inch video magnetic tape	1
VTR 16.7	Recommended practice—modulation levels for monochrome 2-inch video magnetic tape recording	4
VTR 16.8	Speed for 2-inch video magnetic tape	4
VTR 16.9	Recommended practice—tape vacuum guide radius and position for recording standard video records on a 2-inch magnetic tape	3
VTR 16.10	Recommended practice—control track record for 2-inch video magnetic tape recordings	1
VTR 16.11	Recommended practice—signal specifications for a monochrome video alignment tape for 2-inch video magnetic tape recording	4
Unassigned	Pre-emphasis/de-emphasis	1

E. 2 — Radio-frequency

REPORT 32 *

HIGH-FREQUENCY BROADCASTING

Directional antenna systems

(Question 23(X))

(London, 1953)

Question 23(X) is concerned with the reduction of subsidiary lobes in high-frequency broadcasting directional antenna systems, for the purpose of avoiding interference in frequency sharing. This interference is generally caused by the radiation pattern of the transmitting antenna having subsidiary lobes in unwanted directions, or by scatter of the energy of the main lobe, due to propagation anomalies. Reduction in intensity of the subsidiary lobes is possible by correct antenna design, while the propagation scatter in unwanted directions presents a complex problem, and its effect should be treated statistically.

A large amount of work has been done on the properties of directional antennae and on the elimination of subsidiary lobes. Foster [1] has shown that, by proper choice of rhombic antenna parameters, optimum subsidiary lobe reduction can be obtained, within a limited frequency range, without significant impairment of the main lobe. A convenient method of design of such an antenna is presented by Laport [2]. Further improvements in subsidiary-lobe reduction can be achieved by stacked or coplanar arrays as shown by Christiansen [3, 4, 5]. Such arrays, although more complex, will provide a more satisfactory pattern than a single antenna.

In broadside arrays, reduction of subsidiary lobes is, in general, accomplished to a higher degree than in the rhombic arrays; using the binomial distribution [6], the subsidiary lobes can be elimated to a large extent although the main beam is slightly broadened. A narrower beam with small subsidiary lobes is possible by applying the Dolph-Tchebyscheff distribution [6, 7]. Thus, for a maximum subsidiary lobe intensity 20 db below that of the main lobe, it is possible to get a beamwidth of 27°. It should be noted that Christiansen [5] attains results from a four-unit array of rhombics which are equivalent to large arrays of tuned elements. He confirmed this on radiotelegraph circuits over a period of some years.

Reduction of subsidiary lobes when the main beam is slewed, is a difficult problem, as the angle of slew, type of antenna, and distortion of its radiation pattern must be considered. This makes it more difficult to give general rules for subsidiary-lobe reduction.

A type of array commonly used [8], consists of four rows of radiating elements, each containing four elements with the lowest row one wavelength above ground. The array is normally provided with a reflector, and the feeder arrangements usually allow for reversing or slewing. The slewing in azimuth of the direction of maximum radiation of this type of array is achieved by the adjustment of the relative phase of the current distribution between the left and right halves of the array. The limit of effective slewing by this means can be taken as 17° on either side of the normal direction, but the amount of slew commonly used does not as a rule exceed 15°.

While this method of slewing does not appreciably affect the horizontal width of the main lobe of radiation, it does increase its asymmetry and at the same time produces a principal subsidiary lobe of considerable intensity. The ratio of the field strength of the main lobe in a slewed array, compared with that in the unslewed condition has been determined theoretically; for the type of antenna under discussion the ratios for 0°, 5°, 10° and 15° of slew would be 1·0, 0·98, 0·94 and 0·84. Similarly the ratio of the field strength of the principal subsidiary lobe to that of the

* This Report was adopted unanimously.

main lobe can also be determined and for the same angles of slew would be 0·18, 0·27, 0·45 and 0·7 respectively. These theoretical figures are in close agreement with measured values [9].

Although it is possible, as described in the publications mentioned above, to achieve a substantial degree of suppression of side lobes with either rhombic or curtain arrays, the methods so far employed introduce mechanical difficulties and increase the cost. It is therefore proposed that further consideration be given to the best method of specifying a degree of suppression, for example:

— by limiting radiation in a specified direction, so as to avoid interference in the reception area of another transmission, to a certain proportion of that given by an omnidirectional antenna;

— by limiting the radiation over a wide angle, which excludes the main lobe and any neighbouring strong subsidiary lobes, to a certain proportion of that given by an omnidirectional antenna;

— by limiting radiation in all directions, other than those comprised in the main lobe, to a certain proportion of that given by an omnidirectional antenna.

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REPORT 77 *

FREQUENCY-MODULATION SOUND BROADCASTING IN THE VHF (METRIC) BAND

(Question 150)

(Warsaw, 1956)

In the study of Question 99 at the VIIIth Plenary Assembly, it became evident that not enough experience was as yet available to determine the protection ratios required in § 3 of the Question.

* This Report was adopted unanimously.

The following figures were examined:

	(1)	(2)	
For co-channel working	20 db	26 db	for 99% of the time
For carriers spaced at 100 kc/s	10 db	10 db	
,, ,, ,, 200 kc/s	0 db	6 db	
,, ,, ,, 300 kc/s	– 10 db	0 db	
,, ,, ,, 400 kc/s	– 20 db	– 12 db	

Figures under (1) resulted from tests with receivers provided with a suitable limiter preceding the discriminator or ratio detector and with characteristics:

kc/s off-tune	0	50	100	200	300
response (db)	0	0	– 3	– 20	– 36

Figures under (2) resulted from using about 20 different types of receivers and are an average of the results.

A figure of 30 db for co-channel working was also proposed, as necessary to give an entirely satisfactory quality and, in fact, to give a quality superior to the minimum quality required for the sound channel in television (Recommendation 418, § 6).

REPORT 296 *

HIGH-FREQUENCY BROADCASTING

Protection at a great distance by the use of directional antennae

(Recommendation 80, Study Programme 23A(X))

(Geneva, 1963)

The United Kingdom and the Republic of South Africa have carried out an experimental study of the real protection obtained at a great distance by the use of directional antennae in the HF band. This was done by comparing, in South Africa, the field strength produced by two transmitting antennae located at the same and at different sites in the United Kingdom, directed towards South Africa and South Asia respectively. Frequencies in the 21 Mc/s broadcasting band were used. A system of simultaneous reception with signal strength recordings enabled the effects of short-term propagation variations to be reduced to a minimum and a large number of measurements was made to take account of longer-term variations.

It was observed that the real protection provided by the transmitting antennae at the same site was, under these conditions, about 22·5 db (average value), as compared with a protection of 19 db calculated on the basis of Recommendation 80. The protection deduced from the theoretical antennae characteristics was about 38 db.

Using transmitting antennae at different sites, which were separated by 250 km, the real protection as measured was 21·3 db (average value), as compared with a protection of 16 db calculated on the basis of Recommendation 80. The protection deduced from theoretical antennae considerations was in this case about 35 db.

The difference between the measured value and that calculated on the basis of Recommendation 80 is considered to be sufficiently small to establish the validity of the Recommendation in these particular cases. However, many more measurements will need to be carried out, using different antennae, frequencies and transmitter sites, before the general validity of the Recommendation can be confirmed.

It is hoped to extend these studies, which are of particular interest to the I.F.R.B.

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* This Report was adopted unanimously.

REPORT 297 *

HIGH-FREQUENCY BROADCASTING

Bandwidth of emissions

(Stockholm, 1948 — Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

1. Introduction

Listening tests have been made in connection with this problem, on the quality of reception obtainable on short waves and the effects of a reduction of the occupied bandwidth. From these tests, it has been deduced that, although there will be some loss in quality if the audio-frequency band is limited to a highest modulating frequency of 6400 c/s, this loss is not serious. Tests have also been made in which the audio-frequency band has been restricted to a highest modulating frequency of 5000 c/s, when, however, the loss in quality becomes quite noticeable.

2. Causes of unsatisfactory reception

One of the main causes of unsatisfactory reception is the presence of heterodyne interference between the sidebands of different stations or between the sidebands of the transmission of one station and the carrier-frequency of a different station. To some extent, this type of interference can be offset by the listener, who can so adjust his receiver that the interference is either eliminated or reduced.

3. Conclusions

3.1 Unless, in specific instances, it is clearly necessary and effective for eliminating interference, the suppression of desirable portions of the occupied bandwidth should be avoided. It is therefore considered desirable, that the normal bandwidth of the modulating frequencies should not exceed 6400 c/s.

To make bandwidth restrictions as effective as possible, steps should be taken to minimize the radiation of harmonic and intermodulation products in the transmitter and to avoid over-modulation, with its inherent production of spurious frequencies.

3.2 At the present time, and with carrier-frequency separation of 10 kc/s, there is no evidence that interference will be caused to the average receiver, by the transmission of normal signal intensities in those portions of the sidebands 5 to 6·4 kc/s from the carrier-frequency. It does not appear that a reduction in the wanted-to-unwanted signal ratio will change this conclusion, as far as present types of receivers are concerned. However, the use of pre-emphasis, more sensitive receivers and modified signal protection ratios, or a combination of these factors, may cause the transmission of energy at modulating frequencies, up to 5000 c/s and 6400 c/s respectively, to assume a new importance.

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* This Report, which replaces Report 174, was adopted unanimously.

REPORT 298 *

PROTECTION RATIOS FOR AMPLITUDE-MODULATION SOUND BROADCASTING **

(Question 262(X) and Resolution 497 of the Administrative Council of the I.T.U.)

(Geneva, 1963)

1. Introduction

This Report is a summary of the information available on the subject of protection ratios for amplitude-modulation sound broadcasting services.

The values of protection are required to be known, as they serve as basic data for use in frequency assignment conferences *** and as basic reference data for the appraisal of new techniques or procedures to be introduced, such as:

— compatible single-sideband modulation, Question 205(X) and Study Programme 205A(X);

— reduction of radiated bandwidth, Question 262(X);

— use of the sky-wave to increase the service area;

— use of filter devices at the receiver.

A great amount of research work has been carried out since the beginning of broadcasting, but, in view of the development of technique since then, this Report is confined to results obtained after 1948.

2. Data available on protection ratios

The curves reproduced in Report 302 represent the data at present available on the subject of Question 102(XII) and Study Programme 102C(XII) and refer principally to the protection ratios required to provide an acceptable broadcasting service in the Tropical Zone in the shared bands. Further information on protection ratios may be found in a paper [1], published in the Federal Republic of Germany and in Docs. X/13 (India) and X/20 (U.S.A.) of Bad Kreuznach, 1962.

In Doc. 218 (France) of Geneva, 1963, the protection ratios necessary for a ground-wave service are shown to be 40 db for 0 kc/s $\pm$ 20 c/s spacing and 46 to 50 db for 5 kc/s spacing, for receivers not fitted with special filters.

2.1 *Protection ratios for ground-wave services*

The lack of standardized measuring techniques has led to wide differences in the published results. For example, some of the figures and curves presented relate to measurements made with limited types of wanted and unwanted programme material, whilst others cover a much wider range. Moreover, certain parameters such as receiver characteristics, emitted bandwidth and degree of listener satisfaction vary widely and, in consequence, some caution must be exercised in applying the available data to problems of frequency planning.

The C.C.I.R. considers that it is necessary to establish protection ratio values for AM sound broadcasting that are acceptable to Administrations.

* This Report was adopted unanimously.

** The protection ratios quoted refer, in all cases, to the ratios at the input to the receiver, no account having been taken of the effect of using directional receiving antennae.

*** According to an Administrative Council Resolution, it is proposed that such a conference be held in 1964 in Madrid.

2.2 *Protection ratios for sky-wave services*

A characteristic of the sky-wave service is that propagation effects usually bring about a degradation of the received signal quality, e.g., distortion due to selective fading. Because of these factors, it is considered that lower values of protection ratios should be applied to a sky-wave service as compared with a ground-wave service, the precise values depending upon whether the service is of a primary or secondary nature.

2.3 *Data used by the I.F.R.B.*

In its technical examination of frequency notifications, according to the terms of Article 9 of the Radio Regulations, Geneva, 1959, the I.F.R.B. uses the figures for protection ratios and receiver discrimination contained in its own Technical Standards, Series A, Second Edition, 1958. For most frequency separations, application of these standards results in protection ratios considerably lower than the measured results referred to in § 2 and § 2.1.

3. Subjective assessment of the quality of reception

Doc. X/53 (U.S.S.R.) of Bad Kreuznach, 1962, gives the results of statistical and subjective tests carried out in the U.S.S.R., on the effects of distortion and interference in a broadcast channel.

The tests were performed using a statistical-subjective method, using special equipment which enabled a comparison to be made between an undistorted sound programme and a second programme, into which predetermined levels of distortion had been injected.

The object of these experiments was to determine the perceptibility of distortion and the following groups of listeners participated:

— qualified experts (sound-broadcasting producers),

— observers without special musical education and without training in the observation of distortion.

The results of these experiments were published in the form of graphs, showing the percentage of perceptibility as a function of the level of the distortion or interference injected.

All these tests were made on the basis of a large amount of statistical data. The correctness of the data obtained was checked by the methods of mathematical statistics. Results were given (see Doc. X/53), in terms of:

— linear distortion of different types (at various levels and for different frequency ranges),

— non-linear distortion (cubic, quadratic and " central-cut off " types),

— background noise (sinusoidal),

— white noise.

In the same document, a system of classification for the estimation of quality of reception is given.

Four classes of quality of reproduction are recommended. They are established on the basis of the degree of perceptibility of distortion and are:

Highest class — This corresponds to sound in which distortion and interference were " practically imperceptible " to highly qualified experts and " quite imperceptible " to the remaining experts.

Class I — This corresponds to sound in which the perception of distortion and interference was " uncertain " to highly qualified experts and " practically imperceptible " to the remaining experts, with direct comparison with sound of the highest class.

Class II — This corresponds to sound in which the perception of distortion and interference was " certain " to highly qualified experts and " uncertain " to the remaining experts, with direct comparison with sound of the highest class.

Class III — This corresponds to sound in which the perception of distortion and interference is " certain ", with direct comparison with sound of the highest class.

Note : " *Quite imperceptible* " means that the given type of distortion or interference was perceptible in less than 15% of the cases; this corresponds to an error in the experts' assessment caused by the experimental conditions.

" *Practically imperceptible* " means that the given type of distortion or interference was perceptible in 15% to 30% of the cases; this corresponds to conditions in which the majority of the experts did not notice any distortion.

" *Uncertain* " means that the given type of distortion or interference was perceptible in 50% of the cases; in other words, the probability of perceiving this distortion is equal to the probability of not perceiving it.

" *Certain* " means that the given type of distortion or interference was perceived in more than 50% of the cases; on the average, the perceptibility was arbitrarily taken as 75% of the cases.

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REPORT 299 *

COMPATIBLE SINGLE-SIDEBAND TRANSMISSION (CSSB) FOR AMPLITUDE-MODULATION SOUND BROADCASTING SERVICES

(Question 205(X))

(Geneva, 1963)

1. Proposed methods of generating CSSB signals

Compatible single-sideband transmission has been the subject of study in several countries, including the U.S.A., the Netherlands, Australia [1], Czechoslovak S. R. and the U.S.S.R.

For modulation of a radio-frequency *f*, by a sinusoidal signal at a frequency *F*, it can be shown that the required single-sideband signal, with an undistorted envelope, can be formed from a signal with three components *f*, $(f + F)$ and $(f + 2F)$, as shown in (1):

$$E = \zeta \sin 2\,\pi f t + a \sin 2\pi\,(f + F)t + \frac{a^2}{4\,\zeta} \sin 2\pi\,(f + 2F)\,t \qquad (1)$$

of which the envelope amplitude is given by

$$A = \zeta + \frac{a^2}{4\,\zeta} + a \cos 2\pi\, Ft \qquad (2)$$

At low indices of modulation only two components are required. It is possible also to calculate the degree of phase (or frequency) modulation necessary to produce, together with the

* This Report was adopted unanimously.

required amplitude-modulation, the required compatible single-sideband signal. The required phase-modulation is given by

$$\varphi = \arc\sin \left[\frac{a \sin 2\pi Ft + \frac{a^2}{4\zeta} \sin 4\pi Ft}{\zeta + \frac{a^2}{4\zeta} + a \cos 2\pi Ft} \right] \quad (3)$$

In spite of a similar theoretical background, workers in the various countries have worked along different lines to bring about results which are very close to the theory.

1.1 *In the U.S.A.* [2], a signal is generated by passage of a single-sideband signal through two different non-linear circuits. By a suitable combination of addition and mixing procedures, a phase-modulation is achieved which is appropriate for eliminating the unwanted sideband, and which gives a close approximation to the waveforms of the three-component signal.

1.2 *In the Netherlands* [3], it was observed that it would be possible to achieve the necessary three-component signal by squaring a full-carrier single-sideband signal. However, a correction must be applied to neutralize intermodulation distortion.

1.3 *In the Czechoslovak S. R.* [4], a signal is obtained which is very nearly a single-sideband signal, from the original audio-frequency input by a combination of a non-linear network and a phase-shift network. Suppression of the unwanted sideband is then improved by the use of negative feedback.

1.4 *In the U.S.S.R.* [5, 6, 7], a CSSB signal is generated by dividing the audio-frequency input signal along two paths: the first path, through a delay-line and an amplitude modulator; the second, through a special integrating network and a phase-modulator.

2. The standardization of a CSSB system should take account of the following factors:

2.1 A CSSB system must satisfy the provisions of Recommendations 328 (out-of-band radiation for AM emissions) and 329 (spurious emissions).

Moreover, it is essential that out-of-band radiation should not exceed that specified for existing double-sideband systems, and that this condition be maintained, in practice, under normal conditions of operation. In particular, no system should be standardized which requires constant supervision of the working transmitter to satisfy this stipulation.

2.2 It is necessary to define the audio-frequency response. It is likely that different definitions will be needed for:

— LF (kilometric) and MF (hectometric) broadcasting,
— HF (decametric) broadcasting.

2.3 The extent (in db) to which the unwanted sideband should be reduced.

2.4 To avoid the need for highly selective filters, suppression of the unwanted sideband below 300 c/s should not be required.

2.5 In connection with § 2.4, there is a possible advantage in permitting double-sideband transmission for frequencies up to 500 c/s. However, this double-sideband transmission may lead to increased co-channel interference on account of fixed beat-frequencies.

2.6 Distortion and interference in normal types of receiver should be of the same order as those acceptable in normal double-sideband broadcasting.

2.7 It is not necessary to use always the same sideband (upper or lower). Doc. X/33 (France) of Bad Kreuznach, 1962, gives a channel arrangement (" tête-bêche " channels), which would permit either an increase in the number of channels, or an improvement in the quality of services, depending upon the interpretation given to the various technical data relating to the problem.

3. Other points of general interest

3.1 It does not seem likely, at the present, that the use of CSSB will reduce the degree of distortion caused by fading and multipath.

3.2 In present types of receivers, where the intermediate-frequency bandwidth limits the audio-reproduction that can be achieved, the use of CSSB may permit an improvement of up to 1·5 to 2 kc/s in the audio-frequency bandwidth, as long as no change in channel allocation is made.

3.3 The effect of the introduction of CSSB on the service area of a transmitter depends on the factors which limit this area. If the area is limited by considerations of interference from other transmitters, measurements of protection ratio would clarify the problem. If the area is limited only by noise, the additional energy in the wanted sideband may assist in increasing the service area.

3.4 The introduction of CSSB operation may give improved service in areas where interference is caused by time-base radiation from television receivers.

3.5 In a CSSB system, it is important that the correct tuning of the receiver shall not be made appreciably more difficult than that of a current double-sideband receiver.

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REPORT 300 *

STEREOPHONIC BROADCASTING

(Question 199(X) and Study Programme 199A (X))

(Geneva, 1963)

1. Introduction

Since the IXth Plenary Assembly of the C.C.I.R., certain Administrations and Broadcasting Organizations have conducted theoretical and experimental work relating to stereophonic broadcasting. At the Interim Meeting of Study Group X (Bad Kreuznach, 1962), documents were submitted by Sweden (Doc. X/24), E.B.U. (Docs. X/28, X/29), U.S.A. (Doc. X/35), Japan (Doc. X/37), U.S.S.R. (Doc. X/45) and United Kingdom (Doc. X/61). Consideration of these documents resulted in the drafting of a Report (Doc. 10, Annex 23, Geneva, 1963) and the drafting of a Recommendation (Doc. 10, Annex 5, Geneva, 1963).

* This Report was adopted unanimously.

At the Xth Plenary Assembly, documents relating to further work on the subject were submitted by Sweden (Doc. 166), E.B.U. (Docs. 205, 206 and 309), Japan (Doc. 223) and U.S.S.R. (Docs. 238 and 261). The draft Report of Doc. 10, Annex 23, as revised (Doc. 315) was adopted and became Report 293. However, Study Group X could not agree on the adoption of the draft Recommendation as revised in Doc. 451.

This Report summarizes the present position with regard to stereophonic broadcasting.

2. Desirable basic characteristics of a system for stereophonic broadcasting

It is generally agreed, that the principal desirable characteristics of any system for stereophonic broadcasting using a single radio-frequency channel, are as follows:

2.1 the system should be compatible; that is to say, it should be possible to obtain monophonic reception of a stereophonic transmission, without reduction of quality in comparison with the reception of the normal monophonic transmission;

2.2 the system should provide high-quality stereophonic reproduction (see Report 293);

2.3 it should be possible to construct stereophonic receivers at reasonably economic prices;

2.4 the introduction of stereophonic transmissions, at an existing monophonic broadcasting station, should not significantly reduce the service area of the station for monophonic reception;

2.5 the service area of the broadcasting station for stereophonic reception should be as nearly as possible equal to that for monophonic reception;

2.6 the protection against interference required for stereophonic reception should not be substantially greater than that for monophonic reception;

2.7 the introduction of the stereophonic system should not necessitate extensive changes in the existing frequency-assignment plans;

2.8 the system should be capable, when not used for stereophonic broadcasting, of transmitting two separate monophonic programmes such as, for example, speech in two different languages accompanying a television signal. However, certain Administrations, while agreeing that this characteristic is desirable, do not consider it to be essential.

3. Results of tests on systems

3.1 *Polar-modulation system*

The system of stereophonic broadcasting, using polar-modulation with partly suppressed sub-carrier, was developed in the U.S.S.R. and has been in service in that country since 1959 (see Doc. 238 of Geneva, 1963). The system ensures a high quality of sound reproduction and good compatibility with monophonic broadcasting.

The system using polar-modulation is an additive-subtractive system, whereby the sum of the signals of the two stereo channels is transmitted directly, while the difference of these signals is used for amplitude-modulation of the sub-carrier frequency. The polar-modulated oscillations, before being applied to the input of the frequency modulator, are subjected to an additional conversion which leads to partial suppression of the sub-carrier frequency by means of a special circuit.

The adaptor used with the receiver in this system must comprise a circuit for the restoration of the sub-carrier frequency, an amplifier, a cathode-follower and a polar detector.

The long-term operation of the broadcasting system, using polar-modulation, has demonstrated its satisfactory reliability and stability in operation.

3.2 *Pilot-tone system*

During the period 1959 to 1962, detailed studies of a system of stereophonic broadcasting, of which the characteristics are given below, were carried out independently in the U.S.A., in Europe and in Japan. These studies have comprised theoretical analysis, laboratory tests, actual service trials and listening tests before and after high-frequency transmission, with the object of evaluating not only the subjective quality of stereophonic reception but also that of compatible monophonic reception. The results and conclusions drawn from the tests are given in Doc. X/28 (E.B.U.) and Doc. X/35 (U.S.A.) of Bad Kreuznach, 1962, as well as in Docs. 205, 309 (E.B.U.) and Doc. 223 (Japan) of Geneva, 1963.

In the U.S.A. the tests were carried out by the " National Stereophonic Radio Committee ", with the collaboration of many industrial firms. The tests were carried out on six systems, from which only the pilot-tone system was retained and put into regular service in 1961.

In Europe, the tests were co-ordinated by the E.B.U. and were carried out by five broadcasting organizations; in addition, seven industrial laboratories took part in the first series of measurements. Tests were made on ten systems and, of these, the pilot-tone system was considered to be the best. More detailed tests on this system were completed in November, 1962.

Among all the systems tried out in the U.S.A. and under the aegis of the E.B.U., the pilot-tone system appeared to the organizations which made the tests to be the only one which complied, on the whole, with the conditions, considered to be indispensable for the introduction of a stereophonic service, as set out in Doc. X/28 (E.B.U.) of Bad Kreuznach, 1962.

The pilot-tone system mentioned above has been tested with a maximum frequency deviation of $\pm$ 75 kc/s. It is defined by the following specification:

3.2.0.1 a compatible signal M, equal to the sum of the left-hand signal A and the right-hand signal B, produces a deviation of the main carrier of not more than 90% of the maximum frequency deviation for monophonic transmission;

3.2.0.2 a signal S, equal to the difference between the left-hand and right-hand signals, is used to obtain the sidebands of an amplitude-modulated suppressed sub-carrier;

3.2.0.3 the frequency of the sub-carrier is 38 kc/s $\pm$ 4 c/s;

3.2.0.4 the residual sub-carrier produces a deviation of the main carrier of not more than 1% of the maximum frequency deviation for monophonic transmission;

3.2.0.5 a pilot signal of frequency equal to half that of the sub-carrier produces a deviation of the main carrier between 8% and 10% of the maximum frequency deviation for monophonic transmission;

3.2.0.6 the pre-emphasis of the S signal is identical to that of the compatible M signal;

3.2.0.7 the phase-relation between the pilot signal and the sub-carrier is such, that when modulating the transmitter with a multiplex signal for which A is positive and B equals $-$ A, this signal crosses the time axis with a positive slope each time the pilot signal has an instantaneous value of zero. Moreover, a positive value of the multiplex signal corresponds to a positive frequency deviation of the main carrier.

As a result of the tests carried out by the U.S.A., the E.B.U. and Japan, the performance of the pilot-tone system may be characterized by the typical test results given below as obtained at the output of the receiver:

3.2.1 *Compatible monophonic reception*

3.2.1.1 Audio-frequency response: $\pm$ 1 db between 50 c/s and 10 kc/s, relative to the response at 1 kc/s.

3.2.1.2 Crosstalk S to M: $-$ 60 db below 1 kc/s; $-$ 44 db from 1 to 10 kc/s.

3.2.1.3 Intermodulation S to M: $\leqslant -$ 40 db up to 10 kc/s.

3.2.1.4 Total harmonic distortion: equal to, or slightly greater than, the value for monophonic transmission.

3.2.1.5 Non-linear crosstalk S to M: comparable with the value of the distortion in monophonic transmission.

3.2.1.6 Signal-to-noise ratio: 66 to 76 db for an input level to the receiver of — 54 dbm.

3.2.1.7 Beat-frequency interference: less than — 50 db.

3.2.1.8 Protection ratio: 0 to 3 db higher than for monophonic reception for a carrier frequency separation between 0 and 300 kc/s.

3.2.1.9 Multipath propagation effects: almost equivalent to a monophonic transmission.

3.2.1.10 Sensitivity to impulsive noise: almost equivalent to that for monophonic transmission.

3.2.2 *Stereophonic reception*

3.2.2.1 Audio-frequency response: 0 to — 4 db from 50 c/s to 10 kc/s relative to the response at 1 kc/s.

3.2.2.2 Crosstalk between A and B: — 35 db from 100 c/s to 3 kc/s, then increasing at times up to — 15 db at 10 kc/s.

3.2.2.3 Intermodulation between A and B: — 45 db at 1 kc/s; — 30 db at 10 kc/s.

3.2.2.4 Total harmonic distortion (100% modulation at 1 kc/s): about 1%.

3.2.2.5 Non-linear crosstalk between A and B: $\leqslant$ 1%.

3.2.2.6 Signal-to-noise ratio: 58 to 64 db for an input level to the receiver of — 54 dbm; equal to 50 db for a simple doublet antenna for a field strength of 250 μV/m.

3.2.2.7 Beat-frequency interference: less than — 50 db.

3.2.2.8 Protection ratio as a function of the separation Δf, of the carrier frequencies:

$\Delta f = 0$: of the same order as the value 36 db adopted for monophonic transmissions;

$\Delta f = 200$ kc/s: equal to or less than the value of 6 db adopted for monophonic transmissions;

$\Delta f = 100$ kc/s: increase of 10 to 15 db relative to the value of 12 db adopted for monophonic transmissions;

$\Delta f = 50$ kc/s: somewhat less favourable than for $\Delta f = 100$ kc/s.

3.2.2.9 Multipath propagation effects: satisfactory reception, if the signal-to-echo ratio is equal to, or greater than, 16 db.

3.2.2.10 Sensitivity to impulsive noise: satisfactory reception, if the field strength is greater than a value between 250 μV/m and 1 mV/m, depending upon the regulations in different countries applying to the suppression of interference.

3.2.3 *Transmission and reception of two monophonic programmes in the M and S channels*

3.2.3.1 Crosstalk M to S: — 48 db up to 1 kc/s; — 32 db from 1 to 10 kc/s.

3.2.3.2 Crosstalk S to M: — 60 db below 1 kc/s; — 44 db from 1 to 10 kc/s.

3.2.4 *Re-broadcasting transmissions*

No difficulties were encountered in transmissions over three links in tandem.

It should be noted that all the preceding test results apply to a system using high quality transmission equipment and receiving equipment of average quality. With a higher quality receiving installation it is possible to improve most of these results.

3.3 *Application of the compandor principle*

Docs. X/24 (Sweden) of Bad Kreuznach, 1962, and 166 (Sweden) of Geneva, 1963, give the results of tests made with a stereophonic FM/AM system using a compressor for the (A–B) information at the transmitter and an expandor at the receiver.

The results obtained have shown that noise is suppressed to a great extent by the compressor/expandor.

4. Conclusions

Bearing in mind the desirable characteristics for a system of stereophonic broadcasting, listed in § 2 of this Report, and taking into account the documents submitted to Study Group X, both at its Interim Meeting, Bad Kreuznach, 1962, and at the Xth Plenary Assembly of the C.C.I.R., it would appear that requirements of § 2.1 (compatibility) and of § 2.2 (quality) can be met by some of the systems that have been tested. Sufficient data have not been received with regard to § 2.3 (price). On the other hand there is a question as to whether any system of stereophonic broadcasting, using only one radio-frequency channel has, so far, been fully tested, which completely fulfils the requirements of § 2.4 (monophonic coverage), § 2.5 (stereophonic coverage), § 2.6 (protection ratios), and § 2.7 (changes in the existing frequency-assignment plans). Sufficient data have not been received with regard to § 2.8 (transmission of separate programmes).

Although a number of Administrations were in favour of recommending the pilot-tone system, a number of Administrations were against recommending any system at the present time, on account of possible deficiencies of the system in respect of §§ 2.4, 2.5, 2.6, 2.7 and 2.8.

Administrations are invited to consider these problems with a view to reaching agreement on a draft Recommendation at the next Interim Meeting of Study Group X for adoption at the XIth Plenary Assembly.

E. 3 – Tropical broadcasting

REPORT 301 *

DESIGN OF TRANSMITTING ANTENNAE FOR TROPICAL BROADCASTING

(Question 156 (XII))

(London, 1953 — Warsaw, 1956 — Geneva, 1963)

This Report summarizes the information submitted to the C.C.I.R. in answer to the studies under Questions 70 and 156(XII).

1. The transmitting antenna should be situated as near to the centre of the reception area as possible.

For antennae relying on ground reflection for their vertical directivity, the site should be chosen where the soil is of good conductivity, though, where this is not possible, an earth mat can be used. This could consist of a number of parallel wires spaced not more than one tenth of a wavelength apart, parallel to the dipoles and extending for half a wavelength beyond the extremities of the antenna array.

Where it is not possible to locate the antenna at the centre of the reception area, it is possible, with multi-element transmitting antennae, to slew the beam away from the vertical in the direction of the main reception area (see Annex I). Angles of slew greater than about 15° often produce large side lobes which may cause interference outside the reception area.

If there are no adjacent reception areas, for example, where the area to be served is an isolated island, a central location is less important.

2. The transmitting antenna for tropical broadcasting should be designed to produce a more or less uniform field, with no skip zone, and of as high a value as possible throughout the reception area. Beyond this area, the field strength should decrease as rapidly as possible. The antenna should be economical in design and simple in operation.

The antenna should, therefore, be designed to produce the greatest high-angle radiation possible, consistent with adequate radiation down to the angle of radiation used to serve the fringe of the service area (see National Bureau of Standards Circular No. 462, p. 106). Thus, for instance, a service area having an outer radius of about 800 km may require a low directivity antenna consisting of a simple dipole between a quarter and a half wavelength above earth but, for smaller areas, more directive multi-element antennae would be desirable to reduce the low-angle radiation ** (see Annexes).

It is considered desirable that the C.C.I.R. should include the curves shown in the Annex, or similar ones, in its antenna charts.***

It is possible that the siting of the transmitting antenna used for tropical broadcasting with respect to the magnetic meridian has an influence on the field produced by reflection from the ionosphere. It is therefore requested that reference should be made to this point in answer to Question 154(XII), dealing with propagation in the tropical zone.

3. For the great majority of domestic tropical broadcast listeners, only simple antennae are possible and the directivity of such antennae cannot be relied upon to improve the signal-to-noise ratio.

The antenna has to be both cheap and simple to install and has to be used on a number of frequencies, with fields corresponding to varying angles of incidence. It appears reasonable

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* This Report, which replaces Reports 86 and 87, was adopted unanimously.

** P. Adorian and A. Dickenson, "High-frequency broadcast transmission with vertical radiation" *Journal of the British Institute of Radio Engineers.* (February 1952.)

*** See *Supplement No. 2 to the antenna charts of the C.C.I.R.*, published by the I.T.U., Geneva, December 1958.

to assume that the average listener's antenna cannot be better than that given in the report of the Geneva Planning Committee; this consists of an L-type antenna with horizontal and vertical limbs 6 feet in length (4·80 m).

4. **Doc. 470 (United Kingdom) of Warsaw, 1956,** describes briefly the measurements carried out in Barbados of short-wave (decametric) broadcast transmissions from Trinidad (350 km) on 3 and 6 Mc/s and the attempts made to observe the field intensities of transmissions from Jamaica.

4.1 Consideration of the data indicates that a vertical incidence 4-element antenna, 1/4-wavelength above ground, will be useful for minimizing low-angle radiation beyond a service area limited to about 350 km and thus reducing the value of received signal level. For greater distances, such an antenna will not provide as high a desired field as a simple dipole, especially one with a height approaching half a wavelength above ground.

4.2 It is considered that further studies should be undertaken, to collect data on antennae which will enable radiation to be maintained at the necessary angle of elevation to provide a service at distances of the order of 800 km, while, at the same time, minimizing radiation at lower angles of elevation.

4.3 It is also desirable that, whilst communicating data on frequency requirements, Administrations should define the area for which the broadcast service is intended.

ANNEX I

NOTES ON THE PERFORMANCE OF ARRAYS OF HORIZONTAL DIPOLES ARRANGED FOR VERTICAL INCIDENCE

1. General

Arrays of this type consist of a number of rows of $\lambda/2$ dipoles end to end, the rows being $\lambda/2$ apart, and all the same height above ground. In passing, it should be noted that the simplest case of all, that of a single dipole, is the array of this type most commonly in use. For a complete knowledge of the performance of such an array, the vertical polar diagram should be known for all angles of azimuth. In practice, however, a knowledge of two polar diagrams, that in the vertical plane containing the dipoles, and that in the vertical plane at right-angles to the dipoles, is sufficient to estimate the performance.

2. Polar diagrams

Figs. 1, 2 and 3 show diagrams in the two vertical planes for three types of array:

Fig. 1 — A single dipole.

Fig. 2 — Two rows, each of two dipoles.

Fig. 3 — Four rows, each of four dipoles.

The diagram in the vertical plane parallel to the dipoles depends solely on the number of dipoles in a row. The diagram in the plane at right-angles to the dipoles depends solely on the number of rows of dipoles. It is thus possible, from the diagrams shown in Figs. 1, 2 and 3, to assess the performance of arrays with up to four dipoles per row and up to four rows of dipoles. For example, for an array consisting of two rows each of four dipoles, the diagram in the plane containing the dipoles would be that of Fig. 3, curve *(a)* and the diagram in the plane at right-angles to the dipoles would be that of Fig. 2, curve *(b)*.

3. Height of array above ground

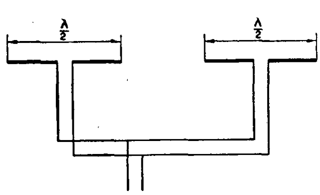
For the vertical radiated field to be a maximum, the optimum height of the dipoles above ground is $\lambda/4$ but the height is not critical. Figs. 1, 2 and 3 correspond to a height of $0{\cdot}2\,\lambda$ above ground, but each of the curves shown may be converted to apply to any height of h wavelengths above ground, by multiplying by:

$$\frac{\sin\,(2\,\pi h\,\cos\,\theta)}{\sin\,(0{\cdot}4\,\pi\,\cos\,\theta)}$$

4. Slewing

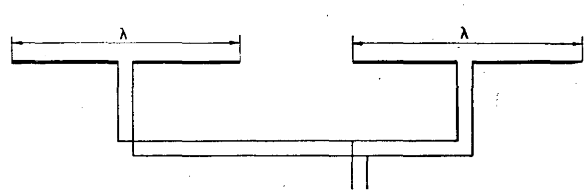
The diagrams shown in Figs. 1, 2 and 3 assume equal co-phasal currents in all the half-wave dipoles, and as may be seen, this results in a diagram suitable for a station situated in the centre of the service area. If it is desired to site a station away from that area, the direction of the vertical beam can be slewed, by dividing each row of dipoles of the array into two halves and driving these two halves with currents in different phases. It follows that the array of Fig. 1, a single dipole, cannot be slewed.

This method of slewing is most easily applicable to arrays of two or four dipoles per row and the following sketches indicate the method of feeding:



Bay feeder offset from centre

Slewing of array 2 dipoles wide



Bay feeder offset from centre

Slewing of array 4 dipoles wide

This method of slewing results in the main lobe being slewed in the plane containing the dipoles, whilst the polar diagram in the plane at right-angles to the dipoles remains unchanged.

For an array with two dipoles in each row, the diagram will be modified by multiplying by:

$$\frac{\cos\left(\frac{\pi}{2}\,\sin\,\theta + \frac{\varphi}{2}\right)}{\cos\left(\frac{\pi}{2}\,\sin\,\theta\right)}$$

For an array with four dipoles in each row, the diagram will be modified by multiplying by:

$$\frac{\cos\left(\pi \sin \theta + \frac{\varphi}{2}\right)}{\cos\,(\pi \sin \theta)}$$

where φ is the phase difference between the currents in the two halves of the array. The approximate angle of slew, in terms of the phase difference between the two halves of the array is:

$\sin^{-1} \frac{\varphi}{\pi}$, for the array two dipoles wide,

$\sin^{-1} \frac{\varphi}{2\pi}$, for the array four dipoles wide,

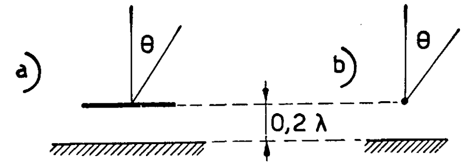
It is inadvisable to slew the main lobe more than approximately 15°, as large side-lobes will otherwise form which may cause interference outside the service area.

5. Ground conductivity

In many cases, the conductivity of the ground is such that the efficiency and the diagram may be degraded if an earth mat is not placed under the array. This earth mat should consist of a number of parallel wires, spaced $0 \cdot 1\ \lambda$ apart and run parallel to the dipoles. The length of the wires and the number of wires should be such that the earth mat extends $\lambda/2$ beyond the extremities of the array when viewed in plan.

(*a*) Diagram in the vertical plane parallel to the dipole

(*b*) Diagram in the plane at right-angles to the dipole



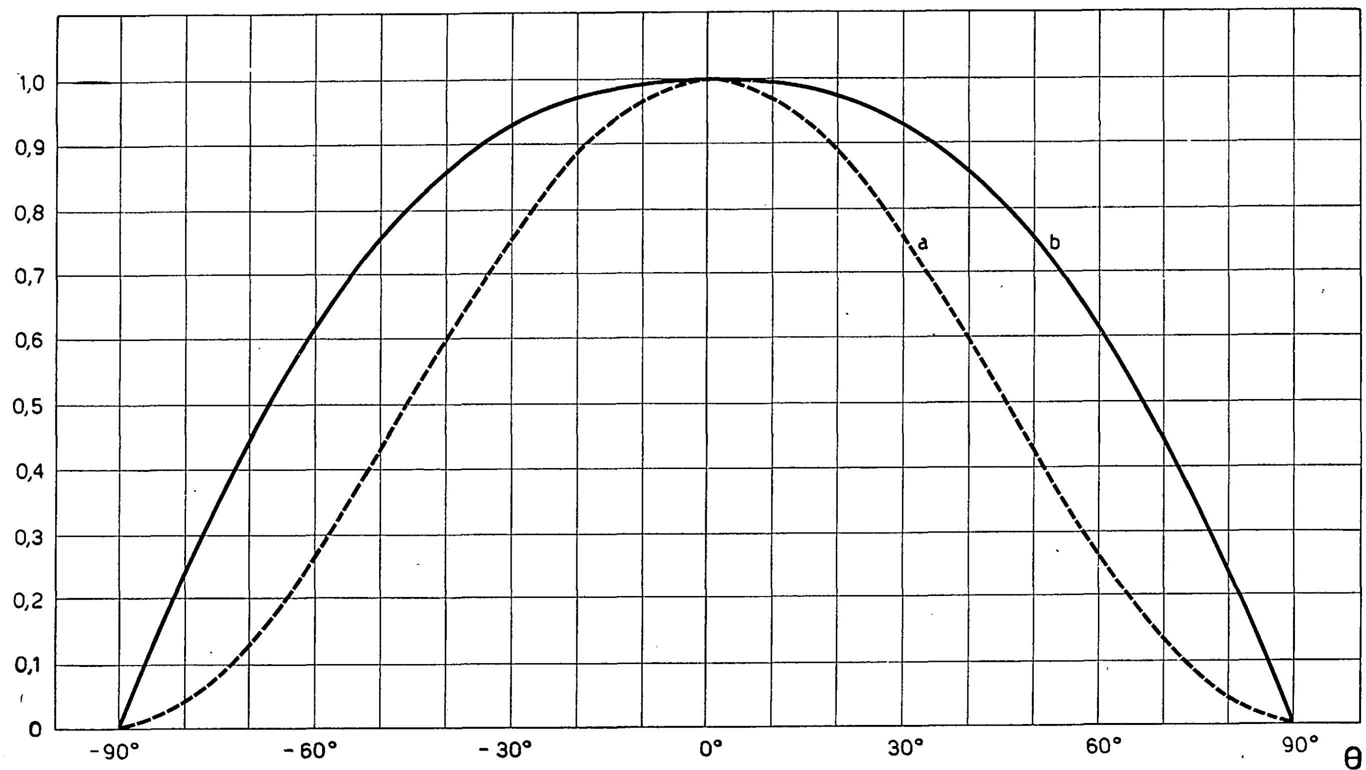


FIGURE 1

Diagram of a single λ/2 horizontal dipole (*a*) Diagram in the vertical plane parallel to the dipoles

(*b*) Diagram in the plane at right-angles to the dipoles

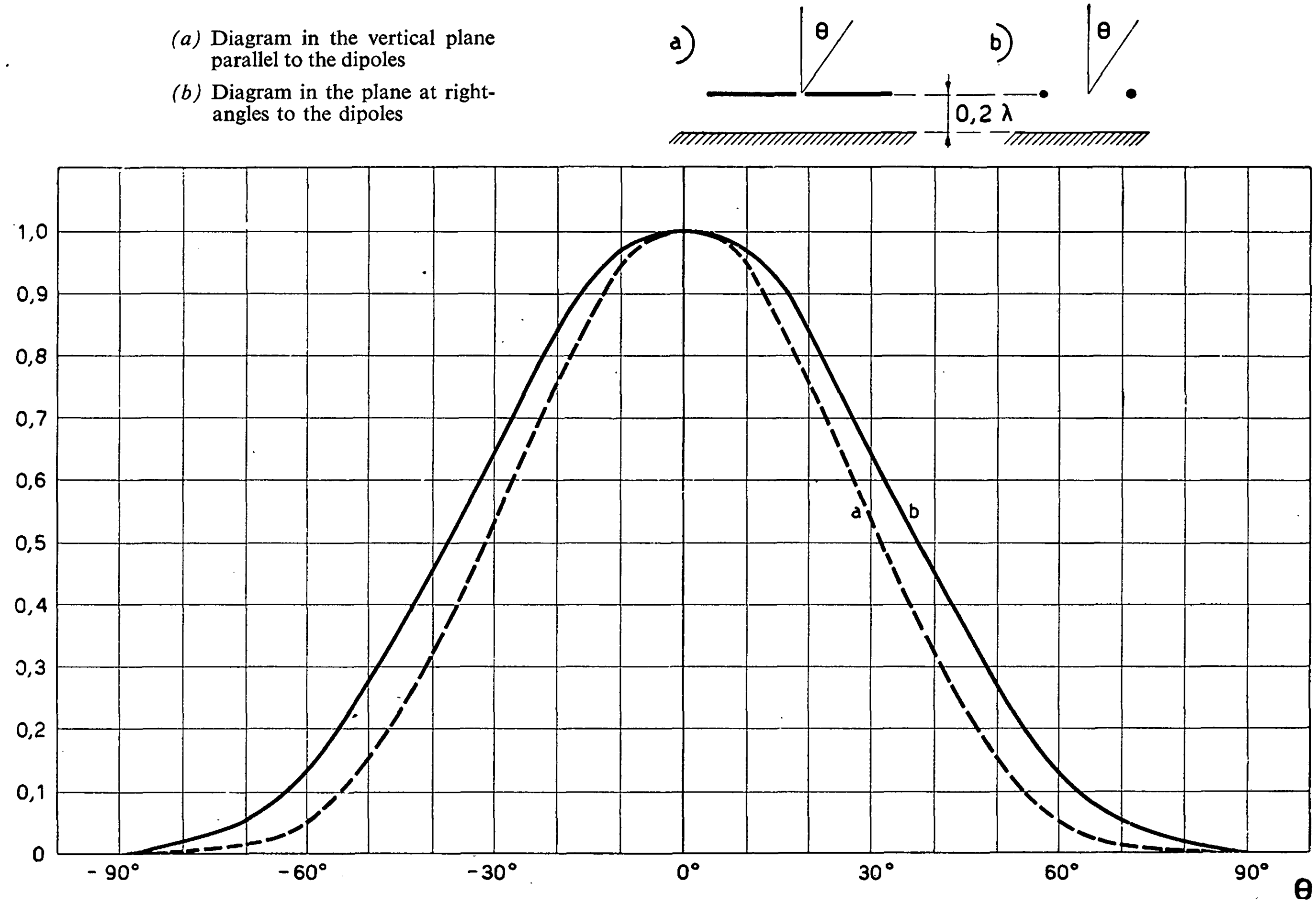


FIGURE 2

Diagram of an H2/2 array on its back

(*a*) Diagram in the vertical plane parallel to the dipoles

(*b*) Diagram in the plane at right-angles to the dipoles

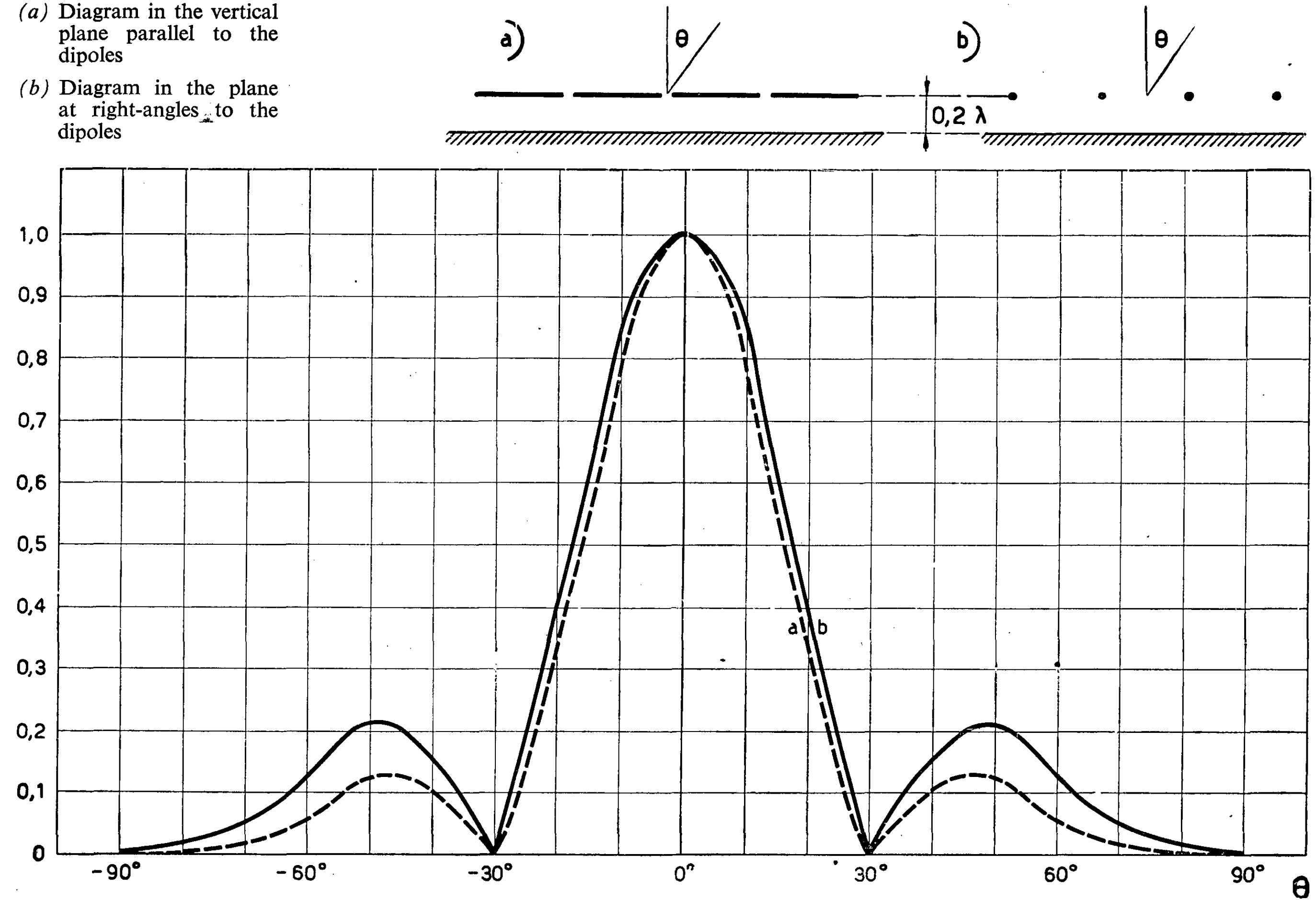


FIGURE 3

Diagram of an H4/4 array on its back

ANNEX II

HIGH-INCIDENCE ARRAY

1. **Doc. XII/1 (Republic of South Africa) of Bad Kreuznach, 1962,** describes a high-incidence array which will give adequate high-frequency coverage over a circular area of up to 1000 km radius. Special attention has been given to the minimizing of low-angle radiation in order to eliminate interference to other services outside the coverage area.

2. The array consists of four full-wave dipoles arranged in the form of a square and fed in such a manner that the currents in any two adjoining elements are in phase. The average height above ground is $0 \cdot 15\ \lambda$, but this does not seem to be critical. Fig. 4 is a sketch of the array showing the method of feeding. The radiating elements are built up of four wire cages, resulting in an impedance of 2200 Ω each which, when paralleled at the centre, give a good match to a 550 Ω feeder. A quarter wave matching stub is included.

Fig. 5 shows the field radiated at an angle of elevation of 10° by a dipole ($h = 0 \cdot 4\ \lambda$) and the high-incidence array.

Fig. 6 shows the distribution of the field of the high-incidence array in two vertical planes:

— diagonal to the square (Fig. 6 *a*),

— parallel to a side of the square (Fig. 6 *b*), representing the directions of maximum and minimum radiation respectively.

Fig. 7 is a power distribution diagram of the high-incidence array, the value of 100% being obtained by integrating the power distribution diagram and equating

$$\int\int E^2 \, d\theta \, d\varphi = \eta P$$

The gain of the array, relative to an isotropic radiator, is 8 db.

3. It is found that the low-angle radiation of the array is less than that of a dipole ($h = 0 \cdot 4\ \lambda$) in all horizontal directions (see Fig. 5). At any elevation angles below 30°, the radiation from the high-incidence array is 16 db less than the maximum radiated by the dipole at that elevation.

The high-angle radiation of the array is greater than that of the dipole in the broadside direction at elevation angles between 50° and 75°, and greater than that of the dipole in the end-on direction at elevation angles between 25° and 75°, representing improved signal strength at distances between 100 and 400 km, and 100 and 1000 km in the respective directions.

The measurements of low-angle radiation (less than 30°), were made on a scale model of the array and the measurements of high-angle radiation were made in the field on the actual array.

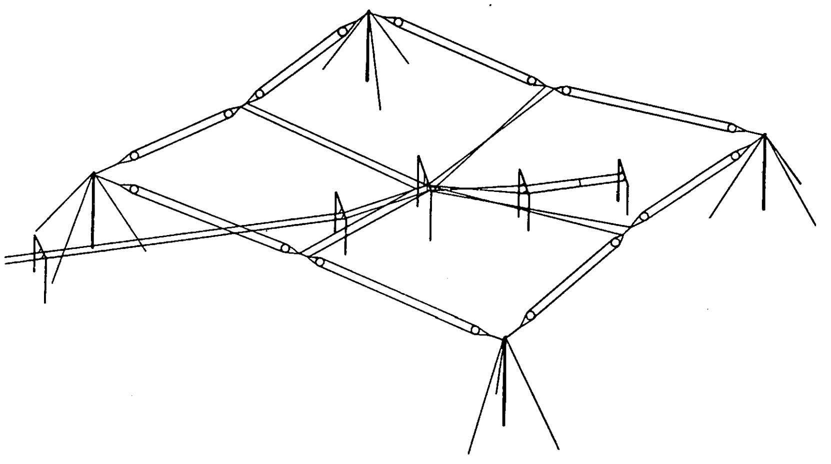


FIGURE 4

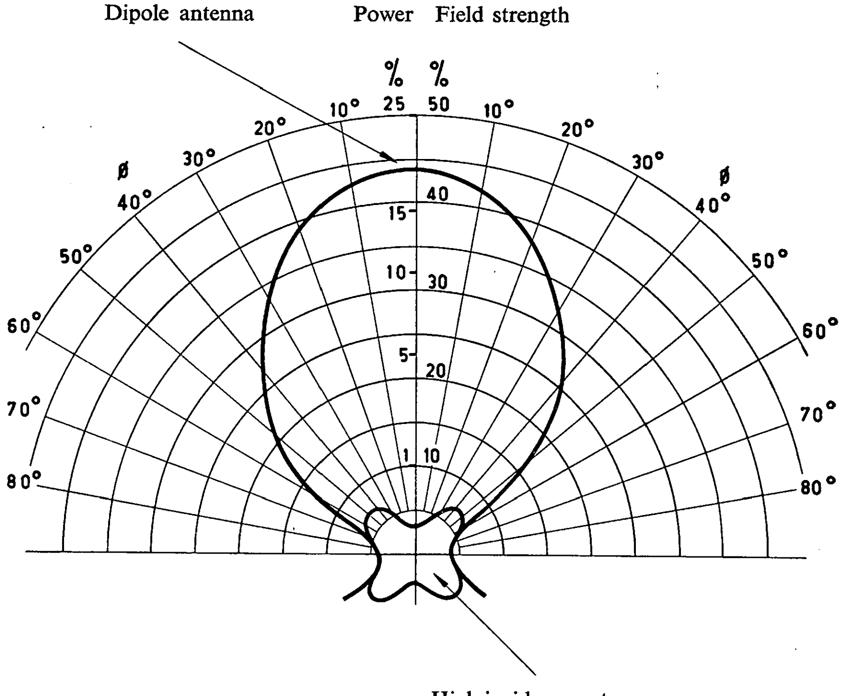


FIGURE 5

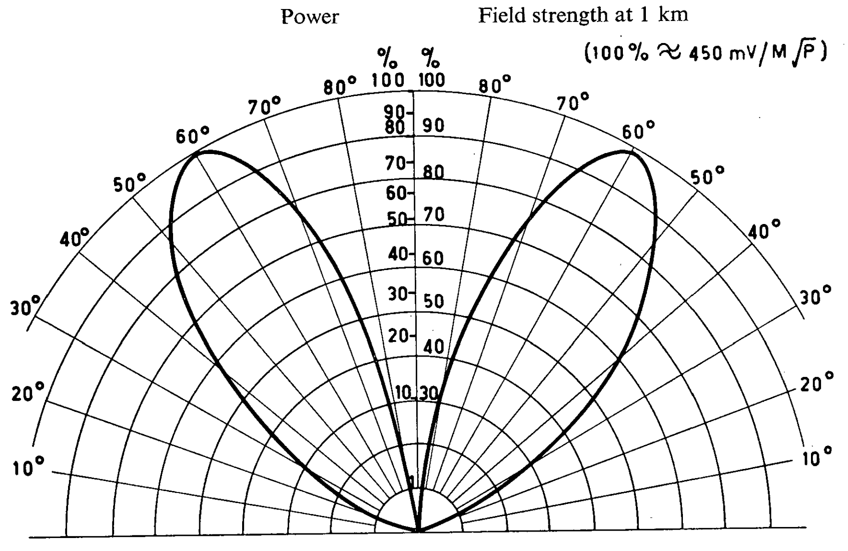


FIGURE 6 (*a*) *(diagonal to the square)*

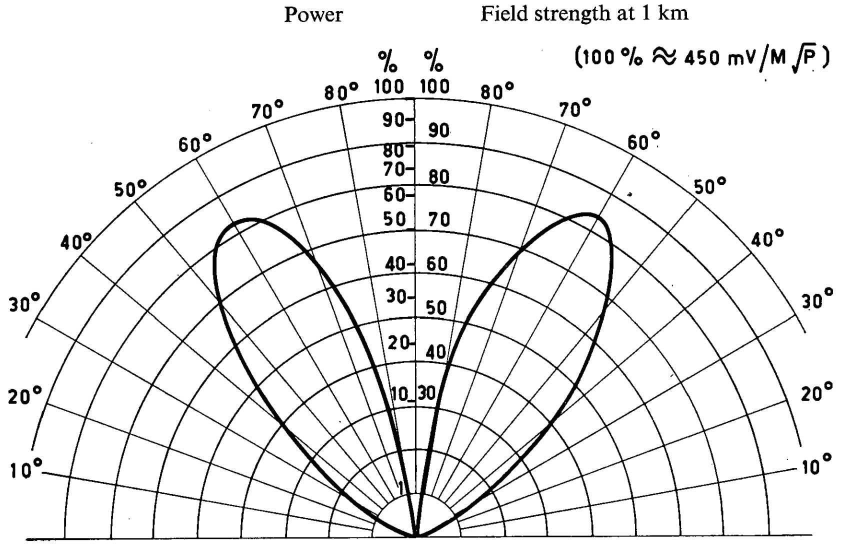


FIGURE 6 (*b*) *(parallel to one side)*

FIGURE 6

Measured polar diagrams for a high-incidence antenna

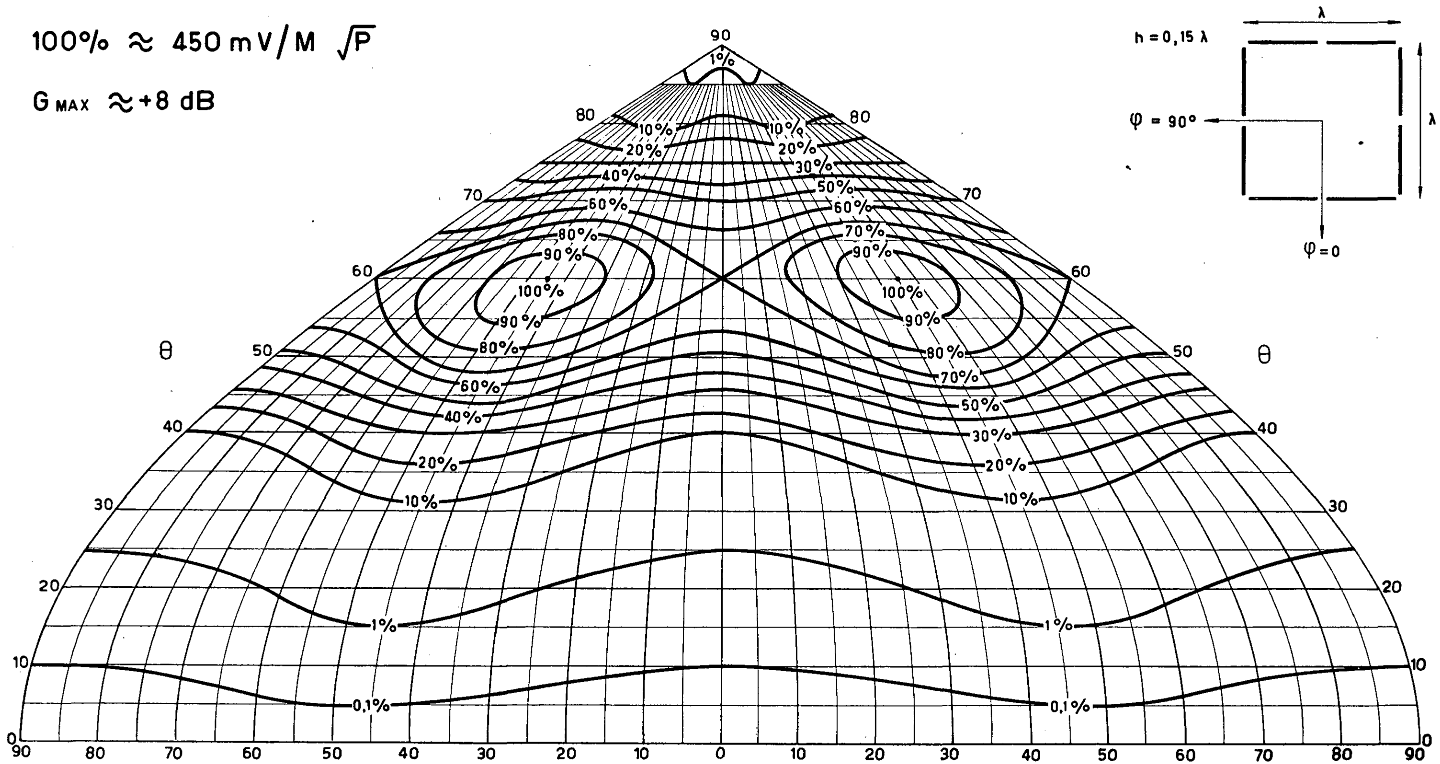


FIGURE 7

Power distribution diagram for the high-incidence array

REPORT 302 *

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

(Question 102(XII) and Study Programme 113(XII))

(Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

This Report summarizes the results of the studies that were carried out to determine, by subjective tests, the ratios of wanted-to-unwanted signal required to satisfy various percentages of broadcast listeners.

1. **Doc. 356 (India) of Warsaw, 1956,** gives the results of an extensive series of subjective tests carried out under conditions which, it is claimed, generally simulate those of actual domestic broadcasting listening in the absence of fading. A broadcast receiver, with a substantially flat response up to about 4 kc/s, but with a filter giving an attenuation of about 8 db at 5 kc/s and a sharp cut-off above this frequency, was used.

For unwanted signals of A2 and A3 classes of emission and for various frequency separations between the carriers of the wanted and unwanted signals, listeners were presented with various ratios of wanted-to-unwanted signal in random order and asked to state whether they considered the reception satisfactory or unsatisfactory. The curves given in the Annex show, the wanted-to-unwanted signal ratios required to provide 90%, 70% and 50% listener satisfaction for unwanted signals of A2 telegraphy, A3 telephony and A3 broadcasting classes of emission, and for various frequency separations up to 5 kc/s.

Table I gives the same information for:

(a) frequency separations of 0 kc/s and 5 kc/s exactly;

(b) nominal frequency separations of 0 kc/s and 5 kc/s under the most unfavourable conditions that could arise within the maximum permissible frequency tolerances of both wanted and unwanted signal, as specified in the Radio Regulations, Atlantic City, 1947.

2. **Doc. 231 (United Kingdom) of Warsaw, 1956,** gives details of the results of subjective tests made to determine the ratio of wanted-to-unwanted signal as a function of the frequency separation of the carriers of the two signals. Two typical broadcast receivers were used, having a fairly uniform response up to about 4 kc/s falling to about − 8 db to − 10 db at 5 kc/s. The unwanted signal was modulated by speech with a frequency range limited to 3 kc/s. The ratio necessary to satisfy nearly all listeners varied from about 54 db at 1 kc/s separation, to a maximum of 56 db between 2 and 3 kc/s separation, falling to 52 db at 5 kc/s separation. The corresponding ratios when nearly all the listeners found the conditions unsatisfactory, were about 15 db lower. Subsequent tests to determine the ratio at which interference was " perceptible " gave intermediate values.

3. **Doc. 553 (Federal Republic of Germany) of Warsaw, 1956,** gives the results of similar tests made with two types of receiver, one, a narrow-band receiver with considerable attenuation above 3 kc/s and the other, a wider-band receiver with an attenuation of about 8 db at 5 kc/s. For the wide-band receiver, as commonly used for broadcast listening, the wanted-to-unwanted signal ratio for various frequency separations follows the same general curve as before and at a frequency separation of 5 kc/s is 43 db for 90% listener satisfaction.

* This Report, which replaces Reports 89 and 127, was adopted unanimously.

4. Comparison of the results arrived at in the three documents show that there is a considerable degree of agreement. The values are within ± 5 db and those in the United Kingdom and Federal German Republic documents bracket those in the Indian document. There is therefore sufficient justification to assume that the values of the wanted-to-unwanted signal to provide the various degrees of listener satisfaction given in Table I and the annexed curves are reliable.

From an examination of Table I, it will be seen that when the unwanted signal is a mobile A3 emission, there is a considerable increase in the required wanted-to-unwanted signal ratio when allowance is made for maximum frequency tolerances. The possibility of interference to broadcasting services from mobile services would be appreciably reduced, particularly where the two services have the same nominal frequency, if the mobile services operated within closer frequency tolerance, if possible with the same tolerance as the fixed and broadcasting services.

Although the sidebands of the unwanted signal contributed to some extent to the interference, the heterodyne beat note between the carriers of the wanted and unwanted signal was always predominant. This was the case for a frequency separation of 5 kc/s between the two signals and, although the receivers used provided an attenuation of some 8 to 10 db to the beat note, the use of a filter to provide further attenuation would have reduced the required wanted-to-unwanted signal ratio. Further studies are needed to ascertain what additional attenuation at 5 kc/s could usefully be provided and what would then be the required wanted-to-unwanted signal ratio. For this purpose, consideration should also be given to the possibilities of providing suitable filters in new and existing receivers.

It is agreed that since the figures shown in Table I are derived from measurements made under steady-state conditions, appropriate allowance should be made for fading, when using these figures to derive the protection ratios to be used in practice. The value of fading allowance to be used for tropical broadcasting requires further study.

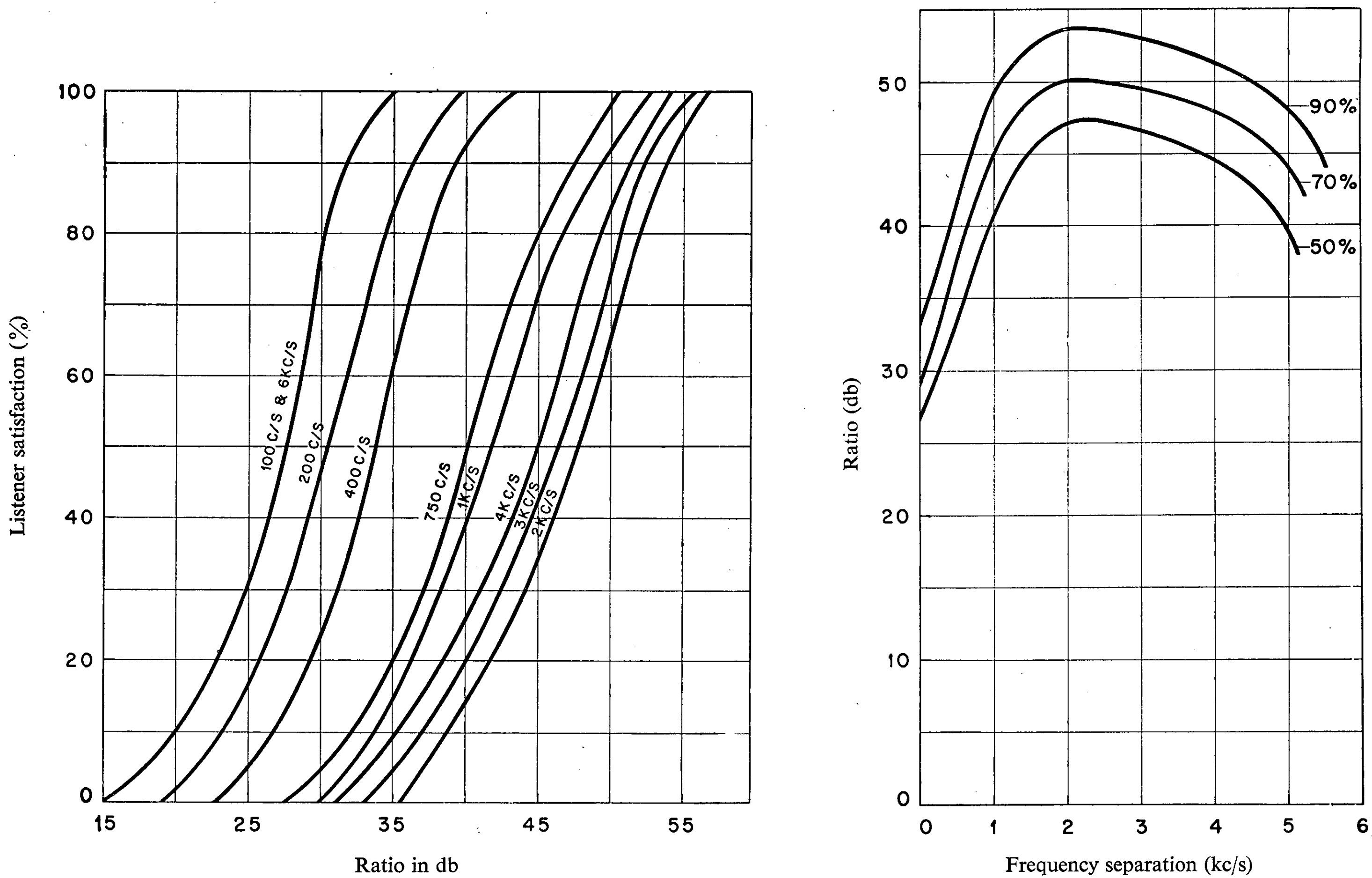
India wishes to record her opinion that protection ratios should be based on those figures in Table I that provide 90% listener satisfaction and that the figures for 70% and 50% are for information only and should not be regarded as the lower limits of acceptability. Australia, the Republic of South Africa and the French Oversea Territories are of the opinion that a listener satisfaction higher than 50% should be provided. The Republic of South Africa and Australia consider it would be impracticable to achieve 90% listener satisfaction from the aspect of signal-to-noise ratio, particularly under heavy static conditions, and therefore to aim to achieve about 80% listener satisfaction for signal-to-interference would be more realistic. The United Kingdom is of the opinion that the wanted-to-unwanted signal ratios given in Table I are based on too critical an assessment and that lower figures would be generally acceptable. The United Kingdom is also of the opinion that, from practical considerations, protection ratios will have to be based on figures providing about 50 to 70% listener satisfaction.

5. **Document XII/1 (United Kingdom) of Los Angeles, 1959,** summarizes the data presented at various times regarding the protection ratio of the wanted-to-unwanted signal that is required for just tolerable interference at various values of separation of carrier frequencies. The graphs of the document are given in Fig. 1. A summary of the conditions of the Post Office tests is also given in the document and is reproduced in § 3 of the Annex.

6. **Doc. XII/6 (India) of Los Angeles, 1959,** describes work carried out in connection with Question 102(XII). Protection ratios required against A1 emissions, both for speech and music programmes, A2 and A3 emissions for music programmes have been assessed. The results are given in § 4 of the Annex.

TABLE I

Interfering emission	Maximum frequency tolerance (Rad. Regs. 1947) (c/s)	Frequency separation (kc/s)	Signal-to-interference ratios for 90%, 70% and 50% listener satisfaction (db)					
			Ignoring frequency tolerances			Allowing for maximum frequency tolerances		
			90%	70%	50%	90%	70%	50%
A2 — fixed (525 c/s tone)	150	0	35	31	28	42	38	34
A2 — mobile (525 c/s tone)	1000	0	35	31	28	49	45	42
A3 — fixed (3 kc/s maximum modulation)	150	0	33	30	28	40	36	33
A3 — mobile (3 kc/s maximum modulation)	1000	0	33	30	28	50	47	44
A3 — broadcasting	150	0	33	30	28	44	40	36
A2 — fixed (525 c/s tone)	150	5	39	37	36	43	40	38
A2 — mobile (525 c/s tone)	1000	5	39	37	36	49	46	43
A3 — fixed (3 kc/s maximum modulation)	150	5	48	44	40	50	46	42
A3 — mobile (3 kc/s maximum modulation)	1000	5	48	44	40	52	48	45
A3 — broadcasting	150	5	48	46	44	49	46	44

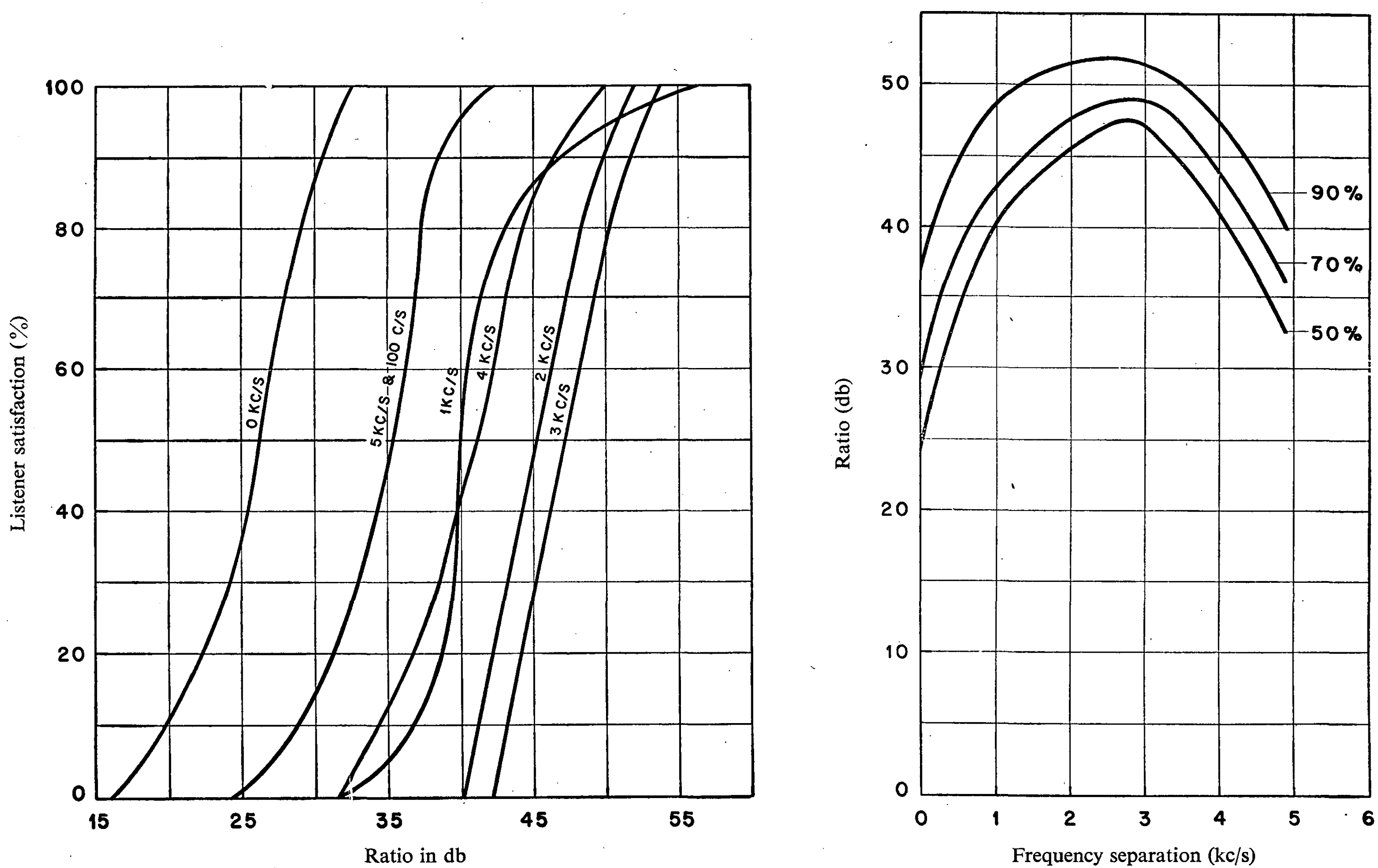


(*a*) Main programme: speech
Interference: A2 telegraphy

(*b*) Ratio of wanted-to-unwanted signal for 90 %, 70 % and 50 % satisfaction

FIGURE 1

Wanted-to-unwanted signal ratio required against interference from A2 telegraphy

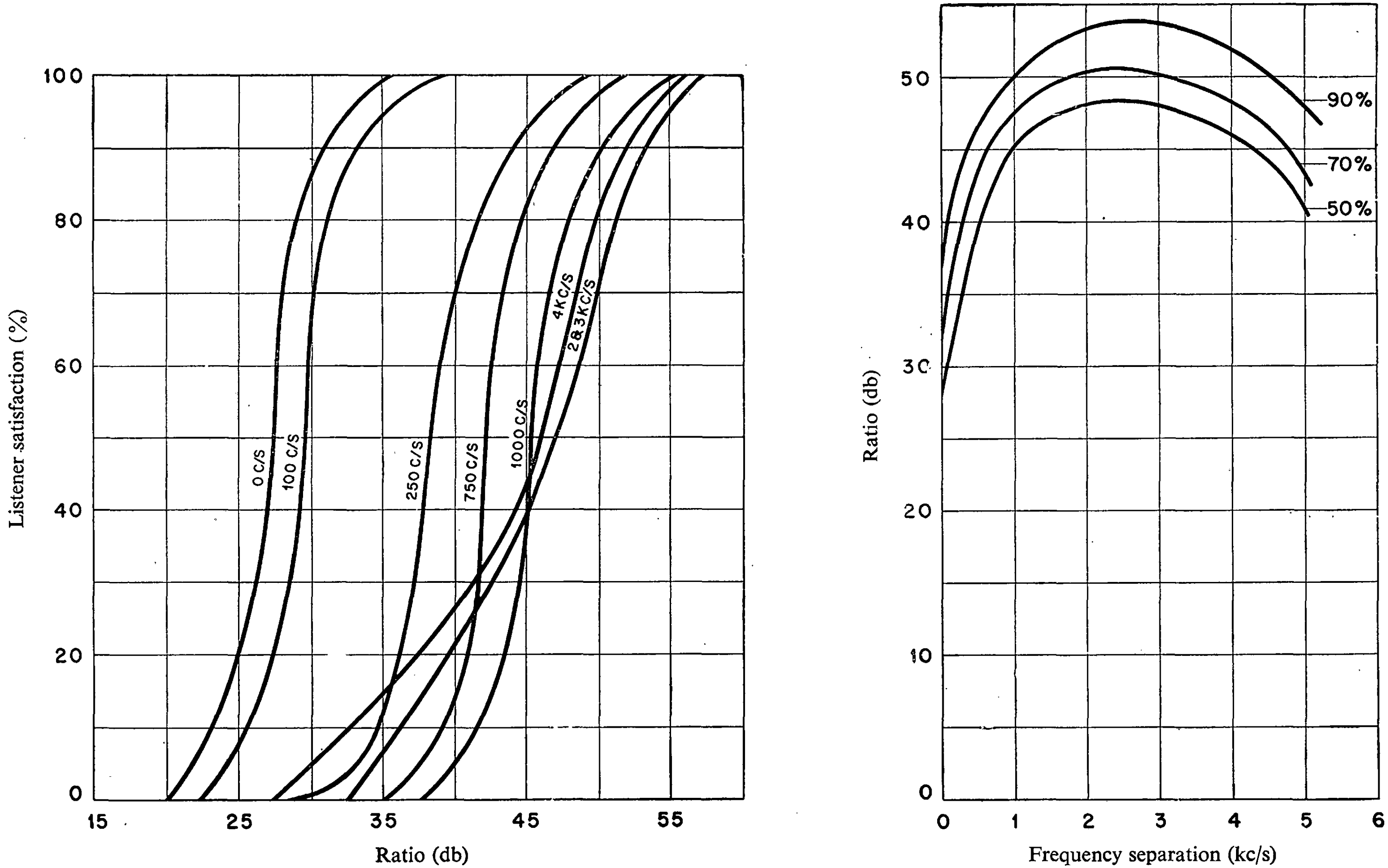


(a) Main programme: speech
Interference: A3 telephony

(b) Ratio of wanted-to-unwanted signal for 90 %, 70 % and 50 % satisfaction

FIGURE 2

Wanted-to-unwanted signal ratio required against interference from A3 telephony



(a) Main programme: speech
Interference: A3 broadcasting (music)

(b) Ratio of wanted-to-unwanted signal for 90 %, 70 % and 50 % satisfaction

FIGURE 3

Wanted-to-unwanted signal ratio required against interference from broadcast transmission

The Indian document takes into consideration the standards for frequency tolerances laid down in the Atlantic City Radio Regulations. The summary is confined to two limiting cases, namely frequency separations of 0 and 5 kc/s respectively and indicates the protection ratios required for various types of emission. The document also states that the results refer to steady-state conditions and that an appropriate allowance should be made for fading.

An analysis of selectivity characteristics of receivers in use in India is also given in the document. Extensive tests were carried out to investigate from the point of view of listeners' satisfaction, the effect of reducing the bandwidth of broadcast transmissions on overall quality.

The conclusion in the Indian document is that it is necessary to maintain the normal bandwidth of modulating frequencies to well beyond 5 kc/s. Any modifications to the design of broadcast receivers tending to attenuate frequencies at 5 kc/s and lower will, therefore, result in serious deterioration in the quality of reception.

7. **Doc. XII/7 (India) of Bad Kreuznach, 1962,** and **Doc. 94 (India) of Geneva, 1963,** give results of further listening tests, in this case for frequency separations of 5-10 kc/s. The experimental set-up was the same as before, except that, as recommended in Study Programme 167(XII), filters with cut-off frequencies at 5, 6, 7, 8 and 9 kc/s were incorporated at the output of the receiver. The wanted signal was modulated with a speech programme, the interfering signals were modulated with music, speech, A1 and A2 telegraphy (Morse — 525 c/s tone modulation). The document shows that on the basis of these experiments, which relate to values

TABLE II

Wanted signal	Interfering signal	Frequency separation (kc/s)	Desired protection ratio (db)
Speech	Music	5	46
Speech	Music	10	22
Speech	Speech	5	44
Speech	Speech	10	16
Speech	A2 telegraphy	5	38
Speech	A2 telegraphy	10	8
Speech	A1 emission	5	38
Speech	A1 emission	10	8
Music	Music	5	38
Music	Music	10	12
Music	Speech	5	38
Music	Speech	10	6

required for 90% listener satisfaction, the protection ratio required * in each case gradually decreases as the carrier separation increases beyond 5 kc/s and also as the cut-off frequency of the filter decreases. Table II gives the values of the protection ratios required when no filter is used in the output circuit of the receiver, for various types of interference.

With the incorporation of filters at the output of the receiver, the required protection ratios become less; the degree of reduction depends upon the frequency separation, the cut-off frequency of the filter and to some extent on the nature of the interference. The details are shown in Doc. XII/7 of Bad Kreuznach, 1962 (Table II and Figs. 1 to 5) and Doc. 94 of Geneva, 1963 (Table III and Figs. 1 to 3).

The documents conclude that, in assessing the required protection, the allowable frequency tolerance limits of various emissions must be taken into account. Considering the frequency tolerance standards, as laid down in the Radio Regulations, Geneva, 1959, the increase in the required protection has been estimated. For a frequency of operation of 5 Mc/s, in the limiting case of interference from a broadcast station, the increase in required protection would be of the order of 2 db for 5 kc/s frequency separation and 1 db for 10 kc/s frequency separation. For frequencies of operation higher than 5 Mc/s, such protection ratios would be still higher. In the other limiting cases of interference from mobile stations, the increase in protection ratio at 5 Mc/s would be of the order of 4 db for 5 kc/s frequency separation and 3 db for 10 kc/s frequency separation. The incorporation of filters with lower cut-off frequencies would result in the reduction of the required protection ratios, only at the cost of the quality of received music programmes.

Since the results presented have been derived under steady-state conditions, appropriate allowance should be made for fading under actual operating conditions.

8. **Doc. 218 (France), of Geneva, 1963,** describes the results of measurements of protection ratio made in the medium-frequency band under steady-state conditions on various types of receivers of recent manufacture.

The measurements were made by the usual method with a wanted signal and an unwanted signal, the level of the latter being set to give a level of interference considered tolerable by the listeners. Various types of programme were used for the tests but programme material particularly susceptible to interference (e.g. music of high quality with a wide dynamic range) and programmes only slightly susceptible to interference (e.g. modern dance music with a restricted dynamic range) were excluded.

The results of the measurements are shown by curve *J* of Fig. 4.

There are two main conclusions to be drawn from Doc. 218, namely that, for medium frequency reception at least, and with the great majority of receivers in use, the protection ratio necessary with no frequency separation ($\pm$ 20 c/s) is 40 db, and with 5 kc/s spacing, 46 to 50 db.

The incorporation of special cut-off filters would reduce the required protection ratios, but only at the expense of quality of received music programmes.

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* The protection ratios quoted refer in all cases to the ratios at the input to the receiver, no account having been taken of the effect of using directional receiving antennae or of the advantage that can be obtained by using different polarization for transmission of the wanted and unwanted signals.

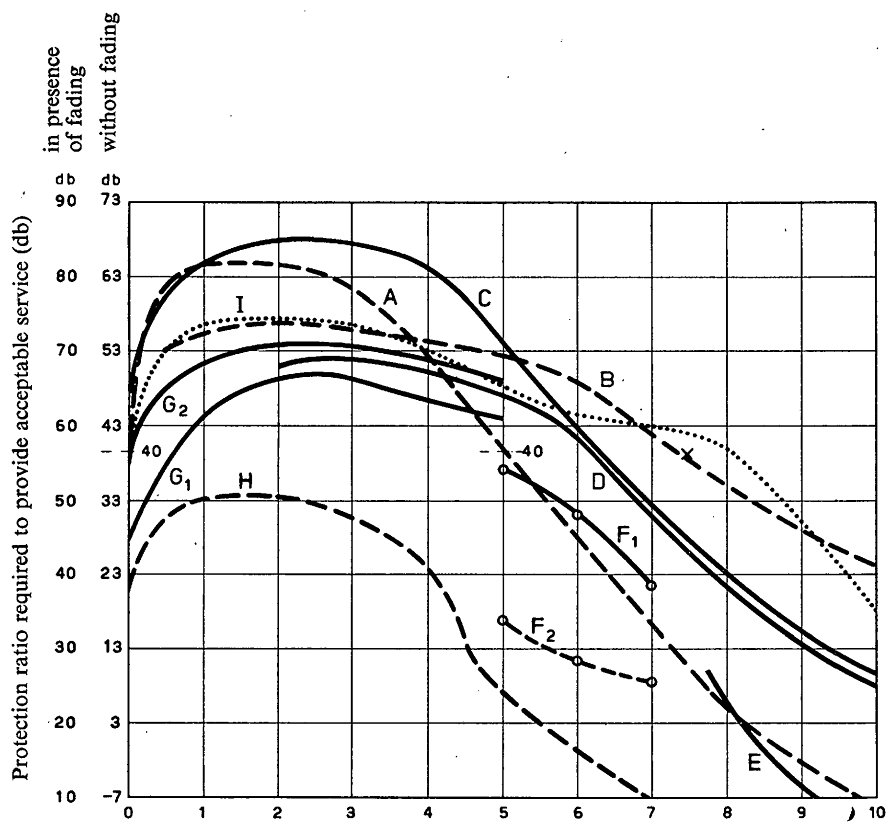


FIGURE 4

Protection ratios required to provide acceptable service

DESIGNATION OF CURVES

A* VAN DER POL (1933).
B* BRAILLARD (C.C.I.R., Bucharest, 1937).
C* B.P.O. tests, 1948.
D** B.P.O. tests, 1950.
E** B.P.O. tests, 1951.
F_1** B.P.O. tests, 1956 (no filter)
F_2** B.P.O. tests, 1956 (whistle filter).
G_1** Indian tests (50% satisfaction).
G_2** Indian tests (90% satisfaction).
H** Curve used by the I.F.R.B., 1956 for HF broadcast plans.
J*** French tests, 1962.

* Criterion of test — Just perceptible interference.
** Criterion of test — Just tolerable interference.
*** Corresponding to a " tolerable " interference for five different types of receivers.

ANNEX

1. Conditions of test for Curve A

The tolerable signal-to-interference ratio (with the receiver tuned to the wanted signal), was chosen as the criterion of receiver sensitivity.

The receiver sensitivity was adjusted to apply 150 mW low frequency power to the loudspeaker, the wanted signal being modulated by a 400 c/s tone to a depth of 30%. The quasi-maximum of the modulation of the interfering signal corresponded to a modulation index of 90%.

The amplitude of the interfering signal was then increased, up to the point when its interfering effect on an unmodulated wanted signal was just perceptible to the ear at a distance of about 50 cm from the loudspeaker.

Further, if the wanted signal was also modulated, the above ratio may be multiplied by a factor between 3 and 5.* (Documents of the European Radiocommunication Conference, Lucerne, 1933, pp. 280-282, and Documents of the Fourth Reunion of the C.C.I.R., Bucharest, 1937, Vol. I, 109-112).

2. Conditions of test for Curve B

Similar conditions to those of Curve A, but relating to very high quality reception (Documents of the C.C.I.R., Bucharest, 1937, Vol. I, 241).

3. Conditions of tests for Curves C, D, E and F (British Post Office tests)

The conditions under which tests F were conducted require some detailed comment.

A " standard " condition of co-channel interference was set up, this in the first place providing an interfering broadcast signal 23 db below the wanted carrier level. As finally set up, however, short-term Rayleigh-type fading was introduced and, on the basis of some

TABLE III

Test	Date of test	Wanted signal		Unwanted signal	
		Type	Modulation index	Type	Modulation index
C	1948	Music (0–8 kc/s)	30% average, peaking to 100% occasionally	Speech (0–8 kc/s)	30% average, peaking to 100% occasionally
D	1950	Broadcast speech	Idem	Telephony (0–3 kc/s)	70%
E	1951	Broadcast speech	Idem	Speech (0–6 kc/s)	30% average, peaking to 100% occasionally
F	1956	Broadcast speech	Idem	Music (6 db down at 4·6 kc/s)	30% average, peaking to 100% occasionally

* *Note by the Director, C.C.I.R.:* The original van der Pol curve was plotted as the ratio of the " tolerable interfering signal to the wanted signal ". Accordingly, with the curve *A* of Fig. 1, which is plotted as the ratio of the wanted signal to the interfering signal, this factor should be 1/3 to 1/5 (−9·5 to −14 db).

practical evidence, this was taken to require the co-channel protection ratio to be increased to 33 db. An allowance of 7 db for long-term fading would thus give the figure of 40 db for planning purposes, as used at the Mexico City Broadcasting Conference, 1948. The tests F, however, were carried out only with artificially produced short-term fading and all adjacent channel figures, therefore, relate to a co-channel protection ratio of 33 db. In the final presentation, these figures have, therefore, been reduced by 10 db to equate the results to the non-fading conditions used for all other tests. The ordinate has been so labelled that protection ratios can be read off either for non-fading conditions, or for full fading conditions incorporating a total allowance of 10 + 7 = 17 db for short-term and long-term fading. For

TABLE IV

Wanted signal	Interfering emission	Frequency separation (kc/s)	Protection ignoring frequency tolerance (db)	Maximum frequency tolerance in the shared bands (Atlantic City) (c/s)	Protection taking into account the tolerance in Column5 (db)
Speech	A1-fixed (40 w.p.m.)	0	26·5	150	33·5
	A1-mobile (40 w.p.m.)	0	26·5	1000	44·5
	A2-fixed (mod. at 525 c/s)	0	35	150	42
	A2-mobile (mod. at 525 c/s)	0	35	1000	49
	A3-fixed (mod. at 3 kc/s max.)	0	33	150	40
	A3-mobile (mod. at 3 kc/s max.)	0	33	1000	50
	A3-Broadcasting	0	33	150	44
	A1-fixed (40 w.p.m.)	5	41·5	150	43
	A1-mobile (40 w.p.m.)	5	41·5	1000	47
	A2-fixed (mod. at 525 c/s)	5	39	150	43
	A2-mobile (mod. at 525 c/s)	5	39	1000	49
	A3-fixed (mod. at 3 kc/s max.)	5	48	150	50
	A3-mobile (mod. at 3 kc/s max.)	5	48	1000	52
	A3-Broadcasting	5	48	150	49
	A3-Broadcasting	0	33	645	51·5
	A3-Broadcasting	5	48	645	50·5
Music (vocal)	A1-fixed (40 w.p.m.)	0	27·5	150	36
	A1-mobile (40 w.p.m.)	0	27·5	1000	42·5
Music (instrumental)	A2-fixed (mod. at 525 c/s)	0	24	150	28·5
	A2-mobile (mod. at 525 c/s)	0	24	1000	36
Music (vocal)	A3-fixed (mod. at 3 kc/s max.)	0	26	150	34
	A3-mobile (mod. at 3 kc/s max.)	0	26	1000	41·5
	A1-fixed (40 w.p.m.)	5	37	150	39
	A1-mobile (40 w.p.m.)	5	37	1000	43
Music (instrumental)	A2-fixed (mod. at 525 c/s)	5	39	150	40
	A2-mobile (mod. at 525 c/s)	5	39	1000	43
Music (vocal)	A3-fixed (mod. at 3 kc/s max.)	5	42·5	150	44
	A3-mobile (mod. at 3 kc/s max.)	5	42·5	1000	46·5

some of these measurements under test *F*, a simple whistle filter was placed in the loudspeaker input leads, so that the improvement in protection ratio that might readily be gained by reducing the audible heterodyne whistle at 5, 6 and 7 kc/s could be assessed.

4. Conditions of test for curve G_2 (Indian tests with 90% listener satisfaction)

See Table IV.

5. Conditions of test for curve H

Curve of the minimum protection ratio used by the I.F.R.B. for high-frequency broadcasting planning which is, for stable transmitters (± 20 c/s). Any 5 kc/s whistle effects are ignored and the tests relate to operational conditions, where the wanted field-strength is considerably stronger (by at least 20 db), than the unwanted field-strength. (Information furnished by the I.F.R.B.)

6. Conditions of test for curve J

See § 8 of the Report (page 141).

7. Comments on results

With such a variety of test arrangements and particularly of types of receiver employed, it cannot be expected that close uniformity of results would be obtained; this is confirmed in Fig. 4. The rather less stringent protection, resulting from test *F*, may imply that the 10 db factor allowed for short-term fading is unnecessarily high. It may also, in part, be a consequence of the reduced bandwidth of the interfering signal as compared with that used for some of the earlier tests.

It will be noted that the I.F.R.B. curve *H* gives protection ratios substantially lower than any of the measured data. A further point of considerable interest is that the introduction of simple whistle filters appears to reduce the required protection ratio at frequency spacings of the order of 5 to 7 kc/s, by as much as 12 to 20 db.

REPORT 303 *

DETERMINATION OF NOISE LEVEL FOR TROPICAL BROADCASTING

(Question 155(XII))

(Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

Question 155 (XII) calls for a comprehensive study of the characteristics of atmospheric noise in tropical broadcasting areas, and for its measurement by both objective and subjective methods.

1. **Doc. 92 (India) of Los Angeles, 1959,** entitled " Determination of noise level for tropical broadcasting ", reports measurements of atmospheric noise made in Delhi, using an experimental arrangement, which is essentially an adaptation of that used in the Thomas method.

* This Report, which replaces Report 120, was adopted unanimously.

The methods adopted for objective and subjective measurements are described and correlation between the two sets of measurements is attempted. An analysis of the data showing seasonal and frequency variations is made and correlation with the sunspot numbers is being attempted. It is concluded on the basis of the analysis of measurements so far carried out that 40 db protection over the prevailing noise is required for average satisfactory listening for 90% of the time, irrespective of the frequency of operation and the time of the day corresponding to listener satisfaction of 50% and/or a steady signal.

Figs. 1, 2 and 3 show the variation of the subjective values of minimum satisfactory signal at various frequencies and time of day for the different seasons.

FIGURE 1 *(Winter)*

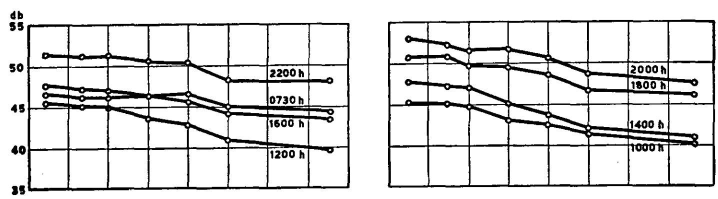


FIGURE 2 *(Equinox)*

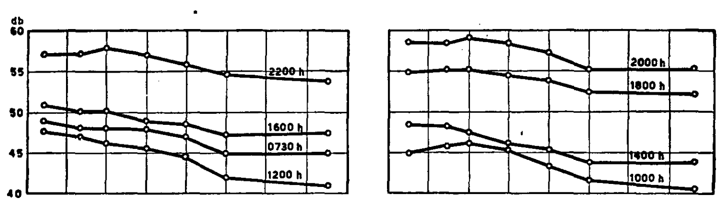
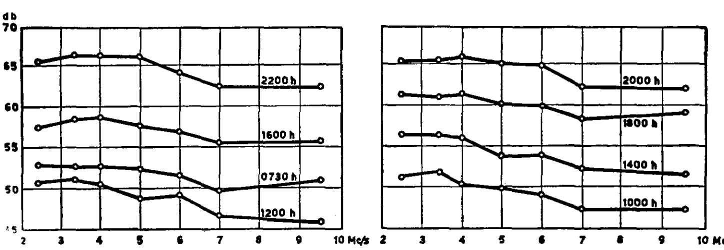


FIGURE 3 *(Summer)*



Minimum signal required for satisfactory listening (db rel. 1 μV/m)

2. **Doc. XII/10 (India) of Bad Kreuznach, 1962,** " Determination of atmospheric noise-level at Gauhati (26° 10′ N, 91° 40′ E) " and **Doc. XII/11 (India) of Bad Kreuznach, 1962,** " Determination of atmospheric radio noise at Trivandrum (8° 29′ N, 76° 57′ E) ", incorporate the values of atmospheric-noise level measured at Gauhati and at Trivandrum. The former is in the north-eastern part of India and the latter is in the southernmost part. The objective method described in Doc. 92 (India) of Los Angeles, 1959, was used for these measurements. The thunderstorm activity in the eastern region of India is very high. The atmospheric noise levels at Gauhati are, therefore, much higher than those in Delhi and its character is also impulsive of an intermediate type. On the other hand, the character of noise at Trivandrum is generally of the fluctuation type.

The seasonal averages of upper decile values of atmospheric-noise level at Gauhati for a receiver bandwidth of 6 kc/s are given in Fig. 4. Similar values for Trivandrum are given in Fig. 5. Noise levels at Trivandrum have been reported, on the basis of measurements for one year and the values should be taken as tentative.

3. **Doc. XII/6 (U.S.A.) of Bad Kreuznach, 1962,** " Determination of noise level for tropical broadcasting ", mentions that a measuring equipment (ARN-2) has been developed by the Central Radio Propagation Laboratory of the National Bureau of Standards, U.S.A., for obtaining an objective measure of the average power, average voltage and average logarithm of the voltage of the noise envelope. It has also been stated, that a method has been developed for determining the amplitude probability distribution function of the radio-noise envelope from these three measured parameters.

There are sixteen such recorders in operation in different parts of the world, with eight of these stations in the tropical zone. To determine the relationship between the noise received on a vertical antenna and on a horizontal antenna, the ARN-2 is to be used to record on a time-sharing basis from three antennae the standard vertical whip, a horizontal antenna oriented North-South and a horizontal antenna oriented East-West.

Report 65 has been revised (Report 322) using data obtained during the last few years. Until supplementary information is available for further revision of Report 322, the data contained in Report 322 should be used with some caution in predicating noise conditions in tropical areas.

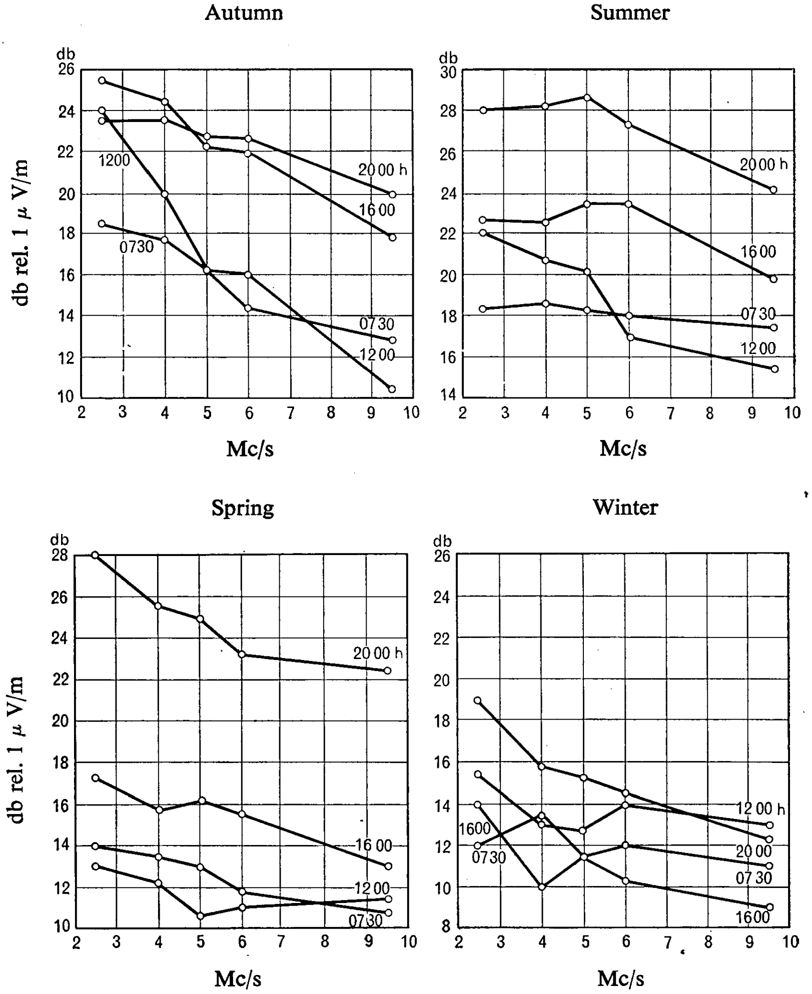


FIGURE 4

Atmospheric radio-noise at GAUHATI

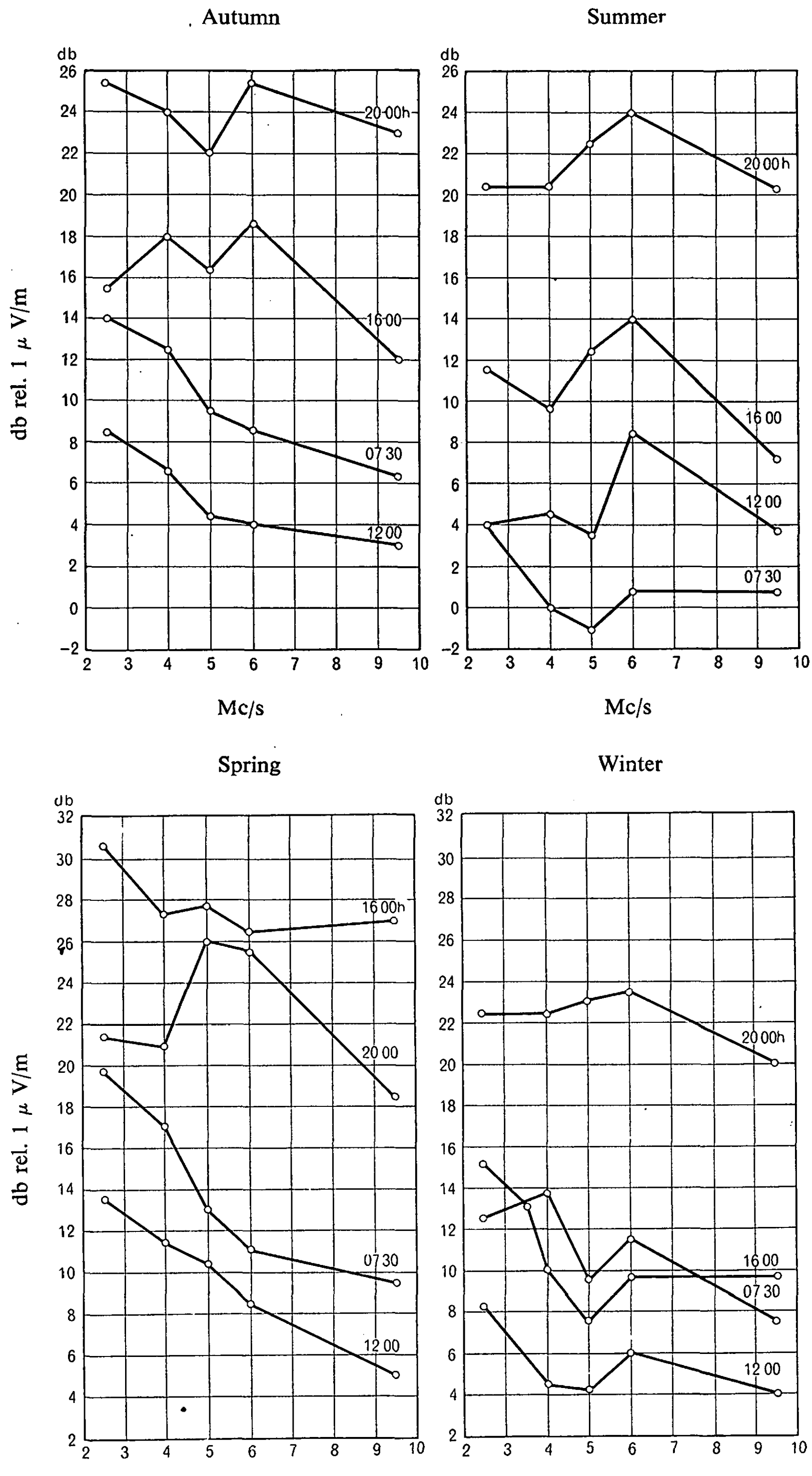


FIGURE 5

Atmospheric radio-noise at TRIVANDRUM

REPORT 304 *

FADING ALLOWANCES FOR TROPICAL BROADCASTING

(Question 157(XII))

(Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

Question 157(XII) calls for a study of the characteristics of fading in the tropical zone, on assessment of the annoyance value of fading to reception from the point of view of listener satisfaction and determination of the allowances that should be provided for fading when planning tropical broadcasting services.

The following is a summary of contributions received in response to this question:

1. **Doc. XII/8 of Los Angeles, 1959** (Preliminary report on the statistical analysis of fading on short-wave transmission)

This contribution from India describes experiments in the measurement of fading of continuous-wave emissions at oblique incidence, voice-modulated broadcast transmissions on 4·7 Mc/s, 9 Mc/s and 15 Mc/s, as well as on pulse transmissions on the equivalent vertical incidence frequency. The theoretical considerations and the experimental set-up used in the measurements are described and an analysis of the data collected is given. Based on the analysis of the data, the following conclusions are drawn:

1.1 The distributions observed from the analysis of a few typical random curves are found to be Rayleigh, normal or log-normal and this finding is in keeping with similar observations elsewhere.

1.2 On short waves, no correlation or similarity has been observed between the amplitude distributions for the simultaneously recorded fading records of:

— an oblique-incidence CW transmission, and

— the equivalent vertical-incidence frequency for pulse transmission with reflection; both records are taken at the same spot.

A possible explanation for this conclusion is lack of similarity or correlation between the region of reflection of the vertical incidence pulse signal and that of the oblique-incidence CW signal, owing to the large distances separating them.

2. **Doc. XII/12 of Bad Kreuznach, 1962** (A report on the severity of fading on short waves)

This contribution from India discusses quantitative estimates of the severity of fading, and the effects upon fading of such factors as time of day, season and geographical location for oblique-incidence transmissions. The report concludes that:

2.1 Based upon fading measurements conducted at Nagpur by the Research Dept., All India Radio, using transmissions from four regional short-wave broadcasting stations at Delhi, Bombay Madras and Calcutta over a three-year period, the ratio between the monthly median and the monthly lower decile values of the hourly-median field intensity was found to vary from 1·0 to 15·4 db. The overall median value was 7·4 db with a standard deviation of 2·9 db. The overall average was 7·6 db. Morning and midday ratios were generally higher than the night values. Night values remained at approximately the same level regardless of season for

* This Report, which replaces Report 121, was adopted unanimously.

Delhi, Bombay and Calcutta, while day-time values fluctuated with the season. In Madras, night values were higher in winter and equinox months than in summer. The average ratio was not found to vary much among the four locations measured, although there were times when the instantaneous value observed from one location was considerably different from the others.

2.2 The diurnal and seasonal variations of the ratio between the monthly median and the monthly lower decile values of the hourly-median field-intensity appear to show a good correlation with the occurrence of sporadic-E and the variations of absorption. It appears reasonable to assume, therefore, that the day-to-day fluctuations of the received signal are caused by sporadic-E reflections, variations of absorption and, under appropriate conditions, by multi-hop transmissions.

2.3 Based on the analysis of field strength recordings made at Patna of short-wave broadcast transmissions from Srinagar, Bombay and Madras, as well as of the signals of regional short-wave transmitters referred to in § 2.1, which were measured at several locations in India, the ratio between the median signal level and the received signal intensity exceeded 90% of the time was found to vary from 1·6 to 27 db. The most probable value was found to be 9 db. The highest ratio occurred at approximately 2200 hours, both for summer and winter months, with average levels generally higher during the late afternoon and evening hours than during the morning and mid-day periods. Ratios during the summer months were approximately 4 db higher, on the average, than values observed during winter periods.

2.4 On comparing the observed data with those obtained by other countries, it is found that fading, as referred to instant-to-instant variations in field strength, appears to be more severe in India than in countries in the temperate zones. The day-to-day fluctuations, however, appear to be of the same order as in the temperate zones.

3. **Doc. XII/5 of Los Angeles, 1959** (Fading allowances for tropical broadcasting transmissions)

This contribution by the United Kingdom, describes a method of measurement developed for investigating the nature, type and intensity of fading of broadcast transmissions under tropical conditions. Recordings of fading signals are made on magnetic tape in tropical areas and are analyzed later in the United Kingdom. The paper presents an analysis of recordings made in three tropical broadcasting areas at different times of the day and at various distances from the transmitter.

The method of measurement employs a receiver connected to a suitable antenna having preferably the same orientation as the polarization of transmission being measured. The receiver which operates linearly over the fading range, is tuned to the transmission with the beat frequency oscillator on, the automatic gain control off and the selectivity set to a narrow bandwidth. The output is fed to a good tape recorder which has a calibration signal covering a range of 20 db in 4 db steps.

The recordings are analyzed in the United Kingdom by means of a level distribution analyzer.

For three areas, namely Barbados and Trinidad, Ghana and Singapore, the recordings have been analyzed and a mean-level distribution-curve obtained for each case, covering the period around 1800 hours local time.

3.1 The results showed little dependence on location of transmitters or time of the day. However, they appeared to show some small dependence on range and have, therefore, been grouped under three ranges, 0–100 km, 100–350 km and over 350 km.

3.2 The fading experienced in the 100–350 km range is somewhat less than that for the other two ranges. This has been attributed as possibly due to inter-action between ground and one-hop sky-wave for 0–100 km and multipath sky-wave propagation for over 350 km groups.

3.3 The results appear, in general, to conform fairly closely to the Rayleigh type of distribution. The records show evidence of phase interference between ground and sky-wave at very short distances, giving rise to a more or less regular beat pattern with a period of 15–20 seconds. Another feature noticed is the increased rate of fading experienced after local sunset.

4. **Doc. XII/17 of Bad Kreuznach, 1962** (Fading allowances for tropical broadcast transmissions)

This contribution by the United Kingdom, describes the results of more recent fading measurements carried out at Barbados and Trinidad, Ghana, Singapore and Johannesburg along the lines discussed in § 3. The additional data cover, for the most part, ranges exceeding 350 km, and have been combined with those obtained previously to obtain a more statistically stable sample. The additional results confirm earlier conclusions, that the short-term fading characteristics for ranges between 0 and 350 km conform closely with that of a Rayleigh type of distribution. The inclusion of additional data for ranges in excess of 350 km, however, indicates a greater departure from a Rayleigh type of distribution than from previous data. The characteristics of the received signal waveforms were, in general, similar to those analyzed previously, showing a tendency for an increased rate of fading after local sunset.

5. **Doc. XII/5 of Bad Kreuznach, 1962** (Equatorial effects in HF broadcasting)

This contribution by the United States, is devoted mainly to a discussion of equatorial flutter fading, which the paper considers to be the most serious of the several propagation effects peculiar to equatorial regions, from the standpoint of circuit degradation.

5.1 The paper discusses published observations of equatorial flutter, which appears to be most serious within a geographical area defined by a belt of width between 650 and 1300 km centred on the magnetic equator. To date, data are available mainly from the Far East and Africa and it is not certain that the belt is uniformly wide around the world. It appears that north-south circuits, with a reflection point in the critical belt, may be more affected than east-west circuits, with the same reflection point. The fading effect is most intense within two hours of local sunset at the point where the propagation path crosses the magnetic equator. All evidence seems to point to the fact that equatorial fading is most serious during sunspot maximum and becomes almost negligible during periods of sunspot minimum. Seasonal variation, however, is not nearly so well defined, but it appears that equatorial flutter fading is more intense during the equinoctial periods than during the other seasons.

5.2 Signal degradation, caused by equatorial flutter, appears to be equally serious throughout the entire audio spectrum. Subjectively, its effects are more noticeable on musical transmissions than on speech. A Doppler effect has been observed up to 40 c/s.

REPORT 305 *

BEST METHOD FOR CALCULATING THE FIELD-STRENGTH PRODUCED BY A TROPICAL BROADCASTING TRANSMITTER

1. Introduction

Doc. 227 and *357 of Warsaw, 1956*, considered the currently used C.R.P.L. and S.P.I.M. methods for calculating the sky-wave field-strength from a broadcast transmitter in the tropical zone. At the VIIIth Plenary Assembly, Warsaw, 1956, Study Group XII came to the conclusion that the methods were inadequate and that further studies were required to derive a satisfactory method.

The following contributions to Question 154 (XII) were submitted to the IXth Plenary Assembly: *Docs. XII/2 (United Kingdom), XII/3 (French Overseas Territories) and XII/7 (India) of Los Angeles, 1959.* The following documents were received during the period 1960-62 and considered at the Interim Meeting of Study Group XII: *Docs. XII/8 (India), XII/9 (India) and XII/18 (United Kingdom), of Bad Kreuznach, 1962.* These documents, together with Doc. 98 (India) of Geneva, 1963, are summarized in this Report.

2. Doc. XII/2 (United Kingdom) of Los Angeles, 1959

Question 154(XII) asks what is the best method for calculating the field strength produced at the surface of the earth by the indirect ray, by a transmitter situated in the "tropical zone" (as defined in Nos. 135 and 136 of the Radio Regulations, Geneva, 1959) under various conditions and, in particular, at distances up to 800 km and from 800 to 4000 km from the transmitter.

In recent years, work has been carried out in the United Kingdom by the Department of Scientific and Industrial Research covering this particular problem and the results have been described in a paper by W. R. Piggott **. In this paper the author refers to the new data now available for amendment of the basic factors used in earlier standard methods of field-strength calculation. With these new data and a fresh approach to the derivation of the various possible propagation modes, a method of calculation is described which covers the problem set by Question 154(XII).

In effect, the method proposed is comparable with that given in Circular No. 462 of the National Bureau of Standards in the U.S.A. The original curves of absorption index K are, however, replaced by new curves which take into account more recent measurements of absorption in tropical latitudes, including those at Singapore (Malaya) and Ibadan (Nigeria) and also allow for the finite recombination time of the absorbing layers. It is interesting to note, that the new K-curves make allowance for greater absorption after sunset than had been allowed in the Circular No. 462 data.

The final results are given in terms of the median values of field-strength set up by a 1 kW transmitter and will need to be weighted by allowances for fading of the signal. At present, little is known about the characteristics of fading of HF signals reflected at steep angles of incidence from the ionosphere, but it is hoped that studies being made in this and other countries of C.C.I.R. Question 154 (XII) will provide the necessary quantitative data.

* This Report, which replaces Report 128, was adopted unanimously.

** Piggott, W. R.: The calculation of the median sky-wave field-strength in tropical regions. D.S.I.R. Radio Research Special Report 27, H.M. Stationery Office, London (1958).

Attention is drawn to the statement on page 6 of the paper by Piggott, regarding the effect of scattering at low latitudes near the geomagnetic equator and further data on this aspect are required.

3. Doc. XII/3 (French Overseas Territories) of Los Angeles, 1959

This document discusses the main characteristics of tropical broadcasting. The paper includes graphs indicating the influence of antenna gain, directivity, absorption, E- and F-layer reflections, etc., for ranges up to 4000 km.

The method of calculating the graphs as well as their interpretation are given and certain conclusions concerning the main requirements for a rational use of tropical broadcasting are drawn as follows:

— absorption: an attempt should be made to absorb, as much as possible, fields due to all reflections other than the first;

— antennae with adequate directivity should be used without creating undesirable concentration;

— concerning the working frequency, one alternative would be to choose a frequency of about two-thirds the average critical frequency for F-layer operation both by day and night. This method would be economical in power but would have drawbacks arising from sporadic E-layer reflections, interference, echoes, etc. Another method would be to choose a rather low frequency distinctly below the critical frequency of the E-layer for daytime operation. At night, the frequency would have to be increased to a limited extent for operation with the F-layer. In this case antennae with adequate directivity and with facility for variation of the transmission angle would have to be used.

3.1 *Method of calculation*

The field at the receiver is obtained by the quadratic summation of the different components due to each of the possible routes of the sky-wave, neglecting the ground-wave whose range is very restricted. The antennae recommended radiate only a small part of their energy at horizontal incidence and, as they are horizontally polarized, the attenuation of the direct wave by ground effect is very rapid. We are limited in the present study to an examination of the effect of the first four routes simultaneously possible.

Each of the components is calculated, making allowance for:

— the attenuation of the field by propagation (distance attenuation),

— the antenna gain used, knowing that its total radiated power is 1 kW,

— the attenuation due to D-layer absorption.

The graphs are valid in the particular azimuthal plane of the antenna, i.e. in the vertical plane perpendicular to the horizontal wires of the antenna and passing through its centre.

3.2 *Method of presenting the graphs*

The graphs show the level of the field received, as a function of the distance, for certain frequencies which would be transmitted from Dakar, at peak listening hours (0800, 1200 and 2000 hours LMT), at a certain time of year and at low, medium and high sunspot numbers, corresponding respectively to the Wolf numbers 10, 70, and 150.

The level is indicated in decibels as a ratio of the reference field of 300 μV/m, which is regarded as practicable for listeners with an ordinary six-transistor receiver and generally sufficient to procure a signal/noise protection ratio better than or equal to 40 decibels.* However, at periods of intense noise, it is advisable to take higher reference field values for low frequencies.

* In India, it has been found that a much higher field-strength is required to give a satisfactory service.

The field-strength can be read off from each of the graphs as a function of the distance. It is shown by the unbroken curve, designated by the letter E, with index E or F according to whether the method of propagation envisaged is made by the E-layer or the F-layer. The first four components of the field (each one designated by a figure showing the number of ionospheric reflections, with a letter showing the layer on which reflections are made), appear also.

3.2.1 *Comments on Figs. 1a and 1b*

For a total radiated power of 1 kW, Fig. 1*a* shows the field strength furnished, as a function of distance, by a half-wave doublet 0·25 of a wave-length high, propagated by the F-layer at 2000 hours LMT, that is to say, after the sun has set and the layers E and D have disappeared. Hence absorption has been ignored.

Fig. 1*b* shows the field produced in the same circumstances, by a four-slot antenna at the same height.

The effect of antenna gain, and the advantages offered by vertically directive antennae for tropical broadcasting, will be seen at once. The field is intense within the area less than five hundred miles round the transmitter, while being low beyond. Thus the interference that might be caused at long ranges is kept to a minimum.

3.2.2 *Comments on Figs. 2a and 2b*

These graphs show the effect, for a particular type of antenna, of the inclination from the vertical of the transmitter antenna lobe. Once again, we are dealing with F-layer propagation at 2000 hours LMT. Fig. 2*a* represents the field of an antenna with a single slot at a height of 0·25 the wave-length, transmitting vertically. Fig. 2*b* shows that of a single-slot antenna, at a height of 0·4 times the wave-length, and hence offering, on either side of the vertical, a lobe inclined at about 25°.

It will be seen, that when the area close to the transmitter is served by a medium-wave transmitter, it might be well to have an antenna height equal to 0·4 times the wage-length, without there being an increased risk of interference in the area beyond 800 km (500 miles) from the transmitter.

3.2.3 *Comments on Figs. 3a and 3b*

These graphs show the advantages of E-layer reflection, in comparison with F-layer reflection for a particular antenna, by day, allowance being made for absorption. In E-layer propagation, the field is relatively more intense at short distances than in F-layer propagation, while it falls off faster for greater distances. The antenna used in both cases is made up of a half-wave doublet in a horizontal plane, at a height of 0·25 times the wave-length above ground. The moment considered, for each graph, is 0800 hours LMT, in June ($R = 10$). The frequency is 5 Mc/s. Note that F-layer propagation, shown in Fig. 3*b*, can be considered normal, whereas the E-layer propagation in Fig. 3*a* occurs only when the critical frequency of the sporadic E-layer reaches 5 Mc/s.

3.2.4 *Comments on Figs. 4a and 4b*

These two graphs were drawn up for a half-wave antenna at a height of 0·25 times the wave-length, by day. In both cases, the field is produced by F-layer reflection, but in Fig. 4*a* there is but little absorption, while in Fig. 4*b*, absorption is very great.

It will be seen at once, that advantage can, to some extent, be taken of absorption to get better broadcasting conditions, provided always that very great powers are used and a relatively low frequency. In this fashion, we can do without special antennae with narrow vertical beams, since, in this particular instance, a simple horizontal half-wave, 0·25 times the wave-length above the ground, will do perfectly well. The field shown in Fig. 4*b* is produced almost entirely by a single F-layer reflection, so that, in this instance, the quality of the transmission will approach that of medium-wave broadcasting, except very close to the transmitter where the ground-wave interferes with the sky-wave.

4. Doc. XII/7 (India) of Los Angeles, 1959 and Doc. XII/8 (India), of Bad Kreuznach, 1962

These two documents report the results of further measurements on ionospheric absorption at Delhi, some of which were reported earlier in a document of the VIIIth Plenary Assembly. The main conclusions are summarized below:

4.1 *The diurnal variation of absorption*

The diurnal variation of absorption may be expressed by the relationship

$$\left| \log \rho \right| = k (\cos \chi)^n \quad (1)$$

where

ρ = apparent reflection coefficient,
$-\log \rho$ = measure of absorption and
χ = solar zenith-angle

Since, however, the exploring wave frequency of 5 Mc/s used in the investigation has not always been much higher than the critical frequency of E-layer during midday, deviative absorption in penetrating the E-layer might contribute towards the total absorption measured.

Following Jaeger's method, the absorption suffered in penetrating the E-layer was calculated and subtracted from the total absorption. The value of n_D for the non-deviative absorption in the D-layer has also been determined. The values of n and n_D during various seasons are given in Table I.

TABLE I

Diurnal variation factor n and n_D

Season	Forenoon			Afternoon			Mean of forenoon and afternoon values		Weighted average	
	Number of observations	n	n_D	Number of observations	n	n_D	n	n_D	n	n_D
Summer (May, June, July, August)	11	1·05	0·86	8	0·94	0·77	1·0	0·81		
Equinox (March, April, September, October)	8	0·99	0·82	11	0·96	0·80	0·97	0·81	0·92	0·77
Winter (November, December, January, February)	13	0·88	0·74	21	0·82	0·72	0·84	0·73		

It will be seen from this table that the mean value of n_D works out to be 0·77.

4.2 *The seasonal variation of absorption*

The seasonal variation of absorption may be expressed by the relationship

$$\left| \log \rho \right| = k'(\cos\chi_{\varphi = o})^m \qquad (2)$$

where

$\chi_{\varphi = o}$ is the solar zenith-distance at zero hour-angle. The values of m and m_D have been found to be distinctly lower than the average values of n and n_D. This leads to the conclusion, that there is slightly more absorption during winter than would have been expected from the value of n and n_D given in § 4.1. The winter anomaly has also been reported from an analysis of Slough data.

4.3 *The sunspot-cycle variation*

The sunspot-cycle variation may be expressed by the relationship

$$A_R = A_o\ (1 + C\overline{R}) \qquad (3)$$

where

A_R = absorption when the sunspot is R,
A_o = absorption when the sunspot number is zero,
C = sunspot cycle variation factor,
$\overline{R}$ = running average sunspot number.

The value of C was found to be 0·0017.

4.4 *Night-time absorption*

On most of the days absorption at night was found to be low. The mean value of night-time absorption was found to be 2·5 db. On a few nights, however, the absorption was abnormally high.

4.5 *Frequency variation of absorption*

The frequency variation of absorption may be expressed by the relationship

$$\left| \log \rho \right| = k''(f \pm f_L)^{-n_f} \qquad (4)$$

where

f = frequency of the radio-wave; and
f_L = longitudinal component of the gyromagnetic frequency.

The average value of n_f was found to be 1·8 and no significance can be attributed at this stage on the value of n_f being slightly less than 2·0 as predicted from theory.

5. Doc. XII/9 (India) of Bad Kreuznach, 1962 and Doc. 98 (India) of Geneva, 1963

The non-deviative absorption measured at Delhi has been used by the Research Department of All India Radio to evolve a formula for calculating the sky-wave field intensity in tropical regions. Doc. XII/9 describes the various considerations that are involved in working out the formula and compares the results obtained by its use with those achieved by other methods. Additional field-strength measurements and calculations are given in Doc. 98.

5.1 *Factors involved in the estimation of field-strength*

The field-strength produced by a short-wave transmitter at any distance may be expressed as:

$$F = F_o + a_1 + a_2 - (a_3 + a_4 + a_5 + a_6 + a_7 + a_8) \qquad (5)$$

where

F: field-strength (db above 1 μV/m),

F_0: field-strength (db), produced at unit distance (1 km), by a transmitter of unit power (1 kW) using an antenna of unit gain (i.e. omni-directional),

a_1: power gain of the transmitter (db),

a_2: gain of the transmitting antenna (db),

a_3: losses due to spatial attenuation (db), (focusing, if any, is included),

a_4: losses due to non-deviative absorption (db),

a_5: losses due to deviative absorption (db),

a_6: losses due to ground reflection for multi-hop propagation (db),

a_7: losses due to the non-linear polarization of the downcoming wave (db),

a_8: losses due to partial reflection as in the presence of Es (db).

The field produced at 1 km by a 1 kW transmitter using an omnidirectional antenna may be taken as 173·8 mV/m. This gives a value of 104·8 db for F_0. The power gain, a_1, and the antenna gain, a_2, may easily be determined from a knowledge of the transmitter power and the polar diagram of the antenna.

The terms a_3 to a_8 may be described as the loss factors. Of these terms, spatial attenuation a_3 and non-deviative absorption are dealt with separately in §§ 5.2 and 5.3.

Losses due to deviative absorption, a_5, are important only when the frequency is close to the MUF for E- and F-layer propagation (within 20% of the MUF) and, in such cases, an appropriate correction factor must be considered. In normal calculations, this factor is ignored. However, on the basis of measurements of ionospheric absorption at night, a_5 is taken as 2·5 db in all cases in the calculation of night-time field-strengths.

In multi-hop transmissions, appropriate ground reflection loss, a_6, depending on the particular terrain must be taken into account.

The factor a_7 arises from the elliptical polarization of a radio-wave propagated through the ionosphere and the field-strength measured with a linearly polarized antenna is less than the maximum value of the rotating vector.

Following the C.R.P.L., a_7 has been taken to be equal to 3 db.

It is recognized that partial reflections from Es result in some losses, a_8. However, in any practical method of calculation, it is difficult to take this factor into account. Similarly, it is also difficult to take into account any losses when spread F is present.

5.2 *Spatial attenuation, a_3*

The attenuation suffered by a radio-wave due to spreading is directly proportional to the distance. But in ionospheric propagation, some additional factors come into play. Due to the concavity of the reflecting layers, a decrease in the attenuation, in comparison with the usually assumed law, may be expected especially at large distances. A detailed study of this phenomenon has been carried out by Rawer. According to him, this focusing effect reduces the spatial attenuation considerably, at distances greater than about 1500 km. Since the distances involved in tropical broadcasting circuits are usually less than 1500 km, it is not possible at this stage to verify the presence and the degree of the focusing effect.

5.3 *Non-deviative absorption, a_4*

During the day, non-deviative absorption is one of the most important factors to be considered in calculating sky-wave field-strength.

Non-deviative absorption:

$$a_4 = \frac{635n\,(1 + 0{\cdot}0017\overline{R})\sec\varphi}{(f \pm f_L)^2\,[\mathrm{Ch}(R, \chi)]^{0{\cdot}77}}\ \text{(db)} \qquad (6)$$

where

n: number of hops

$\overline{R}$: twelve months running average of sunspot number

φ: angle of incidence of the wave at the absorbing layer

f: frequency of the radio-wave

f_L: longitudinal component of the gyromagnetic frequency.

$\mathrm{Ch}(R, \chi)$: Chapman function for a scale height of 5·8 km.

$\pm$: signs correspond to the ordinary and extraordinary ray respectively.

For $\chi \leq 80°$, $\mathrm{Ch}\,(R, \chi) \approx \sec \chi$

The seasonal variation of absorption has not been found to be of much consequence. f_L may be taken as unity for all practical purposes.

5.4 *Graphical aids*

To facilitate speedy evaluation of field-strength of any transmitter at any distance up to 2000 km, the above method is presented in the form of graphs. A typical set of such graphs for 1F-propagation is given at the end. In Fig. 5, values of cos χ have been given for different latitudes at various local times for the month of February. From Fig. 6 an intermediate variable X can be found, corresponding to any value of cos χ and the sunspot number $\overline{R}$.

Here
$$X = \frac{(1 + 0{\cdot}0017\,\overline{R})}{[\mathrm{Ch}\,(R, \chi)]^{0{\cdot}77}}$$

and serves as an index for the ionizing power of the sun in the determination of non-deviative absorption by (6). In Fig. 7, the field-strength (db above 1 μ V/m), at any distance up to 2000 km, is given for the 7 Mc/s frequency band and for different values of X.

This field-strength corresponds to a 1 kW transmitter using an omnidirectional antenna. The antenna gain and power gain (both in db), of the transmitter in question are added to this, to obtain the actual field-strength. As the polarization loss (3 db) has been taken into account in drawing the graphs, it need not be considered separately. In Fig. 7, the curve corresponding to $X = 0$ denotes the unabsorbed field-strength. Field-strength at night is obtained by deducting 2·5 db from this. The dotted curve in Fig. 7 is the expected unabsorbed field-strength, if the focusing effect is taken into consideration.

In the preparation of this nomogram, the reflection height has been taken as 240 km. This is based on actual observation on lower short-wave frequencies.

5.5 *Consideration of the mode of propagation*

By following the procedure outlined in the previous sections, it would be possible to calculate the field-strength that may be expected, if the propagation is by any particular mode (such as 1F, 1E, 2F, 2E, etc.). To estimate the actual field-strength for any particular circuit, it is necessary to determine the predominant mode of propagation. This can be done by first examining the possibility of cut-off by any lower layer and then calculating the field-strength due to a few plausible low order modes. The actual field-strength would be that due to the mode of propagation that gives the highest field-strength. However, occasionally, the field-strength due to two modes or more may be found to be nearly equal. In such cases, the r.m.s. value of these signals is taken as the actual estimated field-strength.

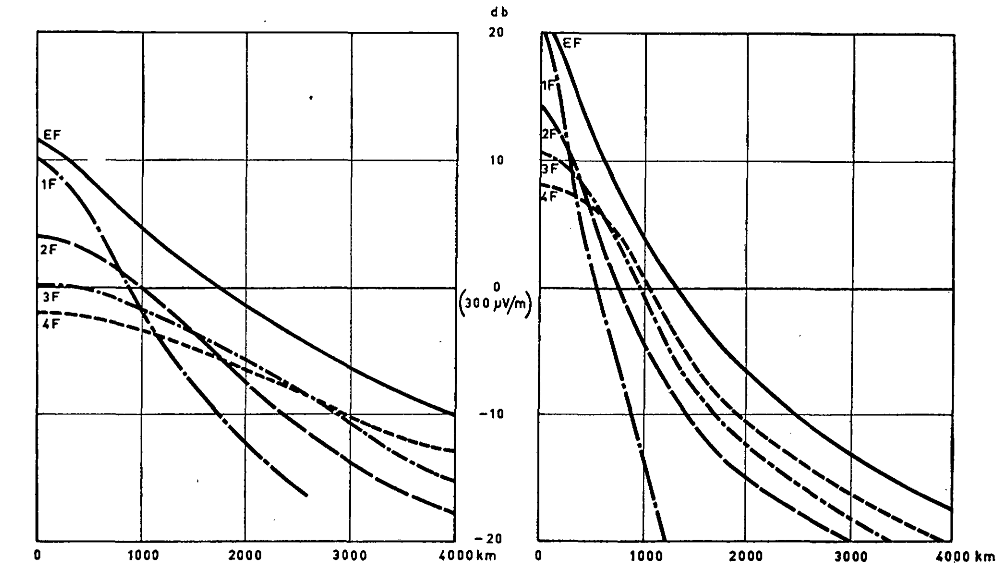
5.6 *Comparison of calculated and measured values of field-strength*

The measured values of field-strength have been compared with the calculated values obtained by C.R.P.L., S.P.I.M., RPU9, D.S.I.R. and the A.I.R. methods. It has been observed, that the values calculated by the A.I.R. and D.S.I.R. methods are in close agreement with the measured field-strength values, whereas the deviation is considerable in the other three methods, namely C.R.P.L., S.P.I.M. and RPU9.

6. Doc. XII/18 (United Kingdom) of Bad Kreuznach, 1962

For a period of approximately twelve months, field-strength recordings of seven transmissions were made by the D.S.I.R. at Singapore and the monthly-median field-strength for each hour has been determined. The curves of field-strength against time for all stations show the same general characteristic, namely, a rise in field-strength from the commencement of transmission in the early evening and a levelling off from about 2000 hours L.M.T. At Saigon, which operated for a large part of the day, the field-strength time curves show that this rise in strength begins at about 1300 hours L.M.T., when the absorption in the ionosphere begins to decrease.

6.1 *Calculations of field-strength* were made by the C.R.P.L. and RPU9 methods. While both methods, generally speaking, give curves following closely the shape of the measured curves, there are differences of up to 6 db in the two field-strengths. C.R.P.L. values are, in general, lower than those measured, while the RPU9 values are higher.



Distance

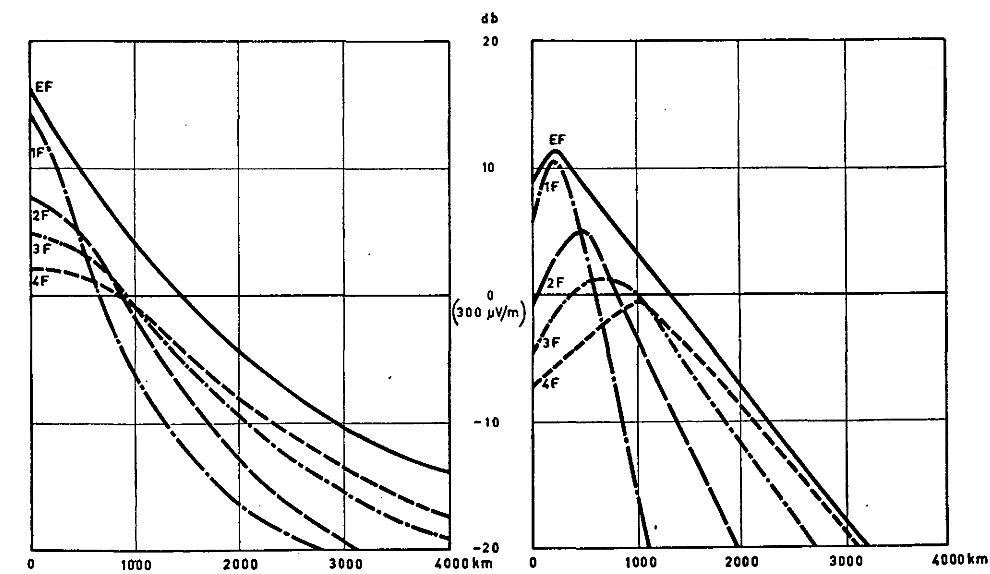
(a) A simple half-wave antenna: $H = 0{\cdot}25\ \lambda$

Distance

(b) Four-slot antenna: $H = 0{\cdot}25\ \lambda$

FIGURE 1

Influence of antenna gain for radiation towards the vertical—Dakar, at 2000 hrs LMT



Distance

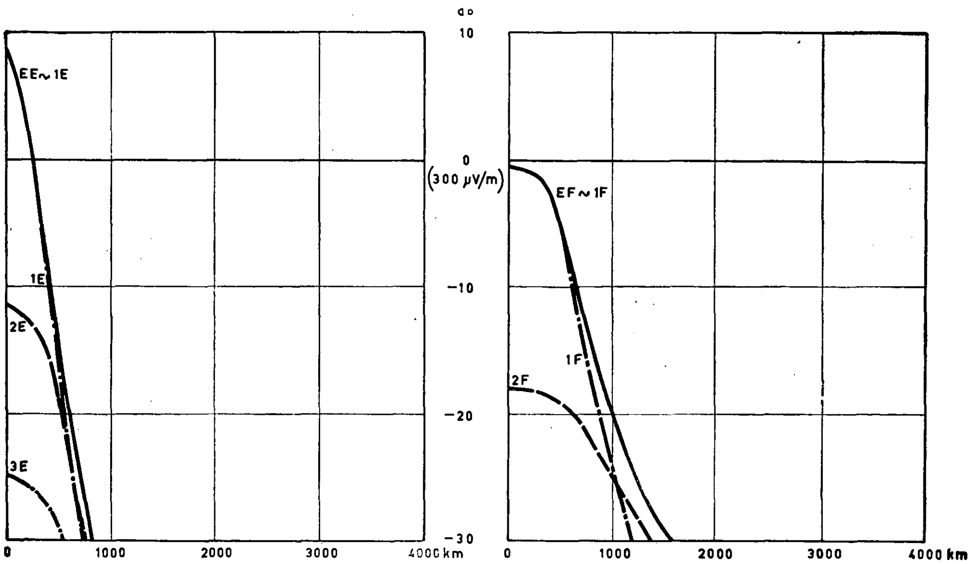
(a) Single-slot antenna—vertical transmission
$H = 0{\cdot}25\ \lambda$

Distance

(b) Single-slot antenna—oblique transmission
$H = 0{\cdot}4\ \lambda$

FIGURE 2

The effect of angle of elevation for narrow-beam antennae—Dakar, 2000 hrs LMT



Distance

(a) E-layer reflection

Distance

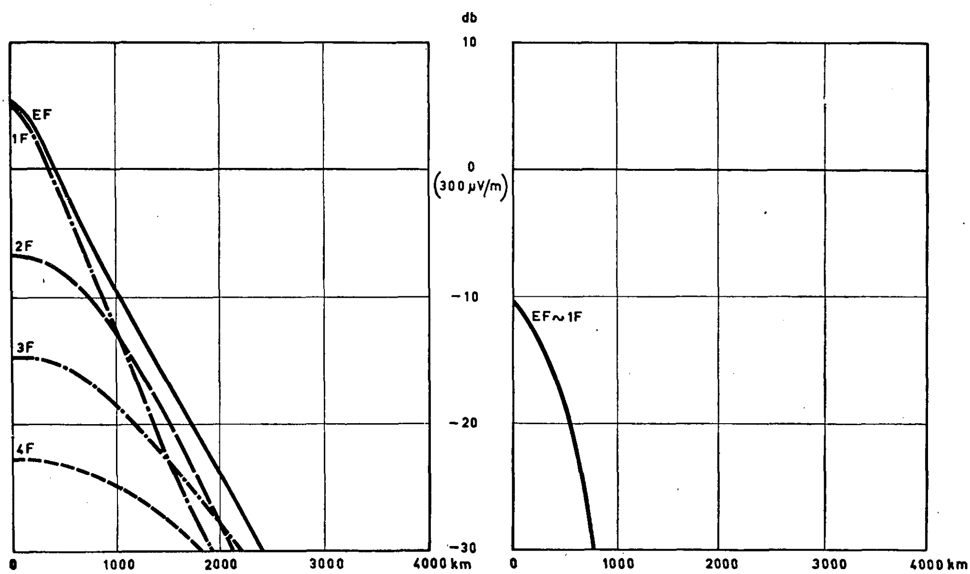
(b) F-layer reflection

FIGURE 3

Comparison between E-layer and F-layer reflections

Dakar, 5 Mc/s, June, $\overline{R}$ = 10; 0800 hrs LMT

Comparable absorption for a half-wave antenna $H = 0{\cdot}25\ \lambda$



Distance (km)

(a) Low absorption —

Dakar, June, $\overline{R}$ = 10; 0800 hrs LMT; 7Mc/s

Distance (km)

(b) Heavy absorption —

Dakar, June, $\overline{R}$ = 150; 1200 hrs LMT; 7 Mc/s

FIGURE 4

The effect of absorption — Half-wave antenna, $H = 0{\cdot}25\ \lambda$

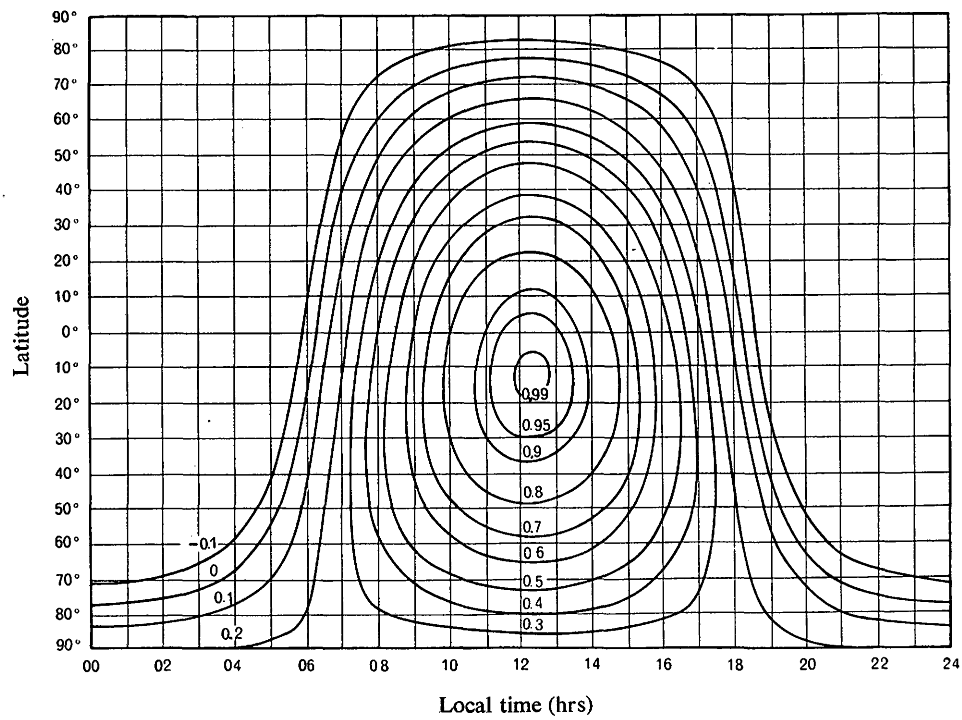


FIGURE 5

Values of cos χ (χ = Solar zenith angle) for February

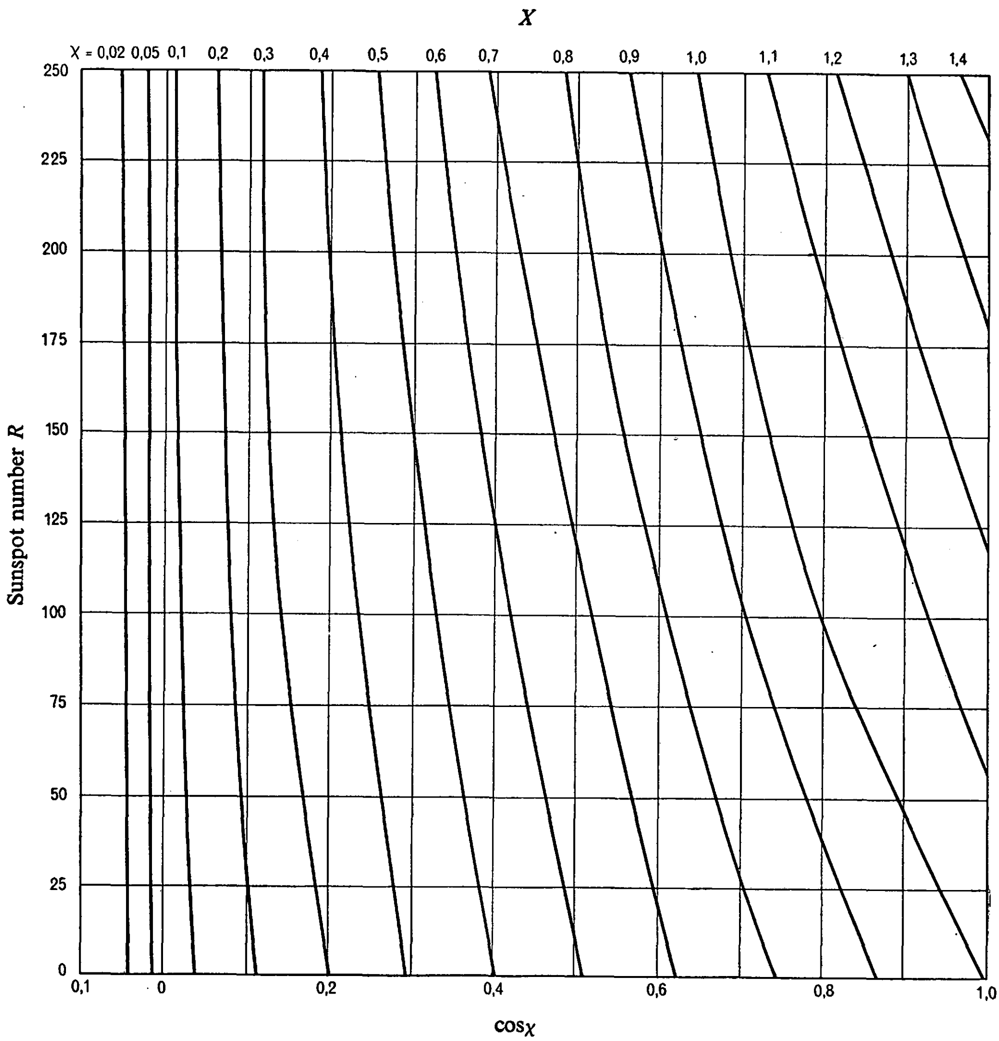


FIGURE 6

Value of X for different values of cos χ and $\overline{R}$

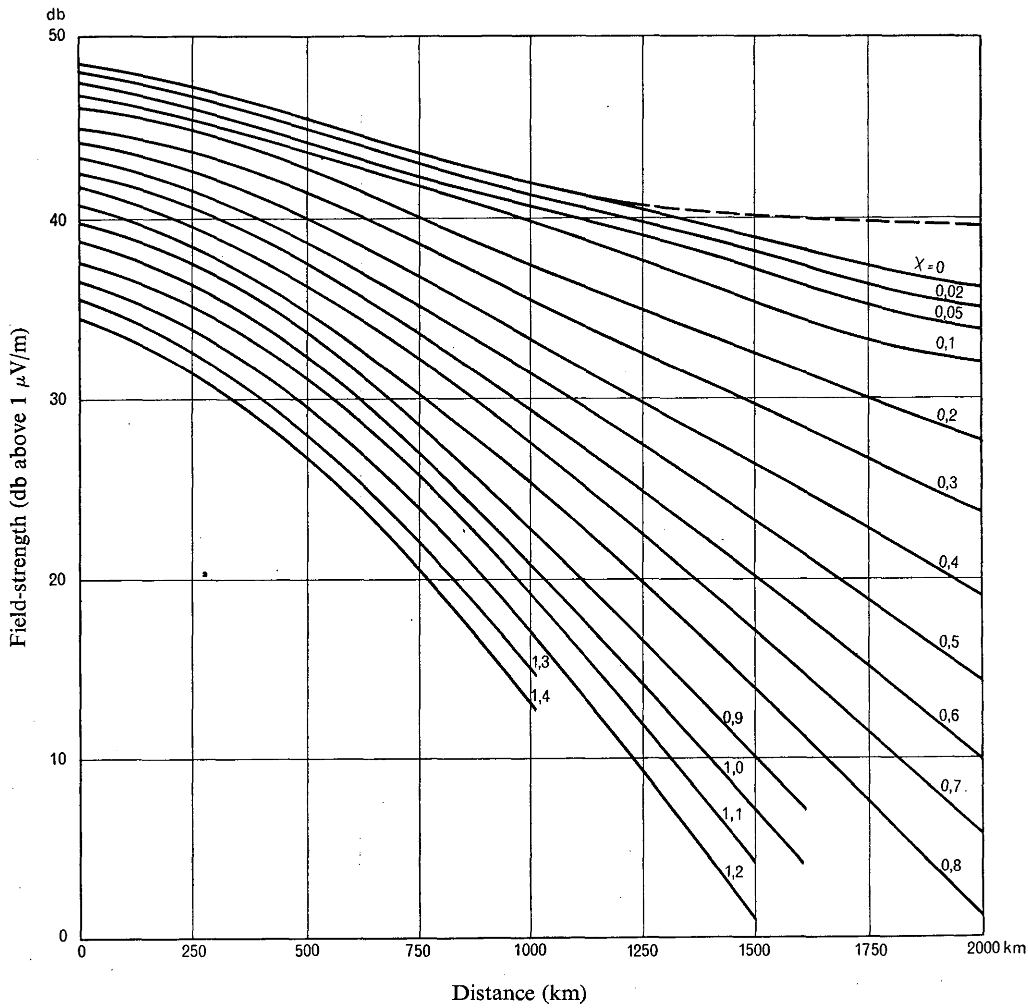


FIGURE 7

Field-strength (db above 1 μV/m) for various values of X in the 7 Mc/s band

(The values of X are shown on the curves)

E.4 — Television

REPORT 122 *

ADVANTAGES TO BE GAINED BY USING ORTHOGONAL WAVE POLARIZATIONS IN THE PLANNING OF BROADCASTING SERVICES IN THE VHF (METRIC) AND UHF (DECIMETRIC) BANDS

Television and sound

(Question 101)

(Warsaw, 1956 — Los Angeles, 1959)

Investigations have been conducted in several countries to ascertain the advantages which can be obtained in sound and television broadcasting by using polarization discrimination in reception. The results of extensive studies made in Europe by the Federal Republic of Germany, France, Italy and the United Kingdom and also in the United States of America, have been made available in documents at Warsaw (1956) and Geneva (1958); and a reasonably definite answer may now be given to the question.

1. VHF (metric) band

In this band of frequencies, between 30 and 300 Mc/s, the median value of discrimination that can be achieved at domestic receiving sites by the use of orthogonal polarization may be as much as 18 db, and under these conditions, the values exceeded at 90% and 10% of the receiving sites are about 10 db and 25 db respectively.

The values of discrimination are likely to be better in open country and worse in built-up areas or places where the receiving antenna is surrounded by obstacles. For domestic installations in densely populated districts, the median values of 18 db will usually be realized only at roof level; and this value may be reduced to 13 db or less at street level.

No significant changes in the polarization of metric waves due to transmission through the troposphere have been observed over distances exceeding 200 km. Furthermore, there have been no reports of systematic changes in polarization effects with frequency in the metric band, neither with distance nor with type of terrain.

It must be emphasized, however, that to realize the discrimination ratios mentioned above, certain precautions are necessary at both the transmitting and receiving installations; cases have been reported in which, for a transmitter of horizontally polarized waves, some 7% of the radiated power was vertically polarized. It is clear that if the best discrimination is to be obtained for co-channel operation, the transmitters and antenna systems must be designed and installed so as to radiate as much as possible of the total power on the assigned polarization.

In the same way, to achieve the desired discrimination at the home receiving installation, the reception of the undesired orthogonally polarized waves on the antenna feeder and on the receiver itself must be reduced to the minimum practicable value.

2. UHF (decimetric) band

Experiments have been conducted in the United Kingdom using horizontally polarized radiation on a frequency of about 500 Mc/s. Systematic measurements were made to

* This Report, which replaces Report 85, was adopted unanimously.

determine the polarization discrimination at typical urban and rural sites at distances up to about 55 km from the transmitter. The results showed that the discrimination obtained is similar to that already described above for frequencies in the VHF band, although the factor exceeded for 90% of the receiving sites was only 8 db (as compared with 10 db for VHF). It is to be noted, however, that the transmitting antenna in use had considerable directivity, and there was a marked decrease in the polarization discrimination for directions of reception some 40° away from the direction of maximum radiation.

As in the VHF band, care is necessary to ensure that the transmitter and receiver respectively do not emit or receive radiation of the undesired polarization. Apart from this, however, experience indicates that in the UHF band, the use of horizontal polarization offers advantages, because of the greater directivity obtainable at the receiving antennae; this reduces the effect of reflected waves, particularly in town areas. The European Broadcasting Union, therefore, considers that frequency assignments in these bands should be based on the general use of horizontal polarization, though exceptions may be made in cases where orthogonal polarization is necessary to achieve the desired protection.

3. Conclusion

From the studies described above, it is clear that the use of orthogonal polarization for broadcasting stations operating in the same frequency channel is of material assistance in discriminating against the reception of undesired signals. Worth-while advantages are obtainable over the whole band of frequencies from 40 to 500 Mc/s and within the normal broadcasting service ranges. From the uniformity of the discrimination obtained over these frequencies, it is considered to be almost certain that the advantages will extend to the top of the UHF broadcasting band at nearly 1000 Mc/s.

This Report is considered to provide a sufficient answer to Question 101 for practical use, and this question should now be concluded.

BIBLIOGRAPHY

Docs. 267, 435 and 512 of Warsaw, 1956.
Docs. V/1, V/6, V/12, V/23 and V/27 of Geneva, 1958.

REPORT 306 *

RATIO OF WANTED TO UNWANTED SIGNAL FOR COLOUR TELEVISION IN BANDS IV AND V

(Question 119 (XI))

(Geneva, 1963)

1. Introduction

The information given in this Report is based on the technical data used by the European VHF/UHF Broadcasting Conference, Stockholm, 1961. Minor amendments concerning systems *L* and *M* have been made.

* This Report was adopted unanimously.

The general conditions shown for the case of monochrome television in Recommendation 418, § 1, also apply to this Report.

The protection ratios required by four variants *(G, I, K, L)* of the 625-line system proposed for use in 8 Mc/s channels in bands IV and V, when adapted for colour transmission with a colour sub-carrier of 4·43 Mc/s, have been considered. All the ratios given in this Report should be regarded as tentative, pending decisions upon the type of colour system and the precise parameters to be used. For the purposes of planning, it may be assumed that the power in the chrominance channel at peaks of the colour modulation envelope cannot exceed a value 14 db lower than the power in the main carrier at peaks of the modulation envelope.

2. Co-channel interference—protection ratios for mutual interference between any of the four systems, G, I, K, L.

2.1 *Carriers separated by less than 1000 c/s, but not synchronized*

Protection ratio: 45 db.

2.2 *Nominal carrier frequencies separated by 1/3, 2/3, 4/3 or 5/3 of the line frequency*

Protection ratio: 30 db *.

2.3 *Carriers separated by 1/2 or 3/2 of the line frequency*

Protection ratio: 27 db *.

3. Adjacent-channel interference

3.1 *Lower adjacent-channel interference*

The protection ratios are the same as those quoted for monochrome television in Recommendation 418, § 3.2.

3.2 *Upper adjacent-channel interference*

The protection ratios are the same as those quoted for monochrome television in Recommendation 418, § 3.3.

4. Protection ratio curves

4.1 *625-line NTSC systems*

The curves of Fig. 1 give the estimated protection ratios required by the four variants of the 625-line colour television signal, for interference from a CW or frequency-modulated sound signal.

Letters, *G, I, K, L* shown on the curves, apply to the appropriate systems:

G — 625-line system,
I — 625-line system (United Kingdom),
K — 625-line system (I.B.T.O.) **,
L — 625-line system (France) ***

For frequency differences up to 2·85 Mc/s, the curves are the same as those for the monochrome 625-line systems (see Fig. 4 curves e_1, e_2, e_3, e_4 of Recommendation 418). For

* If the wanted signal is system *K* or system *L*, and the interfering signal is system *G*, the protection ratio must be increased to 35 db to avoid interference from the unwanted sound signal.

** If a vestigial sideband of 1·25 Mc/s is used in a modified system *K*, curve *K'* should be used instead of curve *K* for frequencies located on the same side as the vestigial sideband.

*** For frequencies located on the opposite side to the vestigial sideband, curve *L* refers to a system in which the colour information is transmitted by a process of quadrature modulation, in which double, instead of single-sideband modulation of the chrominance sub-carrier is used (± 1·26 Mc/s relative to the sub-carrier).

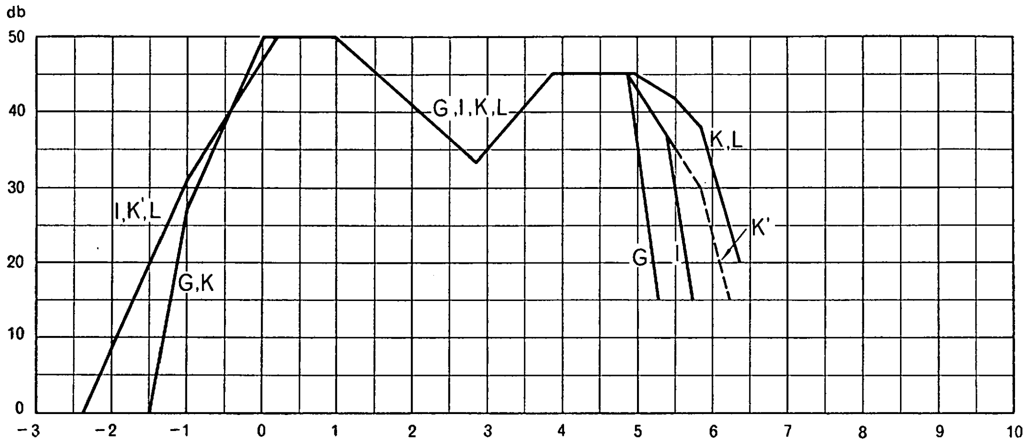


FIGURE 1

Estimated protection ratios for 625-line colour television systems (NTSC system adapted for 625 lines)

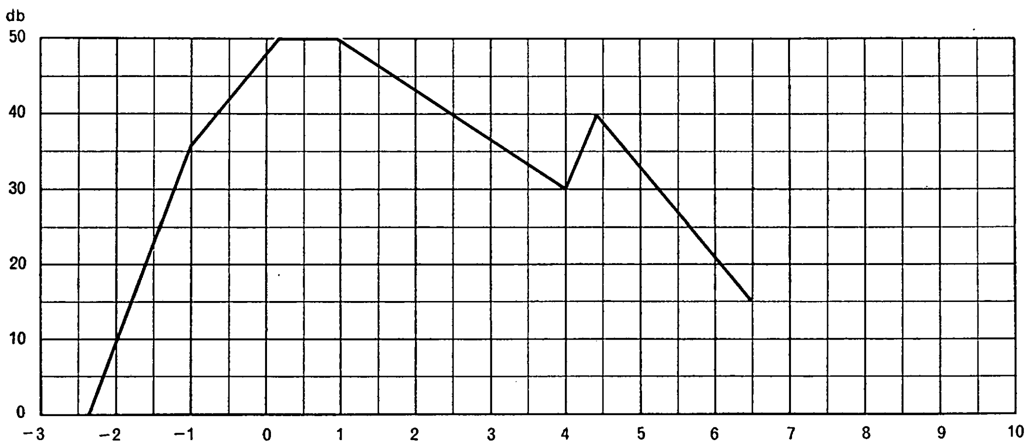


FIGURE 2

Estimated protection ratio for a SECAM 625-line (system L) colour television system

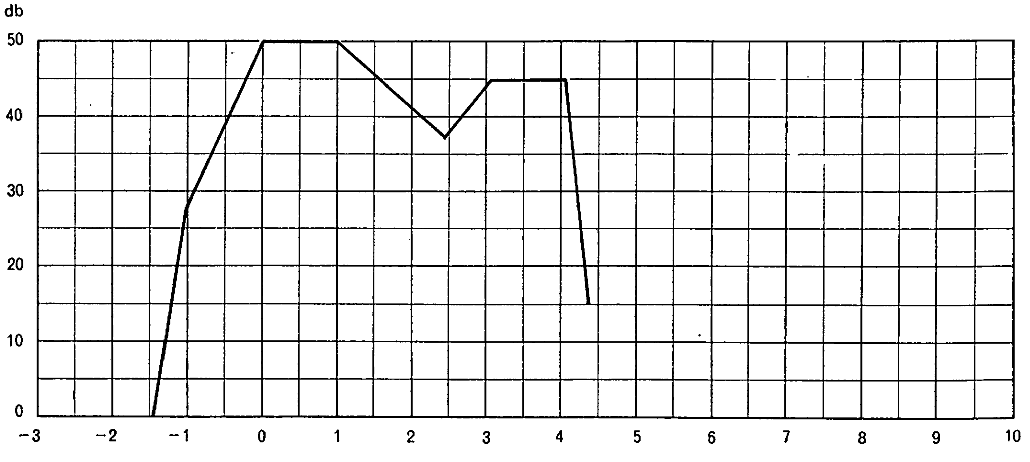


FIGURE 3

Protection ratios for the 525-line NTSC colour television system higher frequency differences, the estimates are based upon the requirements for an adapted NTSC system.

For interfering signals other than CW or frequency-modulated sound, no curves are given, as insufficient information is available.

4.2 *625-line SECAM system*

The curve shown in Fig. 2 gives the estimated value of the necessary protection ratio, required for the 625-line colour television signals (system *L*) using the SECAM system *, when the interfering signals are non-modulated waves or frequency-modulated sound signals.

4.3 *525-line NTSC system*

The curve shown in Fig. 3 gives the protection ratio required for 525-line colour television signals using the N.T.S.C. system. The curve is also applicable in the VHF bands.

REPORT 307 **

PROTECTION RATIOS FOR TELEVISION IN THE SHARED BANDS

Protection against radionavigation transmitters operating in the band 582 to 606 Mc/s

(Question 267 (XI))

(Geneva, 1963)

1. Introduction

This Report is based on subjective tests carried out in Belgium, France and the United Kingdom. The results of some of these tests were used for planning purposes at the European VHF/UHF Broadcasting Conference, Stockholm, 1961 ***, and after some amendment, for the Special Agreement relating to the use of the band 582 to 606 Mc/s by the radionavigation service, Brussels, 1962.

The tests were carried out with monochrome television signals, but the results were assumed to apply also to colour television signals. Further tests, however, are needed to confirm this assumption.

It is considered that the protection ratios quoted in this Report should, in general, be afforded for at least 99% of the time.

The protection ratios quoted apply to the signal at the input of the television receiver. The level of the television signal is expressed in terms of the power at the peak of the modulation envelope and that of the radionavigation signal as the power at the peak pulse level.

2. Protection ratios required when the radionavigation signal falls within the pass-band of the television receiver

It has been found that, when the radionavigation signal falls within the pass-band of the television receiver, the required signal-to-interference ratio is:

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* Described in Doc. XI/47 of Bad Kreuznach, 1962.

** This Report was adopted unanimously.

*** However, at Stockholm, some delegates made reservations as to the prospect of fulfilling the technical criteria in the actual planning.

10 db for systems with negative modulation,

15 db for systems with positive modulation.

The ratio is sensibly constant over the greater part of the passband of the television receiver, but decreases in accordance with the selectivity of the receiver as shown in the Figure.

The protection ratios given in the Figure do not relate to interference to the sound channel from signals of the radionavigation services. Further studies should be carried out on this subject.

3. Protection ratios required when the radionavigation signal falls outside the pass-band of the television receiver

Reference should be made to Recommendation 418, § 5, for second-channel (image channel) interference.

No information exists at present on adjacent channel interference.

Note. — Other interference effects (intermodulation) are likely to occur if radionavigation stations, which in general use high peak powers and highly directional antennae, are situated near receiving locations, especially where the television signal is weak.

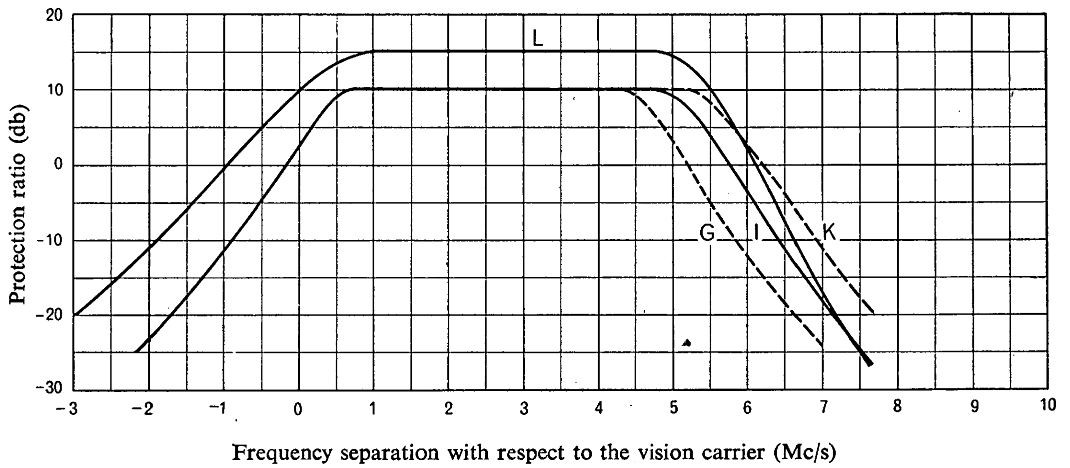


FIGURE 1

Protection ratio required by a picture signal against a radionavigation signal in the 582–606 Mc/s band

REPORT 308 *

CHARACTERISTICS OF MONOCHROME TELEVISION SYSTEMS

(Study Group XI)

(Geneva, 1951 — London, 1953 — Warsaw, 1956 — Los Angeles, 1959 — Geneva, 1963)

The following Tables, given for information purposes, contain details of a number of different monochrome television systems in use at the time of the Xth Plenary Assembly of the C.C.I.R., Geneva, 1963.

* This Report, which replaces Report 124, was adopted unanimously.

TABLE I — *Characteristics of monochrome television systems*

Item	Characteristics	System A	System M (2)	System N	System B	System C	System G	System H	System I	System D, K	System L	System F	System E
	Video characteristics (See also Tables II and III for details of line and field synchronizing signals respectively)												
1	Number of lines per picture (frame)	405	525	625	625	625	625	625	625	625	625	819	819
2	Field frequency (fields/second)	50	60	50	50	50	50	50	50	50	50	50	50
3	Interlace	2/1 *	2/1 *		2/1 *	2/1 *	2/1 *	2/1 *	2/1 *	2/1 *	2/1 *	2/1 *	2/1 *
4	Picture (frame) frequency (pictures/second)	25	30		25	25	25	25	25 ± 0·001%	25	25	25	25
5	Line frequency and tolerance when operated non-synchronously (lines/second)	10 125	15 750		15 625 ± 0·1%	15 625 ± 0·1%	15 625 ± 0·1%	15 625 ± 0·1%	15 625±0·001%	15 625 ± 0·05%	15 625 ± 0·1%	20 475 ± 0·1%	20 475
6	Aspect ratio (width/height)	4/3 *	4/3 *		4/3 *	4/3 *	4/3 *	4/3 *	4/3 *	4/3 *	4/3 *	4/3 *	4/3 *
7	Scanning sequence (Line)	Left to right *	Left to right *		Left to right *	Left to right *	Left to right *	Left to right *	Left to right *	Left to right *	Left to right *	Left to right *	Left to right *
	(Field)	Top to bottom*	Top to bottom*		Top to bottom*	Top to bottom*	Top to bottom*	Top to bottom*	Top to bottom*	Top to bottom*	Top to bottom*	Top to bottom*	Top to bottom*
8	System capable of operating independently of power supply frequency	Yes *	Yes *		Yes *	Yes *	Yes *	Yes *	Yes *	Yes *	Yes *	Yes *	Yes *
9	Approximate gamma of picture signal	0·4–0·5	0·45		0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·6
10	Nominal video bandwidth (Mc/s)	3	4·2	4·2	5	5	5	5	5·5	6	6	5	10
	Radio-frequency characteristics (See also Table IV for ideal sideband characteristics of vision transmitters)												
11	Nominal radio-frequency bandwidth (Mc/s)	5	6	6	7	7	8	8	8	8	8	7	14
12	Sound carrier relative to vision carrier (Mc/s)	− 3·5 *	+ 4·5 *	4·5	+ 5·5 *	+ 5·5 *	+ 5·5 *	+ 5·5 *	6	+ 6·5 *	+ 6·5 *	+ 5·5 *	11·15
13	Sound carrier relative to nearest edge of channel (Mc/s)	+ 0·25 *	− 0·25 *		− 0·25 *	− 0·25 *	− 0·25 *	− 0·25 *	− 0·25 *	− 0·25 *	− 0·25 *	− 0·25 *	0·02
14	Nominal width of main sideband (Mc/s)	3	4·2		5	5	5	5	5·5	6	6	5	10
15	Nominal width of vestigial sideband (Mc/s)	0·75	0·75	0·75	0·75	0·75	0·75	1·25	1·25	0·75 (4)	1·25	0·75	2
16	Type of polarity of vision modulation	A5 * positive, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * positive, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * negative, asymmetric sideband *	A5 * positive, asymmetric sideband *	A5 * positive, asymmetric sideband *	A5 * positive, asymmetric sideband *
17	Synchronizing level as a percentage of peak carrier	< 3	100		100	< 3	100	100	100	100	< 6	< 3	< 3
18	Blanking level as a percentage of peak carrier	30	75		72·5–77·5	22·5–27·5	72·5–77·5	72·5–77·5	77	72·5–77·5	30 ± 2	22·5–27·5	30
19	Difference between black level and blanking level as a percentage of peak carrier	0	2·875–6·75		3–6·5	3–6 (3)	3–6·5	3–6·5	0	3–5	5 ± 2	3–6 (3)	5
20	Peak white level as a percentage of peak carrier	100	$\lesssim$ 15		10–12·5	100	10–12·5	10–12·5	18–20	10	100	100	100
21	Type of sound modulation	A3	F3, ± 25 kc/s 75 μs pre-emphasis		F3, ± 50 kc/s 50 μs pre-emphasis	A3, 50 μs pre-emphasis	F3, ± 50 kc/s 50 μs pre-emphasis	F3, ± 50 kc/s 50 μs pre-emphasis	F3, ± 50 kc/s 50 μs pre-emphasis	F3, ± 50 kc/s 50 μs pre-emphasis	A3, No pre-emphasis	A3, 50 μs pre-emphasis	A3, No pre-emphasis
22	Ratio of effective radiated powers of vision and sound (1)	4/1	2/1–1·43/1 (4/1)		5/1	4/1 (3)	5/1	5/1	5/1	2/1–5/1	8/1	4/1 (3)	4/1

* These characteristics are in accordance with Recommendation 212.

(1) The values to be considered are:
— the r.m.s. value of the carrier at the peak of the modulation envelope for the vision signal;
— the r.m.s. value of the unmodulated carrier for amplitude-modulated and frequency-modulated sound transmissions.

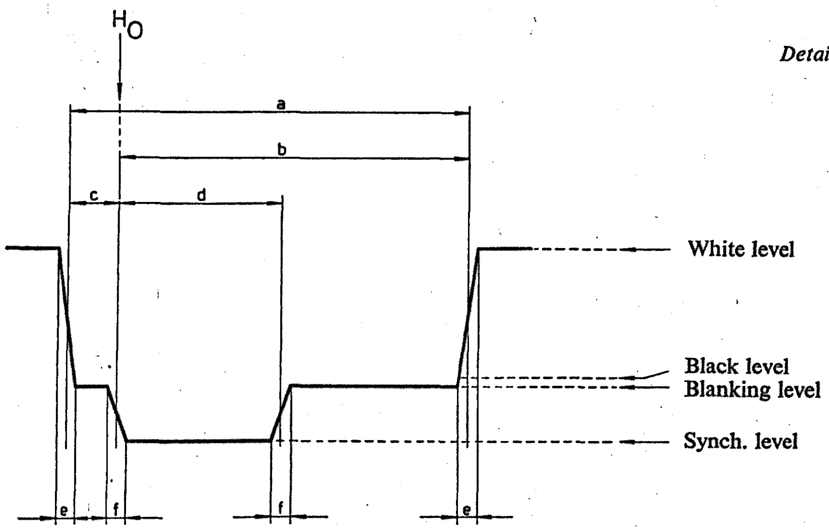
(2) The figures in brackets refer to the Japanese 525-line system.

(3) Tentative data.

(4) The Administrations proposing this standard are studying the possibility of increasing the width of the vestigial sideband to 1·25 Mc/s.

TABLE II

Details of line synchronizing signals



Durations (measured between half-amplitude points on the appropriate edges) for system

Item	Characteristic	A		M		N		B, H, G (¹)	
		% H	μs	% H	μs	% H	μs	% H	μs
H	Line period	100	98·8	100	63·5	100	64	100	64
a	Line blanking interval	17·7–19·2	17·5–19	16–18	10·2–11·4			18·5–19·2	11·8–12·3
b	Interval between time datum (O_H) and back edge of line blanking signal	16·2–17·2	16–17	14·3	> 9·1				
c	Front porch	1·52–1·95	1·5–2·0	> 2·7	> 1·71			2–2·8	1·3–1·8
d	Synchronizing pulse	8·1–10·1	8–10	6·6–8·6	4·19–5·46			7–7·7	4·5–4·9
e	Build-up time (10–90%) of the edges of the line blanking signal	0·26–0·51	0·25–0·5	1	0·64			0·31–0·62	0·2–0·4
f	Build-up time (10–90%) of line synchronizing pulses	⩽ 0·26	⩽ 0·25	0·4	0·25			0·31–0·62	0·2–0·4

(¹) The primary values are those given in μs.
(²) Tentative data.

Durations (measured between half-amplitude points on the appropriate edges) for system

Item	C		I		D, K		L		F		E	
	% H	μs	% H	μs	% H (⁴)	μs	% H (⁴)	μs	% H	μs	% H	μs
H	100	64	100	64	100	64	100	64	100	48·84	100	48·84
a	18·7	11·8–12·2(²)		12·05 ± 0·25	18·4–19·5	11·8–12·5	19	12·1 ± 0·3	18·4	9–9·4(²)	19	9·2–9·8
b	16·5	10·2–11 (²)			16·1–17·3(³)	10·3–11·3(³)	16·7	10·7 ± 0·3	16·4	7·8–8·6(²)	17·8	8·9
c	2·2	1·2–1·6 (²)		1·55 ±0·25	1·9–2·35	1·2–1·5	2·3	1·5 ± 0·2	2	0·8–1·2(²)	1·2	0·5–0·7
d	7·8	4·8–5·2 (²)		4·7 ±0·2	7–8·3	4·5–5·3	7·5	4·8 ± 0·2	7·2	3·4–3·8(²)	5·2	2·4–2·6
e	0·5	0·2–0·4 (²)		0·3 ±0·1	0·3–0·7	0·2–0·45	0·5	0·3 ± 0·1	0·4	0·1–0·3(²)	0·4	0·17–0·23
f	0·5	0·2–0·4 (²)		0·3 ±0·1	0·2–0·4	0·13–0·26	0·25	0·15 ± 0·05	0·4	0·1–0·3(²)	0·25	0·10–0·14

(³) Calculated values.
(⁴) The values given in % H are rounded-off

TABLE III — *Details of synchronizing signals*

Item	Characteristic	System A	System M [5]	System N	System B, H, G [6]
V	Field period . . . . (ms)	20	16·667	20	20
H	Line period . . . . (µs)	98·8	63·5	64	64
j	Field-blanking period . . . (µs)	(13–15·5) *H* [2] + 18·25 [3]	(13–21) *H* + 10·7		(18–22) *H* + 12
k [1]	Build-up times (10-90%) of the edges of field-blanking pulses (µs)	0·25–0·5	6·35		⩽ 6
l	Duration of first equalizing pulse sequence	[4]	3 *H*		2·5 *H*
l′	Nominal interval between beginning of the field-blanking pulse and the leading edge of the field synchronizing pulse (O*v*)				
m	Duration of synchronizing pulse sequence	4 *H*	3 *H*		2·5 *H*
n	Duration of second sequence of equalizing pulses		3 *H*		2·5 *H*

Item	Characteristic	System C	System I	System D, K	System L	System F	System E
V	Field period . . . . (ms)	20	20	20	20	20	20
H	Line period . . . . (µs)	64	64	64	64	48·84	48·84
j	Field-blanking period . . . (µs)	(20–21) *H* + 12	(18–22) *H* + 12·05	(23–27) *H*	(22–24) *H*	(29–30) *H* + 9	41 *H*
k [1]	Build-up times (10-90%) of the edges of field-blanking pulses (µs)	⩽ 6·4	⩽ 6	0·2–6·4	0·2–2	< 4·9	< 0·2
l	Duration of first equalizing pulse sequence	2·5 *H*	2·5 *H*	2·5 *H* or 3 *H*	2·5 *H*	3·5 *H*	
l′	Nominal interval between beginning of the field-blanking pulse and the leading edge of the field synchronizing pulse (O*v*)						3 *H*
m	Duration of synchronizing pulse sequence	2·5 *H*	2·5 *H*	2·5 *H* or 3 *H*	2·5 *H*	3·5 *H*	
n	Duration of second sequence of equalizing pulses	2·5 *H*	2·5 *H*	2·5 *H* or 3 *H*	2·5 *H*	3·5 *H*	

Item	Characteristic	A % *H*	A µs	M % *H*	M µs	N % *H*	N µs	B, H, G % *H*	B, H, G µs
p	Duration of equalizing pulse . . .			3·6	2·54			3·4–3·75	2·2–2·4
q	Duration of field synchronizing pulse	38·5–42·5	38–42	42·6	27·1				
r	Interval between field synchronizing pulses	11·5–7·5	11·4–7·4	7·4	4·7			7–7·7	4·5–4·9
s	Build-up times (10-90%) of the edges of synchronizing signals . .	⩽ 0·26	⩽ 0·25	0·4	0·25			0·31–0·62	0·2–0·4

Item	Characteristic	C % *H*	C µs	I % *H*	I µs	D, K % *H* [8]	D, K µs	L % *H* [8]	L µs	F % *H*	F µs	E % *H*	E µs
p	Duration of equalizing pulse . . .	3·7	2·3–2·5 [7]		2·3 ±0·1	3·5–4·15	2·25–2·65	3·6	2·3 ± 0·1	3·5	1·6–1·8 [7]		
q	Duration of field synchronizing pulse	42	26·8–27·2 [7]		27·3 ±0·2			42·5	27·2 ± 0·4	43	20·6–21 [7]	41	19–21
r	Interval between field synchronizing pulses	7·8	4·8–5·2 [7]		4·7 ±0·2	7–8·3	4·5–5·3	7·5	32–9 or 4·8	7·2	3·4–3·8 [7]		
s	Build-up times (10-90%) of the edges of synchronizing signals . .	0·5	0·2–0·4 [7]		0·3 ±0·1	0·2–0·4	0·13–0·26	0·25	0·15 ± 0·05	0·4	0·1–0·3 [7]	< 0·4	< 0·2

(1) Not indicated on diagram.

(2) The coefficient of *H* is an integral multiple of 0·5.

(3) In reality, the value of *a* given in Table II.

(4) In the 405-line system there are no equalizing pulses; the field-blanking period *j* commences in advance of the field-synchronizing pulse sequence by an interval of from 0·015 *H* to 0·515 *H*.

(5) The figures in brackets refer to the Japanese 525-line system.

(6) The primary values are those given in µs.

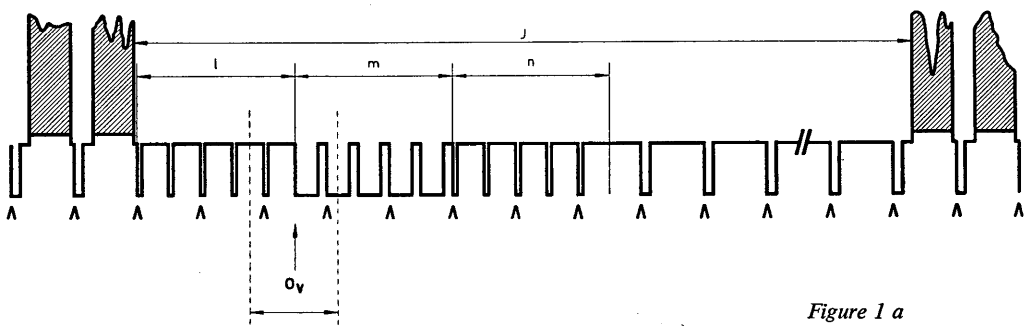
(7) Tentative data.

(8) T values given in % *H* are rounded-off.

TABLE III A

Details of field-synchronizing waveforms

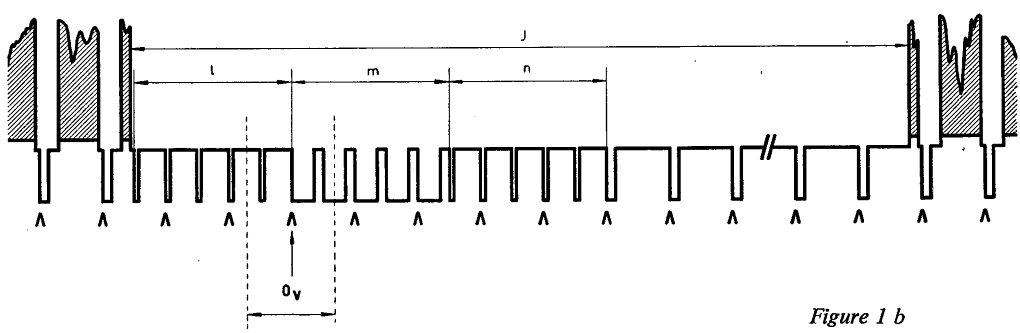
1. Diagrams applicable to all systems except system E



See Fig. 1 *c*

Figure 1 a

Signal at end of even fields



See Fig. 1 *c*

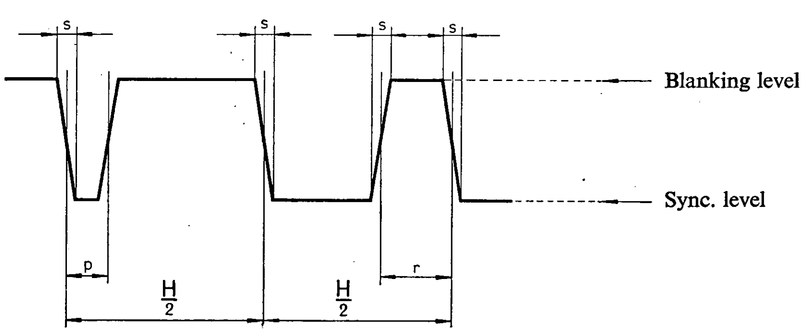
Figure 1 b

Signal at end of odd fields

Note 1 : ∧ ∧ ∧ indicates an unbroken sequence of edges of line-synchronizing pulses throughout the field blanking period.

Note 2 : At end of *even* fields, the edge of the field-synchronizing pulse (O_V) falls midway between the edges of two line synchronizing pulses if *l* is an *odd* number of half-line periods as shown.

Note 3 : At end of *odd* fields, the edge of the field-synchronizing pulse (O_V) coincides with the edge of a line-synchronizing pulse if *l* is an *odd* number of half-line periods as shown.



(The durations are measured to the half-amplitude points on the appropriate edges)

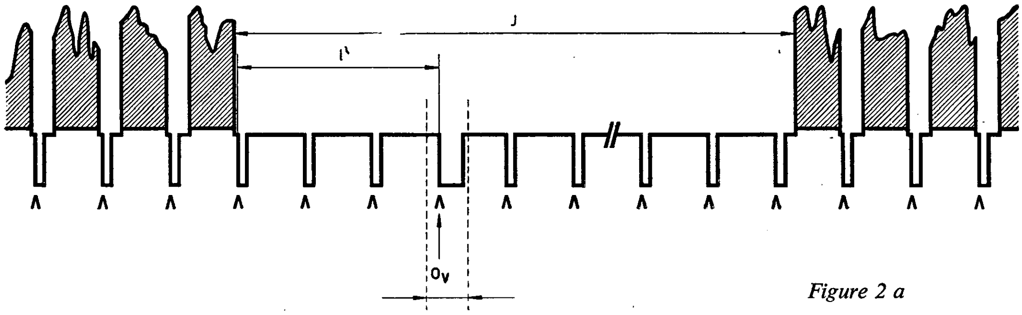
Figure 1 c

Details of equalizing and synchronizing pulses

TABLE III B

Details of field-synchronizing waveforms

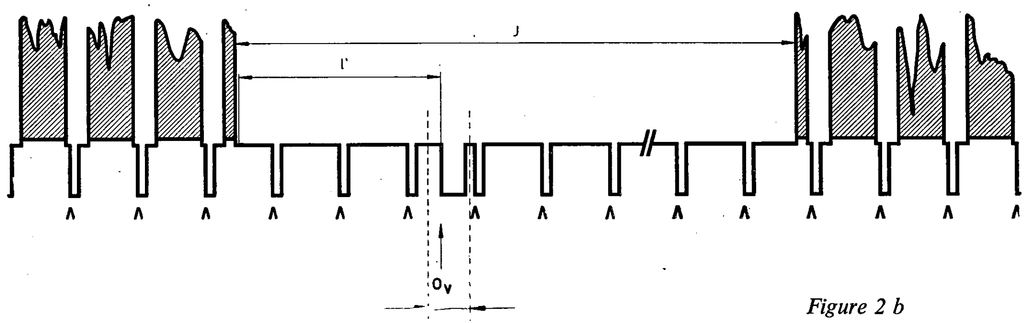
2. Diagrams applicable to system E



See Fig. 2 *c*

Figure 2 a

Signal at end of even fields



See Fig. 2 *c*

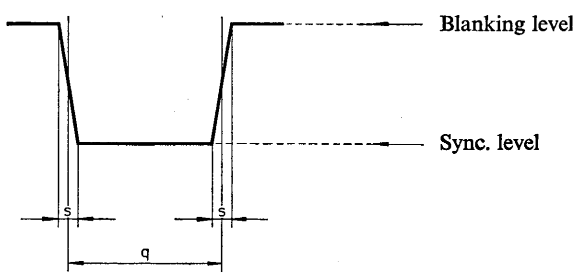
Figure 2 b

Signal at end of odd fields

Note 1 : ∧ ∧ ∧ indicates an unbroken sequence of edges of line-synchronizing pulses throughout the field blanking period.

Note 2 : At end of *even* fields, the edge of the field-synchronizing pulse (O_V) coincides with the edge of a line synchronizing-pulse.

Note 3 : At end of *odd* fields, the edge of the field-synchronizing pulse (O_V) falls midway between the edges of two line synchronizing-pulses.



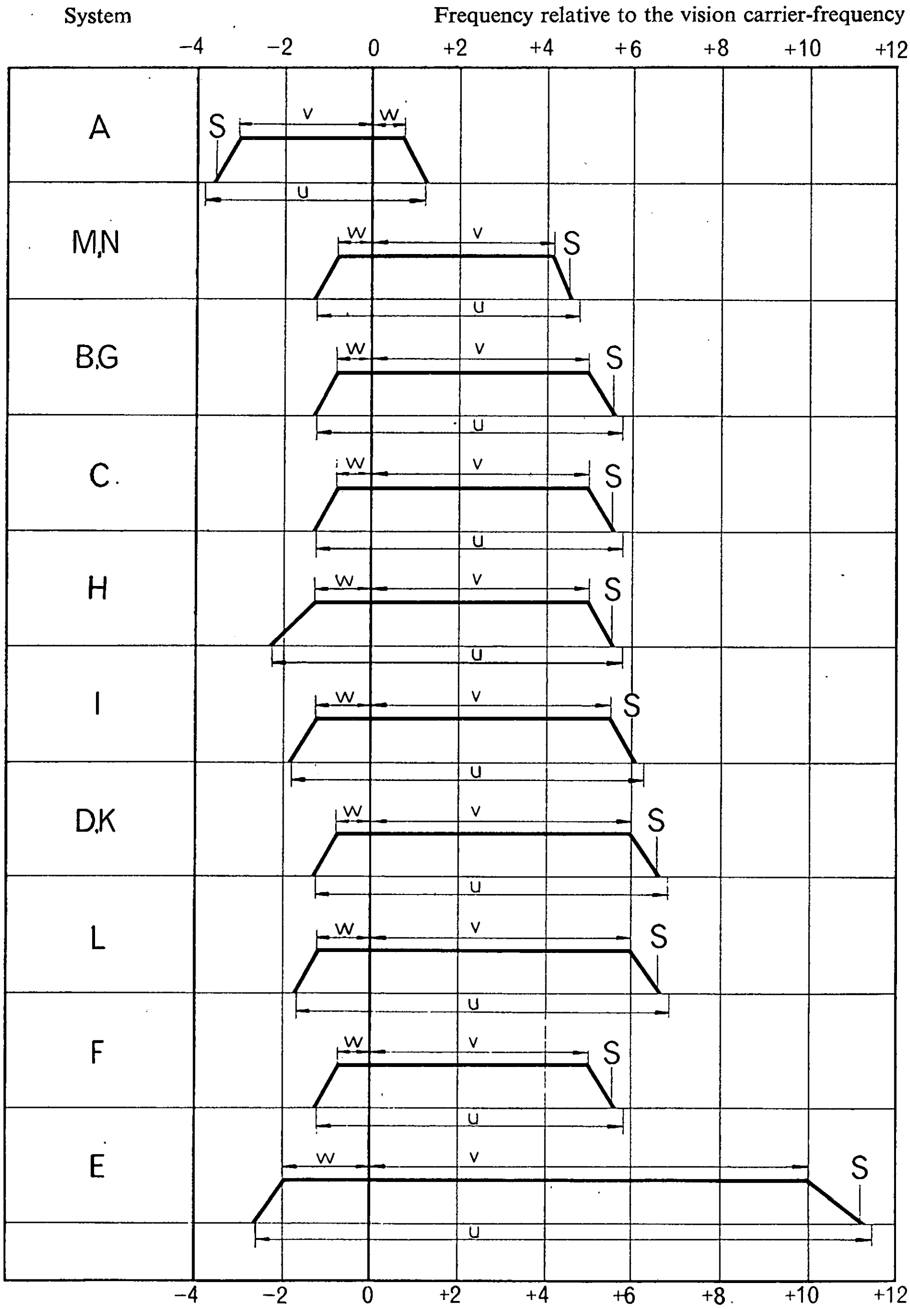
(The durations are measured to the half-amplitude points on the appropriate edges)

Figure 2c

Details of equalizing and synchronizing pulses

TABLE IV

Ideal frequency-characteristics for vision transmitters
(See Table I for precise frequency spacings)



S : sound carrier;
u : limits of radio-frequency channel;
v : nominal width of main sideband;
w : nominal width of vestigial sideband.

ANNEX

SYSTEMS USED IN VARIOUS COUNTRIES

Explanation of signs used in the list:

* : planned (whether the standard is indicated or not);

—: not yet planned, or no information received;

**: data concerning this Administration have been taken from Chapter 2 of the " Technical Data used by the European VHF/UHF Broadcasting Conference ".

NOTES TO LIST

Note 1.—" N " relative to bands IV and V applies to the television signal itself, but not necessarily to the channel bandwidth.

Note 2.—Austria reserves the right to the possible use of additional frequency-modulated sound carriers, in the band between 5·75 and 6·75 Mc/s, in relation to the picture carrier.

Note 3.—The Belgian Administration has not yet decided on the transmission standards for bands IV and V; it reserves the right to use standards G, H, I or L, or a combination of the characteristics of standards G, H, I and L.

Note 4.—No definite decision has been taken about the width of the residual sideband, but this country is willing to accept the assumption that for planning purposes the residual sideband will be 0·75 Mc/s wide.

Note 5.—System " I " will be used at all stations. In addition, during a transition period, transmissions on system " A " will be made from the Dublin and Sligo stations.

Note 6.—This country does not at present intend to use bands IV and V, but accepts the parameters given in the table under " Standard G " as television standard in bands IV and V.

Note 7.—No final decision has been taken about the width of the residual sideband, but for planning purposes this country is willing to accept the assumption of a residual sideband 1·25 Mc/s wide.

Note 8.—The parameters given are those adopted in the United Kingdom for experimental transmissions in bands IV and V.

Note 9.—The Swiss Administration is planning to use additional frequency-modulated sound carriers, in the frequency interval between the spacings of 5·5 and 6·5 Mc/s, in relation to the picture carrier, at levels lower than or equal to the normal level of the sound carrier, for additional sound-tracks or for sound broadcasting.

Country	System used in bands:		Number of Note for bands:	
	I-III	IV-V	I-III	IV-V
British East Africa	B *	—		
Netherlands Antilles	M	—		
Saudi Arabia	M	—		
Argentina	N	N *		1
Australia	B	—		
Austria	B	G *		2
Belgium	C, F	G * H * I * L *		3
People's Republic of Bulgaria	D	K *		
Canada	M	M		
Cyprus **	—	H *		
Korea	M	—		
Denmark	B	G *		4
Spain **	B	G *		
United States of America	M	M		
Finland	B	G *		4
France	E	L		
Ghana	B *			
Greece	B *	G *		4
Hungarian People's Republic	D	K *		
India	B	—		
Indonesia	B *	—		
Iran	M	—		
Ireland	A (I*)	I *	5	
Iceland **	—	G *		6
Israel	B *	H *		7
Italy	B	G		
Japan	M	M *		
Jordan	—	—		
Libya	—	G *		
Luxembourg **	F	H *		
Malaya	B *	G *		
Morocco	B	H *		
Mexico	M	—		
Monaco	E	L *		
Nigeria	B	—		
Norway	B	G *		4
New Zealand	B	—		
Pakistan	B	—		
Panama	M	—		
The Netherlands	B	G *		4
People's Republic of Poland	D	K *p		
Portugal	B	G *		
Republic of the Congo (Leopoldville)	B *	—		
Federal Republic of Germany	B	G		
Rhodesia and Nyasaland	B	—		
Roumanian People's Republic **	D	K *		
United Kingdom	A	I *		8
Senegal	—	—		
Sweden **	B	G *		4
Switzerland **	B	G *		9
Czechoslovak S. R. **	D	K *		
Overseas Territories of the U.K. in the European Broadcasting Area **	—	H *		
Territories of Ruanda-Urundi	—	—		
Turkey **	—	H *		7
U.S.S.R.	D	K		
Yugoslavia	—	H *		

REPORT 309 *

CHOICE OF STANDARDS FOR COLOUR TELEVISION IN THE EUROPEAN AREA

(Question 118 (XI))

(Geneva, 1963)

Studies concerning the choice of a colour television system for use in Europe have been in progress for some years. At the VHF/UHF European Broadcasting Conference, Stockholm, 1961, and subsequently, all the countries in the European Broadcasting Area, which have expressed an opinion, agreed to use 625-line systems in Bands IV and V, with a common chrominance sub-carrier frequency of 4·43 Mc/s, thus preparing the way for the easy interchange of colour television programmes.

At the interim meeting of Study Group XI, Bad Kreuznach, 1962, it was generally considered desirable that:

— colour and monochrome systems should be compatible;
— the signal should be composed of a luminance signal and two signals carrying the colour information, insofar as possible in accordance with the constant luminance principle;
— the chrominance signal should share the luminance frequency band;
— further studies should be made and an agreement on certain parameters of a common system should be reached before establishing public colour services.

Further discussions took place during the course of the C.C.I.R. Xth Plenary Assembly, Geneva 1963, and it is clear that studies ** are actively in progress in a number of countries, to determine the relative merits of the adapted N.T.S.C. system, the SECAM system, and variants of these systems, to enable a final choice to be made. Administrations are requested to submit the results of these studies as soon as they are available.

REPORT 310 ***

VIDEO CHARACTERISTICS OF A 625-LINE MONOCHROME TELEVISION SYSTEM PROPOSED FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Question 120)

(Geneva, 1963)

An examination of the parameters relating to the various monochrome television systems (as given in Report 308) reveals, that the video waveforms of the 625-line systems C, D, G, H, I, K and L, differ only in small details. It would clearly be desirable, to facilitate the exchange of programmes, particularly in the European Broadcasting Area, if countries using these systems could agree to make such small changes in the parameters as are necessary to bring the systems into line with a unified standard. With the object of bringing about such a move, Administrations are requested to examine the parameters set out in the table below, and to consider whether, at the

* This Report, which replaces Report 123, was adopted unanimously.

** See Docs. XI/14, XI/21, XI/24, XI/28, XI/32, XI/42, XI/46, XI/47 of Bad Kreuznach, 1962; CMTT/6, CMTT/12, CMTT/21 of Paris, 1962; 181, 212, 213, 214 of Geneva, 1963.

*** This Report was adopted unanimously.

next meeting of Study Group XI, they could all agree to adopt these parameters or closely related values, as a unified standard.

Note. — For ease of reference, the items are listed in the same order and designated by the same symbols, as in Report 308, to the diagrams of which reference should be made for further information on the definition of the parameters.

General details

1.	Number of lines per picture	625
2.	Field frequency (fields/second)	50
3.	Interlace	2/1
4.	Picture-frame frequency (pictures/second)	25
5.	Line frequency and tolerance when operated non-synchronously (lines/second)	15·625 ± 0.1%
6.	Aspect ratio	4/3
7.	Scanning sequence (lines) (fields)	left to right top to bottom
8.	Systems capable of operating in dependently of power supply frequency:	yes
9.	Approximate gamma of picture signal	0·5
10.	Nominal video bandwidth (Mc/s) *	4·2; 5; 5·5 or 6

Details of line synchronizing signals **

		μs
H.	Nominal duration of a line	64
a.	Line blanking interval	11·7–12·3
b.	Interval between time datum (O_H) and back edge of line blanking signal	(average calculated for information): 10·5
c.	Front porch	1·2–1·8
d.	Synchronizing pulse	4·4–5·0
e.	Build-up time (10–90%) of line blanking edges	0·2–0·4
f.	Build-up time (10–90%) of line synchronizing pulses	{ 0·2–0·4 or 0·1–0·2

Details of the field-synchronizing signal

j.	Field-blanking period	25 H + 12 μs ***
k.	Build-up time (10–90%) of field-blanking edges	⩽ 6 μs
l.	Duration of first equalizing pulse sequence	2·5 H or 3 H
m.	Duration of synchronizing pulse sequence	2·5 H or 3 H
n.	Duration of second equalizing pulse sequence	2·5 H or 3 H
p.	Duration of equalizing pulse	2·2–2·5 μs

* The attention of Study Groups IX, X and the C.M.T.T. is drawn to the desirability of subsequently standardizing tolerances for the corresponding transmission and recording characteristics applicable to all 625-line systems.

** The nominal value of the picture-synchronizing signal ratio is 7/3. For details of permitted tolerances in long-distance transmissions, see Recommendation 382, § 2.3.

*** In the blanking interval, lines 16, 17, 18, 19, 20, 21, 329, 330, 331, 332, 333 and 334 are reserved for the reception of any special signals.

q.	Duration of field-synchronizing pulse	(average calculated for information): 27·3 μs
r.	Interval between field-synchronizing pulses	4·4–5·0 μs
s.	Build-up time (10–90%) of field-synchronizing signal edges	0·2–0·4 μs or 0·1–0·2 μs

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REPORT 311 *

THE PRESENT POSITION OF STANDARDS CONVERSION

(Question 120(XI) and Study Programme 36(XI))

(Geneva, 1963)

1. Review of image-transfer standards conversion between television signals having equal or nearly equal field frequencies

Ever since the inception of international television relays, recourse has been made to standards conversion when exchanging live monochrome television programmes. The earliest converters consisted of little more than a camera, working in accordance with the desired standards directed at a picture-monitor displaying a picture on the available standards, but over the years such " image-transfer " converters have been the subject of considerable development, although their inherent shortcomings still exist. A review of existing practice may be found in [1].

There are two essential features of all standards converters. In the first place, components at the line frequency of the incoming signal must be eliminated from the outgoing signal; otherwise beat patterns may result on the converted picture. At the same time, essential picture detail must be retained. The problem is like passing the signal through a filter having a suitable " vertical " frequency response. In practical converters, the response of this filter must be a compromise between visibility of spurious patterns and loss of detail in a vertical sense. The converter must store the incoming information until the reading device is ready to use the information. When the conversion involves a difference in the number of lines only, the required storage time is of the same order as the scanning line duration. In interlaced systems, wherein the conversion is field by field, it must be understood that necessarily the vertical definition of the converted picture is reduced to nearly half. This is because all systems of standards conversion, where the persistence of the displayed image is short compared with the field time, must rely on interpolation between successive lines. In the light of these fundamental concepts, it is useful to examine the behaviour of existing converters.

Image-transfer converters, employing a display tube and a camera, rely on line broadening or spot wobble to reduce the component of the incoming line repetition frequency in the information which is read by the camera. The storage is provided partly by the persistence of display tube phosphor and partly by the camera. The storage time is necessarily less than a field period to avoid movement blur, and such converters are, therefore, subject to the fundamental loss of vertical definition which has been described. In addition, they are subject to flare and the signal-to-noise ratio is marginal. The use of a photoconductive camera tube improves the signal-to-noise ratio but may introduce some movement blur. Both the display and the camera are non-linear devices and the converter must operate under circumstances suitable for both. In addition, some adjustments are necessary and under the stress of operating conditions the best compromise is not always achieved and the picture quality may fall below the best attainable.

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* This Report was adopted unanimously.

2. Review of image-transfer standards conversion between television signals having field frequencies that are markedly different

Conversion between monochrome television standards, having field frequencies which differ markedly from one another, requires the introduction of methods and devices not previously considered to be necessary for programme exchanges of the type mentioned in § 1.

In converters for such exchanges, there occurs an interference between the field frequencies which, depending upon the difference between them, can have the appearance of an annoying flicker. Although this flicker can be abated by using picture-tube screens having phosphors with long persistence, the portrayal of movement in the scene being televised becomes subject to error in the form of blurring or smearing. Various means of overcoming the flicker, without suffering excessive loss of clarity of moving pictures, have been adopted.

3. Description of image-transfer standards conversion between television signals when both the field frequencies and the numbers of lines are different in the two standards

In one method [2], the field-synchronizing waveforms of the two standards are combined to produce a suitably shaped correction signal, having a fundamental frequency equal to that of the flicker. The correction signal is used to control the gain of an amplifier through which must pass the converted signal. The point of insertion of the correction signal has recently been changed, so that pre-correction rather than post-correction is used. The variable gain amplifier is now situated in the path of the incoming, unconverted signal, before its arrival at the display cathode-ray tube. This is not an automatic system, the shape of the correcting waveform being adjusted manually for optimum results.

In another method [3], the correcting waveform is obtained from a peak detector, which triggers a correcting waveform generator by a signal resulting from the detection of the peak white level of the converted signal.

In yet another method [4], [5], a pulse is inserted into the line blanking interval of the television signal to be converted. The pulse appears as a vertical bright bar on the picture tube and is converted to the scanning standards of the receiving authority by means of the pick-up tube.

After conversion, the pulse signal which suffers from conversion flicker is gated and detected, and used to control the gain of an amplifier through which the converted signal must pass.

In a further method [6], use is made of a combination of the systems referred to under [2] and [4] and an additional feature which relies upon gated contrast correction which is applied, in a conversion from 50 field television to 60 field television, to every sixth field of the converted signal. The field under consideration derives its picture signal from an image which has been stored for a notably longer period than preceding and subsequent images and the application of contrast correction effects a further improvement in the reduction of flicker.

Various picture tubes and pick-up tubes have been used in the above standards converters. In particular, image orthicons, orthicons, and pick-up tubes with photoconductive target, have all given performances of a reasonably satisfactory nature.

4. Further work

Considerable attention continues to be paid to various aspects of the problems of conversion of television signals from one standard to another. In general, the work can be divided into two main categories corresponding respectively to Question 120, (XI) §§ 1 and 2, and the two points referred to in Study Programme 36 (XI).

In connection with the first item of Study Programme 36 (XI), mention should be made of work now being carried out to perfect methods of conversion between television signals having identical and synchronized field frequencies but different line frequencies. This work is directed towards the development of standards converters involving no moving parts and no intermediate optical or electron-charge image. Two types of such devices, known as " computer converters " [7], are being developed. Both types of instrument are based upon the concept of storing each picture element occurring along a scanning line in one of, say, 600 stores, which may consist, in the first type, [8], of low-pass filters having a passband such, that the response of the filter to the signal representing a given picture element in one line of a field is dying away, as the response to the signal representing the homologous picture element in the succeeding adjacent line of the field is reaching its maximum value. In this way, the component at incoming scanning-line frequency is reduced or " smoothed " in the signal output from each filter. Appropriate interpolation between the lines in the incoming signal may be achieved by suitable selection of filter characteristics. Fast-acting electronic switches select, at the correct instants, the instantaneous values of the incoming signal and apply them to the appropriate low-pass filters. A bank of similar switches samples the outputs from the filters in synchronism with the outgoing line-scanning frequency.

In the second type [9] of computer converter, simple capacitors replace the low-pass filters and the appropriate interpolation between homologous picture elements on adjacent lines is obtained by generating an interpolation function $S(t)$, which is then arranged to modulate the incoming signal on the one hand, whilst on the other hand the function $1 - S(t)$ is arranged to modulate the incoming signal after it has been delayed by exactly one incoming line-scan period. The two modulated signals are then added and switched, as in the first type of converter, to a bank of 600 capacitors. Both types of converter could benefit from the use of a store or delay device, having a delay-time equal to the period of one field of the incoming signal. Such a delay device would permit conversion from picture to picture instead of from field to field, and thus the maximum possible vertical resolution permitted by the lower-definition signal involved in the conversion would be approached. It is self-evident that image transfer converters are also capable of benefiting from the application of such a field store or delay device.

In connection with the second item of Study Programme 36 (XI), important work is in progress, aimed at achieving conversion between television signals having markedly different field frequencies, by methods involving the use of magnetic tape video recorders. Various methods have been tried and experiments continue. When both the number of lines and the number of fields differ between the two signals in question two conversions take place. The greater difficulty, which resides in the conversion of the field frequencies, is overcome by recording entire fields diagonally across the magnetic tape and ensuring that the length of the reproducing head magnetic gap is wider than that of the recording head. For conversion from 50-field to 60-field signals, for example, every third field of each group of five fields of the 50-field signal is repeated once (duplicated) and recorded on the tape adjacent to its previous position. The reproducing head, with its longer gap, is then able to read off the tape six fields (for the outgoing 60-field signal), in a time duration equal to that required by five fields of the incoming signal. To duplicate certain fields of the incoming signal as magnetic stripes on the tape, the recording disk carries two heads so that, for example, when field number three of the incoming signal is present, it can be recorded simultaneously by the two heads as adjacent magnetic stripes on the tape.

The device consists of a drum around which is wound, as one turn of a helix, the video magnetic tape. Inside the drum is the disk containing, on its periphery, the two recording heads. The latter protrude through a radial slot in the drum and can, therefore, make contact with the inner side of the single-turn helix of tape.

Such a device has been constructed and gives a satisfactory performance [10]. It will be used for standards conversion of colour television signals, as soon as a satisfactory video tape standards converter for converting between colour signals having the same field frequencies but differing line frequencies, has been developed.

5. Conclusions

In standards conversion between monochrome television signals, having different line frequencies but the same or nearly the same field frequencies, a satisfactory result may be obtained by the well-known image-transfer methods. If the field frequencies are identical, however, new methods, known as computer-type conversion, are being studied. In these methods, no intermediate optical or electron-charge image is used and a more consistent and better quality image is expected. It is hoped, furthermore, that variations in image quality, due to the human element involved in the operation of standards conversion equipment, will be notably reduced by the introduction of these new techniques.

On the other hand, in converting between monochrome television signals, from one standard to another, when the field frequencies of the two standards are different, it is possible, by adopting one of the methods described in § 3, to reduce the flicker of the pictures reproduced to a hardly perceptible level, provided the adjustment of the converter is effected correctly. Here again, however, new methods are being perfected. These rely upon the development of special magnetic-tape recorders.

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   (b) Rout, E. R. and Vigurs, R. F., A wide-range standards converter. *J. Tel. Soc.*, **9** (12), 493-503 (October-December 1961).
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    (b) C.C.I.R., Doc. XI/33 (Japan) of Bad Kreuznach, 1962.

REPORT 312 *

CONSTITUTION OF A SYSTEM OF STEREOSCOPIC TELEVISION

(Study Programme 118C(XI))

(Geneva, 1963)

1. Methods of providing stereoscopic television have long been the subject of study in various countries. Some of these studies were made with mechanical scanning systems, ante-dating the electronic systems now in use. Several methods have been proposed to ensure that each of the two reproduced stereoscopic images reaches the proper eye of the viewer, and many of the methods are applicable to all electronic systems. The first method was based directly on the optical stereoscope and consisted of the reproduction of two spatially separated images, one for each eye. The larger separations, to accommodate larger images, prismatic viewing devices or prismatic spectacles, could be used to produce visual registration of the two images. A second method consisted in the production of two overlapping images in complementary colours and the use of complementary colour filters, sometimes in spectacles worn by the observer, to separate the two images. A third method provides overlapping images, produced by light which is polarized in orthogonal planes for the two images, together with the use of spectacles with polarizing filters. Several methods of separating the two pictures, without the use of spectacles, have been devised. These make use of gratings or lenticular screens. Both gratings and lenticular optical systems have been applied to cathode-ray receiver displays. These methods may have more serious limitations as to permissible viewing positions than do methods employing spectacles.

2. The transmission of a stereoscopic television signal requires the simultaneous or successive transmission of several separate signals. Methods have been suggested for reducing the bandwidth required. This question has many aspects in common with colour television and the use of the transmission methods, of which study has been made for colour television, may be envisaged for stereoscopic television transmission.

3. Various solutions for reproducing the stereoscopic picture have been envisaged. Some of these solutions entail the use, for the reproduction of a stereoscopic monochrome or colour picture, of television sets designed for the reception of normal non-stereoscopic pictures.

4. Further studies should be carried out and it should be borne in mind that the problems of bandwidth and compatibility with monochrome and colour systems are of great importance.

5. Doc. XI/22 of Moscow, 1958; Doc. XI/17, Doc. XI/20 and Doc. XI/34 of Bad Kreuznach, 1962, and their bibliographies, contain some information on the question of stereoscopic television.

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* This Report was adopted unanimously.

REPORT 313 *

ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(Question 152(XI))

(Los Angeles, 1959 — Geneva, 1963)

It appears, that during recent years, extensive studies have been made in many laboratories on the assessment of the quality of television pictures and the respective methods of measurement, both for monochrome and colour television. Since it would appear that these studies cannot yet be considered to be concluded, it seems appropriate, with a view to facilitating future work, to give a list of documents and publications bearing on this question.

Such a list would serve, both to avoid duplication of work and to enable comparisons to be made with results already found elsewhere. It may be extended to include subsequent publications on this subject and would be a valuable aid, within the scope of Question 152 (XI), in arriving at suitable standard methods for measuring the various kinds of picture distortion in television.

List of documents concerning Question 152 (XI)

1. A simple test picture for the assessment of the quality of monochrome television pictures (Doc. XI/3 of Moscow, 1958).
2. An equipment for electro-optical measurements of television image quality (Doc. XI/11 of Moscow, 1958).
3. Method of measurement of interlacing quality on television receivers (Doc. XI/12 of Moscow, 1958).
4. Direct measurement of noise on the receiver screen (Doc. XI/24 of Moscow, 1958).
5. Apparatus for the measurement of signal-to-noise ratio in video signals (Doc. XI/25 of Moscow, 1958).
6. Jesty, L. C., Relation between picture size, viewing distance and picture quality. *Proc. I.E.E.* 105 B (February 1958).
7. Measurement of random noise in television pictures (Doc. 39 of Los Angeles, 1959).
8. Method of measuring the numerical characteristics of gamma correctors (Doc. 124 of Los Angeles, 1959).
9. Influence of the colour parameters of the television receiver on the quality of colour reproduction (Doc. 125 of Los Angeles, 1959).
10. Effect of sub-carrier frequency on luminance (Doc. 126 of Los Angeles, 1959).
11. Assessment of the luminance and chrominance of television pictures (Doc. 145 of Los Angeles, 1959).
12. Measurement of the quality of television pictures (Doc. 383 of Warsaw 1956 and Doc. XI/18 of Bad Kreuznach, 1962).
13. Methods of measuring the basic parameter of a television signal (Doc. XI/22 of Bad Kreuznach, 1962).
14. Psychological aspects of quality assessment (Doc. XI/30 of Bad Kreuznach, 1962).
15. Ratio of the wanted to the unwanted signal in television (Doc. XI/29 of Bad Kreuznach, 1962).

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* This Report, which replaces Report 126, was adopted unanimously.

REPORT 314 *

INSERTION OF SPECIAL SIGNALS IN THE FIELD-BLANKING INTERVAL OF A TELEVISION SIGNAL

(Study Programme 177(XI))

(Geneva, 1963)

1. Special signals can be inserted in and removed from the field-blanking interval of a monochrome television signal without detriment to the quality of the picture. Such insertion or removal can be done, without harmful effects, by electronic procedures commonly employed for other purposes in a television system.

2. The purposes of such special signals can be classified in two main categories:

— supervision and measurements of various transmission characteristics;

— transmission of data concerning operation, such as information, instructions and remote control of equipment.

Practice varies considerably from one country to another, and it would appear difficult, at the present time, to achieve international standardization within the C.C.I.R., other than for a simple signal indicating the peak-white amplitude (this being mainly a consequence of the existence of different television standards). Such a signal could serve to show any change in the overall equivalent (insertion gain), of an international television circuit, and could be used to operate the a.g.c. apparatus.

3. International standardization does not seem to be appropriate to either the insertion or removal points. The point of insertion of the international signals depends upon local practice, and also upon the nature of the particular programme item. It will, in many cases, be the technical control room or switching centre responsible for the production of the programme item. The signal may be removed at the input of the broadcasting transmitter in those countries where radiation of the signal is considered to be undesirable.

As the proposed signals may occur within the part of the waveform where picture signals are permitted, their presence or absence does not affect the standardized synchronizing signals. The responsibility for the special signals should be with the broadcasting organizations.

4. Confusion between national and international signals in international transmissions can be avoided by inserting the proposed international signal at the originating control room, and by forbidding its removal or replacement by other than the control room(s), situated at the lower end of the transmitting chain(s). This will not hinder the insertion or removal of additional national signals, if required, at terminal or intermediate points. Such additional signals can be removed prior to sending the television signal over an international circuit, if removal is requested by a participating organization at the lower end.

Confusion between national and international signals can also be avoided by the standardization of the position of international signals in the field-blanking interval (see § 6). Insertion of identification signals could allow recognition of the source of international signals.

5. The documents mentioned below indicate the special signals used, or proposed for international standardization. A signal, which is considered in all the documents to be necessary, is the peak-white reference signal (see Recommendation 420).

Other signals are used experimentally:

— signals for testing non-linear response; staircase or sawtooth, with or without superimposed sinewave. [2] [4] [5] [7];

* This Report was adopted unanimously.

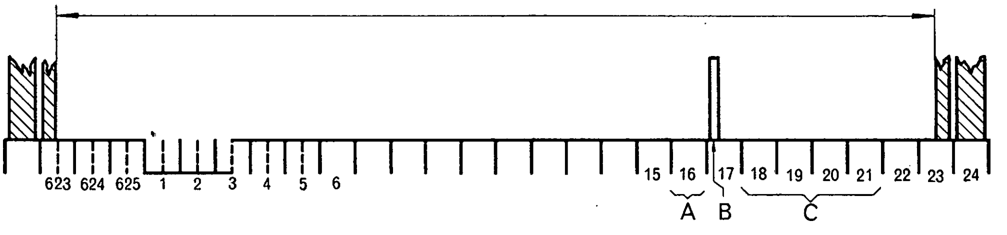
TABLE I

Documents * (1)	Duration of field-blanking (lines) (2)	Total number of lines per field to be reserved for all purposes (3)	Number of lines reserved for supervision of characteristics of transmission (4)	Number of lines reserved for data transmission (5)	Line number for lines of column 4 (6)	Line number for lines of column 5 (7)	Number of unused whole lines between last test line and end of field blanking (8)	Notes (9)
				525-line systems				
Doc. 180 (Japan)	21	2 (3)	2	(1)	17e 18e	(19e)	1	The position of the lines refers to the beginning of the field-blanking
Doc. 276 (U.S.A.)	21	2 (3)	2	(1)	18e 19e	(20e)		
				625-line systems				
Doc. 57 (France) Ann. 15 to Doc. 11	23	3	2	1	18, 19 331, 332	17 330	1 1	
Doc. 211 (I.B.T.O.)	25	3	3	0	17, 18, 19 330, 331, 332		3 3	
Doc. 267 (E.B.U.)	22	1	1	0	17 or (16) 329 or 329		2 (3) 3	For line number see Fig. 1
				819-line systems				
Ann. 16 to Doc. 11 (France)	41	5	4	1	32, 33, 34, 35 442, 443, 444, 445	31 441	3 2	

* Of Geneva, 1963.

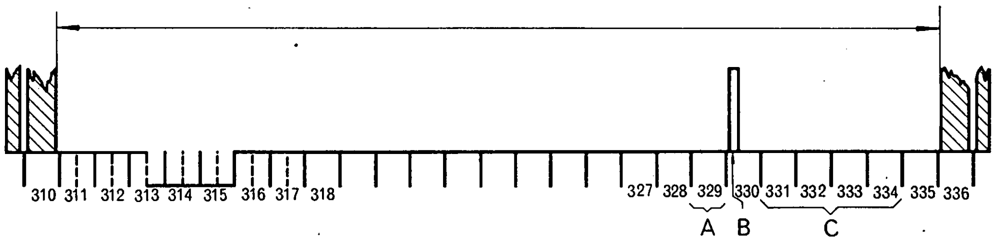
1st field

Field blanking = 25 lines



2nd field

Field blanking = 25 lines



A = Identification signals.
B = International signal.
C = National signals.

FIGURE 1

Position of special signals in a 625-line system

— signals for testing amplitude-frequency response; frequency multi-burst or single-frequency reference signal. [2] [4] [5] [7];

— signals for data transmission: coded pulses. [3] [7].

6. The proposed position for these signals is reported in Table I for various systems.

For 625-line systems, the position of the international signal is indicated in Recommendation 420. It was chosen so as to enable the possible insertion in the preceding line of national identification signals, as well as later insertion of various national signals (Fig. 1). These national signals might be inserted after the white bar, in lines 17 and 330 and in lines 18, 19, 20, 21, 331, 332, 333, 334. The total field-blanking duration should be increased, to leave an unused line between the end of the special signals and the beginning of the picture signal, for instance, up to 25 lines.

This Report is based on the following documents:

1. Ann. 15 to Doc. 11 (France) of Geneva, 1963.
2. Ann. 16 to Doc. 11 (France) of Geneva, 1963.
3. Doc. 57 (France) of Geneva, 1963.
4. Doc. 180 (Japan) of Geneva, 1963.
5. Doc. 211 (I.B.T.O.) of Geneva, 1963.
6. Doc. 267 (E.B.U.) of Geneva, 1963.
7. Doc. 276 (U.S.A.) of Geneva, 1963.

REPORT 315 *

REDUCTION OF THE CHANNEL CAPACITY REQUIRED FOR A TELEVISION SIGNAL

(Study Programme 119(XI))

(Geneva, 1963)

1. Studies on field rate and frame rate

Studies of human perception and of the rates at which the human brain is capable of acquiring information, which have been made since the establishment of existing television systems, have led to suggestions that the potential information rate of present television systems is too high. Since field rates of about 50 to 60 per second are required to prevent flicker over large uniform areas with present types of cathode ray display, if frame rates ranging from 12 to 16 per second are assumed to be satisfactory, it might be inferred that relatively simple systems using a 4/1 line-interlace or a combination of 2/1 line-interlace with a 2/1 dot-interlace would satisfy both conditions, and require but one half the present video bandwidth for equivalent picture detail. In fact, 4/1 line-interlace systems have been studied since 1941, but have been found to be very inferior to systems using 2/1 line-interlace, as regards interline-flicker, line crawl, and the serration of vertical line components in rapidly moving objects. Horizontal dot-interlace has also been examined and rejected as a means of economizing in bandwidth for monochrome television.

It is conceivable that new display devices, with improved storage characteristics, which would provide continuous presentation, might avoid flicker and reduce the need for line-or

* This Report was adopted unanimously.

dot-interlace. A recent survey indicates that such displays are not likely to be available very soon for home use. The use of half-tone storage tubes, in conjunction with standards conversion, would appear to offer some promise for relay purposes, but, up to the present time, this process has not proved to be attractive, because of the degradation of the picture which results. Further improvement in image-storage tubes may make this process practicable in the future.

2. Frame-to-frame redundancy

A second area of investigation which has been suggested is that of transmitting only the differences between successive frames. It is known that, on the average, a large percentage of the information merely repeats the information sent in previous frames. Conceivably, a system could be devised to use a lesser bandwidth and be capable of transmitting some percentage of probable frame sequences. In such a system, changes of information, at rates exceeding the potentialities of the system, would result in a delay in reproducing a complete change of scene in proportion to the reduction in bandwidth. Successive frames of many desired scenes will not in fact be redundant, because of motion of the subject or of the camera. Nevertheless, there is some evidence that a human observer may not perceive the loss of some definition for a short time immediately following a complete change of scene. Moreover, changes in the picture, resulting from a movement of the subject or camera, are sometimes accompanied by a loss of definition due to limitations of the equipment.

Further study is required to determine acceptable values for parameters concerned.

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2. C.C.I.R., Doc. 19 (U.S.A.) of Bad Kreuznach, 1962.
3. C.C.I.R., Doc. 32 (Japan) of Bad Kreuznach, 1962.
4. Seyler, A. J., Channel capacity utilization of television radio links. *Fortschritte der Hochfrequenztechnik*, **5**, 263-306 (1960).
5. Seyler, A. J., The coding of visual signals to reduce channel capacity requirements. *I.E.E. Monograph No. 535E* (July, 1962). (Published in Proc. I.E.E., Part C, **110** (1963))
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REPORT 316 *

REQUIREMENTS FOR THE TRANSMISSION OF COLOUR TELEVISION SIGNALS OVER LONG DISTANCES

(Question 121 (C.M.T.T.))

(Geneva, 1963)

Introduction

The joint C.C.I.R./C.C.I.T.T. Committee for Television Transmission (C.M.T.T.), has studied the problems which occur when transmitting colour television signals over long distances. The Committee expressed the opinion that it would be desirable to have eventually a single Recommendation to cover both colour and monochrome transmissions.

* This Report was adopted unanimously.

With this in view, the C.M.T.T. has examined Recommendation 421, item by item, to ascertain whether, in the light of present knowledge, special requirements for colour television transmissions will be necessary.

The conclusions are laid down in the following paragraphs, which are numbered to correspond with those of Recommendation 421.

1. Definitions

1.1 *Definition of a long-distance international television connection*

As in Recommendation 421.

1.2 *Definition of the hypothetical reference circuit*

As in Recommendation 421.

2. Requirements at video interconnection points

2.1 *Impedance*

The return loss should be raised to 30 db.

2.2 *Polarity and d.c. component*

As in Recommendation 421.

2.3 *Signal amplitude*

A new text is required; however, more extensive study must be made before such a text can be drafted.

3. Transmission performance of the hypothetical reference circuit

3.1 *Insertion gain*

As in Recommendation 421.

3.2 *Insertion gain variations*

As in Recommendation 421.

3.3 *Noise*

3.3.1 *Continuous random noise*

A new text is required. Three methods may be used to specify the circuit performance:

- study of a new weighting curve for the composite signal (luminance and chrominance);
- use of a new weighting network (in addition to the existing monochrome network), for the composite signal (luminance and chrominance);
- use of two separate weighting networks, one for the luminance channel and one for the chrominance channel.

The second method is being tried out in Canada and the United States, while the third method is proposed by the United Kingdom (see Doc. C.M.T.T./21 of Paris, 1962).

3.3.2 *Periodic noise*

The existing text (Recommendation 421) should be amended or expanded. More comprehensive studies must be made before a new text can be drafted. Methods similar to those proposed in § 3.3.1 could be used to specify the characteristics. See also the documents related to Question 267 (XI).

3.3.3 *Impulsive noise*

As in Recommendation 421.

3.4 *Non-linearity distortion*

3.4.1 *Field-time non-linearity distortion*

As in Recommendation 421.

3.4.2 / 3.4.3 *Line-time non-linearity distortion and short-time non-linearity distortion*

A number of delegates felt that the characteristics of line-time and short-time non-linearity distortion need not be specified separately.

It was agreed that § 3.4.3 (Recommendation 421), should be regarded as applicable to differential gain and phase variations. These characteristics should be measured at the frequency of the colour sub-carrier.

Four test signals were suggested for this measurement:

— Test signal No. 3, in which the frequency of the superimposed sine-wave is that of the colour sub-carrier (see Doc. C.M.T.T./5 and C.M.T.T./6 of Paris, 1962).

— A staircase signal with a superimposed sine-wave at the frequency of the colour sub-carrier (see Doc. C.M.T.T./21 of Paris, 1962).

— A sine-wave at line frequency, with another sine-wave at the frequency of the colour sub-carrier superimposed on it.

— A test signal, derived from signal No. 3 by modification of the amplitudes of the saw-tooth and of the sub-carrier (see Doc. C.M.T.T./12 of Paris, 1962).

The gain variations could be conveniently found from the expression ($1\text{-}m/M$), expressed as a percentage or in decibels. It may be advantageous, however, to express gain variations with respect to the gain at the blanking level or some other specified level.

Phase variations would be obtained from the phase corresponding to the blanking level.

In Canada and the U.S.A., gain and phase variations of 1·2 db and ± 2° respectively are accept for N.T.S.C. signal transmission over the hypothetical reference circuit.

3.4.4 *Non-linearity distortion of the synchronizing signal*

For the hypothetical reference circuit, when the gain of the circuit is 0 db, the amplitude (S) of the line-synchronizing signal, measured with Test Signal No. 3, should lie between the limits of 0.27V and 0.33V (0.26V and 0.31V for Canada and the U.S.A.), irrespective of whether the intermediate lines are at black level (S_a) or at white level (S_b).

3.5 *Linear waveform distortion*

3.5.1 *Field-time waveform distortion*

As in Recommendation 421.

3.5.2 *Line-time waveform distortion*

As in Recommendation 421.

3.5.3 *Short-time waveform distortion*

The existing text (Recommendation 421) must be modified. It must take account of the short-time waveform distortion for the modulated sub-carrier. Doc. C.M.T.T./21 of Paris, 1962, offers a method for determining this characteristic. Further studies are required.

3.6 *Steady-rate characteristics*

An amendment is called for. Several types of test signals are proposed for the study of this characteristic:

— use of a frequency-sweep signal (see Doc. C.M.T.T./5 and C.M.T.T./6 of Paris, 1962);

— use of a frequency multi-burst, as is the practice in Canada and the U.S.A. This type of signal is also mentioned in Doc. C.M.T.T./2 of Paris, 1962.

The tolerances for amplitude/frequency and envelope-delay/frequency characteristics will be more stringent than those accepted for monochrome signals in Recommendation 421.

In Canada and the U.S.A., the characteristics specified for colour television circuits are those used in monochrome television, with the tolerances slightly reduced in the region (± 0·5 Mc/s) of the colour sub-carrier.

QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO STUDY GROUP X (BROADCASTING); OPINIONS AND RESOLUTIONS OF INTEREST TO THIS STUDY GROUP

STUDY GROUP X

(Broadcasting)

Terms of reference

To study the technical aspects of transmission and reception in the sound broadcasting service (except for tropical broadcasting), including standards of sound recording and sound reproduction to facilitate the international exchange of programmes; to study also the technical aspects of video recording in liaison with Study Group XI.

Chairman : Mr. A. Prose WALKER (U.S.A.)
Vice-Chairman : Dr. H. RINDFLEISCH (Federal Republic of Germany)

INTRODUCTION BY THE CHAIRMAN, STUDY GROUP X

1. Subjects essentially concluded

1.1 *The techniques of measuring wow and flutter in audio-frequency applications* have been brought up to date in Recommendation 409, which replaces Recommendation 210 and Report 116. The Study Group decided, however, not to terminate Study Programme 161 (X), but, until additional information becomes available as the result of further work, this Recommendation terminates consideration of the matter. Although there has been no agreement as to a single technique for the *measurement of programme level* in sound broadcasting, Report 292 indicates the present practices in various Administrations, and concludes the study of Question 151 and Study Programme 109.

1.2 *The exchange of programme material on disc and tape* is covered in Recommendation 407, with the exception that an imminent revision of I.E.C. Publication 98 was not available for discussion in Geneva. Work on standards for discs and tape is proceeding in certain countries, and this may require further liaison work between the Director, C.C.I.R. and the I.E.C.

1.3 Recommendation 412 deals with the *technical characteristics of the frequency-modulated wave for VHF-FM sound broadcasting*, including protection ratios for both steady-state and tropospheric interference.

1.4 Question 39, which was referred to the C.C.I.R. by the HF Broadcasting Conference, Mexico City, 1948-49, was terminated by the adoption of Recommendation 411.

1.5 *The conditions under which more than one frequency per programme may be used* are dealt with in Recommendation 410.

1.6 The presentation of the results of *subjective measurements on protection ratios* for amplitude-modulation sound broadcasting is the subject of Recommendation 413.

1.7 *The presentation of the antenna diagrams* in the C.C.I.R. Book of Antenna Diagrams, is dealt with in Recommendation 414, in which it is recommended that the curves of equal field-strength should be expressed in db, instead of in percentages of power, as formerly. Preferred values in db are given.

2. Subjects for further study

The following general subjects remain for further study, and references are given to the relevant documents of the Xth Plenary Assembly.

2.1 *LF, MF and HF broadcasting :* Antenna, sky-wave reception, bandwidth of emissions, etc., (see Question 23 (X), Question 264 (X), Study Programme 23A (X), Report 296, Question 263 (X) and Report 297).

2.2 *Television :* Magnetic recording, exchange of programmes by means of film, two sound channels (see Question 66(X), Question 266(X), Study Programme 266A(X), Report 295, Report 294, Recommendation 264, Recommendation 265 and Question 265(X)).

2.3 *Standards for sound recording on tape and film :* (see Question 200(X), Report 291 and Recommendation 408).

2.4 *Protection ratios in amplitude-modulation sound broadcasting :* (see Recommendation 413, Question 262(X), Study Programme 262A(X) and Report 298).

2.5 *Compatible single-sideband amplitude-modulation broadcasting :* (see Question 205 (X), Study Programme 205A(X) and Report 299).

2.6 *Stereophonic broadcasting :* audio-frequency parameters, characteristics of systems (see Question 199(X), Study Programme 199A(X), Report 293 and Report 300).

OPINION 15 *

USE OF THE 26 Mc/s BROADCASTING BAND

(London, 1953)

The C.C.I.R.,

CONSIDERING

(a) that it is important that long-distance broadcasting should use all channels available to it;

(b) that when the smoothed relative sunspot number reaches 70, long-distance broadcast transmissions can be carried out efficiently during daylight hours, over many routes, on frequencies within the 26 Mc/s broadcasting band;

(c) that hitherto these frequencies have been very little used;

(d) that such transmissions on these frequencies, whenever they are possible, are particularly advantageous, because of the very low atmospheric-noise intensity and the low absorption;

(e) that this band will not be fully used until receivers covering it are available;

IS UNANIMOUSLY OF THE OPINION

1. that Administrations should bring to the notice of broadcasting organizations, the advantages of the 26 Mc/s band for long-distance broadcasting when ionospheric conditions are favourable;

2. that, when broadcasting organizations have decided that they will make use of the 26 Mc/s band, they should make their intention known well in advance, to expedite the availability of suitable receivers.

OPINION 16 **

ORGANIZATIONS QUALIFIED TO TAKE ACTION ON QUESTIONS OF SOUND RECORDING

The C.C.I.R., (Warsaw, 1956)

CONSIDERING

(a) that differences of opinion may exist as to which of the organizations I.E.C., ISO or C.C.I.R. is in the best position to take action in questions concerning recording;

(b) that unnecessary duplication of work and multiplicity of standards may result, if the present situation is allowed to continue;

* This Opinion was previously designated " Resolution 17 ".

** This Opinion was previously designated " Resolution 31 ".

IS UNANIMOUSLY OF THE OPINION

1. that the C.C.I.R. should determine the acceptability of existing standards and should collaborate with other international organizations in formulating new standards, when the existing ones are unsuitable for the international exchange of programmes;

2. that the Director, C.C.I.R. should keep in close touch with the I.E.C. and the ISO, with a view to avoiding unnecessary duplication of work.

OPINION 17 *

RECORDING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

The C.C.I.R. (Geneva, 1963)

IS UNANIMOUSLY OF THE OPINION

1. that the Director, C.C.I.R. should inform the I.E.C. and the ISO of the views expressed in Report 291 and Report 294;

2. that the I.E.C. and the ISO should be invited to take these views into account.

OPINION 18

TECHNICAL STANDARDS FOR USE IN THE FREQUENCY PLANNING OF AMPLITUDE-MODULATION SOUND BROADCASTING

The C.C.I.R., (Geneva, 1963)

CONSIDERING

that, in its Resolution 497, the Administrative Council of the I.T.U. requested the C.C.I.R. to expedite the preparation of technical information necessary for the preparation of frequency assignment plans for the national sound and television broadcasting stations in Africa;

IS UNANIMOUSLY OF THE OPINION

that, with regard to amplitude-modulation sound broadcasting on long and medium waves' the required technical data can best be drawn up by a Committee of Experts drawn from the appropriate C.C.I.R. Study Groups (Study Groups V, VI, X and XII), which could be organized to meet in a way similar to the Meeting of Experts of the C.C.I.R., Cannes, 1961, which preceded the European VHF/UHF Broadcasting Conference, Stockholm, 1961.

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* This Opinion replaces Resolutions 58 and 59.

STUDY PROGRAMME 161(X) *

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

The C.C.I.R., (Geneva, 1951 — London, 1953 — Los Angeles, 1959)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. an investigation of the possibility of adopting, for the international exchange of sound programmes on magnetic tape, a speed of 3·75 in./s (9·525 cm/s), and the determination of the standards to be used, especially the reproducing characteristics;
2. investigation of methods for measuring wow and flutter for magnetic tape recording and reproducing, and of the values of those which may be allowed;
3. further investigation of methods of absolute measurement of the characteristics of the signal recorded on a magnetic tape, to define and measure, over as wide a range of wave-lengths on the tape as possible, the absolute level of a recorded signal, independently of the particular magnetic properties of each type of tape;
4. further investigation of the technique of sound recording to extend and improve the recommendations already made and to reduce the tolerances.

STUDY PROGRAMME 162 (X) **

MEASUREMENT OF AUDIO NOISE FOR BROADCASTING AND IN SOUND RECORDING SYSTEMS

(Report 292)

The C.C.I.R., (Los Angeles, 1959)

CONSIDERING

that no methods exist for measuring noise in the audio channels of broadcasting systems and in sound recording systems, which provide satisfactory agreement with subjective assessments;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. what type of measuring set (mean, r.m.s. or peak) should be used for the measurement of noise;
2. what characteristics should be recommended for these measuring sets?

Note. — Study of §§ 1 and 2 should be made, with reference to the measurement of noise with and without programme modulation (modulation noise in magnetic recording).

* This Study Programme replaces Study Programme 74. It does not refer to any Question under study.

** This Study Programme does not refer to any Question under study.

QUESTION 23 (X) *

HIGH-FREQUENCY BROADCASTING

Directional Antenna Systems

(Stockholm, 1948)

For the following Questions it will be appropriate to organize the compilation of statistical measured results from antennae 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 should 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?

ANNEX

The characteristics of directional antenna systems, used in broadcasting, have been very completely studied from theoretical aspects, and a number of experimental investigations have been undertaken by various bodies on the actual measured performance. **

With a suitably designed antenna, the power radiated in unwanted directions can be reduced to a small proportion of the power radiated in the wanted direction. An antenna system, with a reflector having an aperture of two wavelengths, should have a radiation at 25° off the main beam, reduced 16 db below the main radiation field. At 40° off the main beam, the radiation should be reduced to 35 db below the main radiation path. Tests have been made as to the actual reception at distant points at places which are off the main radiation beam. These show, however, that the field at such reception points is often in excess of the expected field predicted from the power radiated in the given direction.

These abnormal signal strengths presumably result from a field which is a combination of a direct radiation in the given direction, and indirect radiation due to scattering of the main beam on reflection. Measurements of this phenomenon would clearly take a very considerable time and could only be properly evaluated on a statistical basis. It appears possible that the limitation to frequency sharing may be the scattering of the main beam of radiation.

It will, however, always be of utility to reduce the power radiated in unwanted directions and particularly in the subsidiary lobes of an antenna system.

Further study of this question is recommended and, in particular, it is recommended that attention be given to the development of methods of avoiding the production of subsidiary radiation lobes when a directional antenna is fed asymmetrically to produce a slew of the main lobe of radiation.

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* The reasons which justify this Question are given in the Annex.

** H. PAGE, The measured performance of horizontal dipole transmitting arrays. *J.I.E.E.*. **92**, Part III, 18, June 1945.

E. K. DANDEMAN, *Radio Engineering*, Chapman & Hall, page 674.

L. W. HAYES and B. N. MACLARTY, The Empire Service Broadcasting Station at Daventry. *J.I.E.E.*, **85**, 513, September 1939.

N. WELLS, Aerial Characteristics. *J.I.E.E.*, **89**, Part III, 6, June 1942.

J. E. HACKE Jr. and A. H. WAYNICK, *Restricted range sky wave transmission*. Elec. Eng. Dept., Pennsylvania State College, Pa., U.S.A.

STUDY PROGRAMME 23A(X) *

HIGH-FREQUENCY BROADCASTING

Directional Antenna Systems

(Recommendation 80)

The C.C.I.R., (Warsaw, 1956)

CONSIDERING

(a) the development in the use of highly directional antenna systems in HF (decametric) broadcasting;

(b) the need to share frequencies wherever possible, to allow the most efficient use of the broadcasting bands;

UNANIMOUSLY DECIDES that the following studies should be carried out:

the extent to which the theoretical protection can be obtained in practice when using the usual types of directional broadcasting transmitting antennae.

Note 1. — It is suggested that actual field-strength measurements should be obtained to verify the nominal gain in the main beam and the validity of Recommendation 80.

Note 2. — Tests should be arranged in such a way as to eliminate to the greatest possible extent the effects of changing ionospheric conditions.

QUESTION 66 (X)

TELEVISION RECORDING

The C.C.I.R., (Geneva, 1951)

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.

QUESTION 199 (X) **

STEREOPHONIC BROADCASTING

The C.C.I.R., (Los Angeles, 1959)

CONSIDERING

(a) that stereophonic recording of sound on both disc and magnetic tape is already becoming well established in the industry and such discs and tapes are already on sale to the public in some countries;

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* This Study Programme was previously designated " Study Programme 106 (X)."

** This Question replaces Question 170.

(b) that experimental transmissions of stereophonic sound programmes have already been made by broadcasting stations in a number of countries;

(c) that, if such transmissions become general without international co-ordination, serious problems of interference to existing broadcasting services could arise;

(d) that, by the adoption of suitable techniques on an international scale, such interference problems could be avoided and spectrum occupancy reduced;

(e) that it is desirable to achieve international standardization of transmission parameters, so as to make possible the standardization of some parts of receivers for stereophonic broadcasting;

UNANIMOUSLY DECIDES that the following question should be studied:

1. by what methods can satisfactory stereophonic sound be broadcast to ensure maximum economy in frequency usage;

2. what systems can ensure compatibility * together with no significant loss of coverage or increase in mutual interference with existing services;

3. what parameters should be standardized?

STUDY PROGRAMME 199A(X) **

STEREOPHONIC BROADCASTING

Standards for compatible systems in sound and television broadcasting

The C.C.I.R., (Los Angeles, 1959)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. investigate the systems for compatible stereophonic broadcasting, indicating:

1.1 the general principles of each system;

1.2 the detailed specification of each system;

1.3 the overall theoretical evaluation of the performance of each system;

2. study the systems with particular regard to their feasibility and applicability to existing broadcast transmitters;

3. study the systems with regard to:

3.1 performance of existing non-stereophonic receivers when tuned to the stereophonic transmission;

3.2 performance of stereophonic receivers when tuned to the stereophonic signal;

3.3 performance of stereophonic receivers when tuned to non-stereophonic signals;

3.4 possibility of adapting existing non-stereophonic receivers for stereophonic reception;

4. investigate the systems with particular regard to:

4.1 coverage;

4.2 interference effects;

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* " Compatible " in the sense that, when a stereophonic programme is being broadcast, an ordinary receiver may continue to receive a satisfactory balanced, non-stereophonic programme.

** This Study Programme was previously designated " Study Programme 163(X)."

4.3 bandwidth involved and other matters concerned with channel utilization;

5. carry out field tests of those systems that appear most satisfactory;

6. study and report on the required technical characteristics of studio-transmitter links and related stereophonic transmission facilities;

7. study the subjective aspects of stereophonic sound.

QUESTION 200(X)

STEREOPHONIC RECORDING FOR BROADCASTING

The C.C.I.R., (Los Angeles, 1959)

CONSIDERING

(a) that studies are being carried out to determine the best systems of stereophonic sound broadcasting;

(b) that audio-frequency stereophonic recordings are necessary for these new broadcasting systems;

(c) that the Recommendations of the International Electrotechnical Commission should be examined in this respect to see if they are acceptable;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what stereophonic sound-recording methods can be used by broadcasting authorities;

2. what standard should be established to allow for the international exchange of these recordings?

QUESTION 205(X)

COMPATIBLE SINGLE-SIDEBAND (CSSB) TRANSMISSION FOR AMPLITUDE-MODULATION SOUND BROADCASTING SERVICES

The C.C.I.R., (Los Angeles, 1959)

CONSIDERING

(a) that compatible (unsuppressed carrier) single-sideband transmissions (see Note) are now in limited experimental use by broadcast stations in certain countries;

(b) that the use of such a system of transmission could improve reception;

(c) that further information is required regarding such systems;

UNANIMOUSLY DECIDES that the following question should be studied:

1. by what methods can compatible single-sideband transmissions be accomplished;

2. what parameters should be standardized, to derive the maximum possible advantages from such transmissions?

Note.—A single-sideband transmission is considered to be compatible if it can be received on the existing conventional double-sideband receivers, without any modifications whatsoever and with satisfactory quality of reception.

STUDY PROGRAMME 205A(X) *

AMPLITUDE-MODULATION SOUND BROADCASTING SERVICES

Compatible single-sideband (CSSB) transmissions

The C.C.I.R. (Los Angeles, 1959 — Geneva, 1963)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the protection ratios required to guarantee the same grade of service with this type of transmission as is accepted for normal AM broadcasting;

These protection ratios should be measured for the following cases:

Wanted transmitter	Unwanted transmitter
CSSB	CSSB
CSSB	double-sideband AM
double-sideband AM	CSSB

2. the best objective method of measurement of signal-to-interference ratios with this type of transmission;
3. the effects of the introduction of this means of transmission on the quality of reception;
4. the relative advantages of using CSSB transmissions to improve the quality of reception with existing channel separations, or to provide a large number of channels by a different distribution of carrier frequencies in the spectrum;
5. the real spectrum of emission of this type of transmission;
6. the effects of fading and multipath propagation in this system;
7. the effects of the use of this system on the size of the service area of a transmitter;
8. any other features of this system that may lead to improved reception.

Note.—A single-sideband transmission is said to be " compatible " if it can be received on an existing conventional receiver, without any modification whatsoever to the receiver, and gives a quality of reception at least as satisfactory as that obtained at present in a double-sideband system.

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* This Study Programme replaces Study Programme 165.

QUESTION 262(X) *

AMPLITUDE-MODULATION SOUND BROADCASTING **

Protection ratios

The C.C.I.R., (Los Angeles, 1959 — Geneva, 1963)

CONSIDERING

that there is a need for generally accepted values of protection ratios for amplitude-modulation sound broadcasting;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the value of the protection ratio (expressed as a function of the separation between the carrier-frequencies of two amplitude-modulated sound broadcast signals carrying different programmes), when the levels of both signals are stable, and when the wanted signal is unaffected by distortion or noise;

2. what is the effect of limitation of the occupied bandwidth at the transmitter (for example, to less than $\pm$ 10 kc/s), on these protection ratios ***;

3. how do the values of the protection ratios, referred to in § 1, vary if:

3.1 one or both of the signals is affected by fading;

3.2 the quality of the wanted signal is impaired by atmospheric or industrial noise;

3.3 the quality of the wanted signal is impaired by distortion introduced by the propagation medium (e.g., multipath effects) ****;

4. what are the values of protection ratio, derived from the results of measurements carried out in accordance with §§ 1, 2 and 3 of the wanted-to-unwanted signal ratio, between two broadcasting transmitters, radiating different programmes, but operating on frequencies separated by 0 to 10 kc/s, for:

4.1 LF (kilometric) and MF (hectometric) broadcasting;

4.2 HF (decametric) broadcasting;

5. what are the values of:

— the wanted signal-to-atmospheric noise ratio,

— the wanted signal-to-industrial noise ratio,

necessary to ensure satisfactory reception in:

5.1 LF (kilometric) and MF (hectometric) broadcasting;

5.2 HF (decametric) broadcasting;

6. how are the values of protection ratios obtained in HF (decametric) broadcasting, as given in § 4.2, affected by:

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* This Question replaces Questions 201, 203 and 204. The results of studies on this Question should be communicated to Study Group XII. The protection ratios quoted refer, in all cases, to the ratios at the input to the receiver, no account having been taken of the effect of using directional receiving antennae.

** Recommendation 413 gives the form in which these results should be presented.

*** See Report 297.

**** See Question 263(X).

— the length of the transmission paths;
— the direction of the transmission paths;

7. what would be the smallest value of occupied bandwidth for amplitude-modulated broadcast transmitters under existing conditions, taking into account:
   — spacing between carriers,
   — distances between adjacent-channel transmitters,
   — the selectivity characteristics of current types of receivers;

   to give satisfactory reception? *

STUDY PROGRAMME 262A(X)

AMPLITUDE-MODULATION SOUND BROADCASTING

Protection ratios—Objective two-signal methods of measurements

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that subjective methods for determining the necessary protection ratios are complicated and difficult to carry out because of the many parameters involved;

(b) that objective methods for determining the selectivity of receivers based on single-signal techniques cannot be used to determine these protection ratios;

UNANIMOUSLY DECIDES that the following studies should be carried out:

which objective two-signal methods of measurements can be used to measure protection ratios?

QUESTION 263(X) **

AMPLITUDE-MODULATION SOUND BROADCASTING

Reception of the sky-wave signal

The C.C.I.R., (Los Angeles, 1959 — Geneva, 1963)

CONSIDERING

that more information is desired concerning various propagation effects that lead to distortion of broadcasting signals;

UNANIMOUSLY DECIDES that the following question should be studied:

1 what is the nature of the distortion, due to the effects of the ionosphere at distances beyond the ground-wave service area;

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* See Recommendation 413.

** This Question replaces Question 202 and Study Programme 164.

2. how is the subjective quality of the sky-wave broadcast signal degraded as a function of distance beyond the limit of the ground-wave service area and as a function of other possible parameters, such as the geographical location of the transmitter, the frequency or the season of the year;

3. what is the maximum degree of distortion that would still permit a sky-wave service to be considered satisfactory?

QUESTION 264(X)

LOW AND MEDIUM-FREQUENCY BROADCASTING

High-efficiency transmitting antennae

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that there is a general tendency to increase the size of the service area of low- and medium-frequency broadcasting transmitters by increasing the transmitter power;

(b) that, especially with high-power transmitters, it is preferable to increase the size of the service area by the use of high-efficiency antennae, especially when the size of the service area is limited by interference between the sky- and the ground-waves;

UNANIMOUSLY DECIDES that the following question should be studied:

what types of antenna can be used in practice to increase the area served either by the ground-wave or the sky-wave, taking into account the effects of reflections from the E- and F-layers?

QUESTION 265(X) *

SIMULTANEOUS TRANSMISSION OF TWO SOUND CHANNELS IN TELEVISION

The C.C.I.R., (Los Angeles, 1959 — Geneva, 1963)

CONSIDERING

(a) that it is often desirable, for the purpose of international programme exchange, to transmit two sound channels simultaneously in television;

(b) that such a transmission may also be useful in areas where several languages are spoken;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what systems can be used, preferably with a single transmitter, for the transmission of two sound channels in television. These systems should not involve any significant increase in bandwidth of the television channel. Moreover, existing types of receivers should be able to receive, without modification, one of the sound channels while maintaining picture and sound quality;

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* This Question replaces Question 198.

2. what modifications would have to be made to existing types of receivers, to allow the viewer to select either of the sound channels;

3. to what extent could these systems be used for stereophonic sound transmissions in television;

4. what change in service area (determined by either random noise, impulsive noise or interference) arises from the introduction of such systems, as compared with the service areas for existing single sound channel transmission;

5. what value of cross-talk between the two sound channels can be obtained with such systems?

QUESTION 266(X)

RECORDING OF TELEVISION SIGNALS ON MAGNETIC TAPE

The C.C.I.R., (Geneva, 1963)

CONSIDERING

that various equipments are being developed for magnetic recording of monochrome and colour television signals;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the methods of magnetic recording of television programmes which can be used by broadcasting organizations;

2. what standards should be established to enable the international exchange of such recordings to be made?

STUDY PROGRAMME 266A(X)

RECORDING OF TELEVISION SIGNALS ON MAGNETIC TAPE

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that there is at present a system of magnetic recording of television programmes used for the international exchange of programmes;

(b) that exact standards for this system have not yet been established;

(c) that the results obtained in operation deserve to be taken into consideration;

(d) that a study should be made of possible improvements to both the mechanical and the electronic aspects of the system;

(e) that there is a pressing need to collect sufficient information as to the possibility of adapting the equipment to different colour television systems already in operation or in the experimental stage;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. standards for the geometrical and kinematic characteristics of the machines, with a view to improved reliability in the exchange of programmes;

2. the best methods of dealing with the video-frequency signal in relation to the overall quality of the system;

3. standards relating to the use of tracks for the recording of sound;

4. ways of adapting the system under consideration for the recording of colour television signals.

LIST OF DOCUMENTS OF THE Xth PLENARY ASSEMBLY CONCERNING STUDY GROUP X

Doc.	Origin	Title	Reference	Other Study Groups concerned
10	Chairman, Study Group X	Report by Chairman of Study Group X (Mr. A. Prose Walker)	—	—
90	C.C.I.R. Secretariat	Antenna diagrams	—	—
92	India	An investigation into the errors in the indicated programme-level, as measured in relation to the true peak value, arising from the use of existing equipment	S.P. 109	—
93	India	An investigation of the possibility of adopting a speed of 9·5 mm/s (3·75 in./s) for the international exchange of programmes on magnetic tape; and determination of the standards to be applied, especially the reproducing characteristics	S.P. 161	—
94	India	Determination of the protection required for a broadcast signal in the presence of interference	Q. 102 (XII) S.P. 167 (XII) Q. 203	XII
129	C.C.I.R. Secretariat	Bibliographic references in the volumes of the C.C.I.R.	—	I-XIV
153	C.C.I.R. Secretariat	Refinement of the I.F.R.B. technical standards (withdrawn)	—	I, II, III, V, VI, XII, XIII
166	Sweden	Stereophonic broadcasting	Q. 199	—
191	C.C.I.R. Secretariat	High frequency directional antennae—Replies to C.C.I.R. Circular AC/55	Circ. AC/55	III, XII
205	E.B.U.	Technical results of the tests on the service area of the suppressed sub-carrier stereophonic system	Q. 199 S.P. 163	—
206	E.B.U.	Admissible tolerances for the phase difference between the signals in the left-hand and right-hand channels in the stereophonic reproduction of sound	Q. 199 S.P. 163	—
210	I.B.T.O.	Technical parameters of monochrome films intended for international exchange of television programmes (I.B.T.O. Recommendation 14)	Rec. 265	—
218	France	Protection ratio for amplitude-modulation broadcasting	Q. 201	—
221	United Kingdom	High frequency broadcasting-directional antenna systems	S.P. 106	—
223	Japan	Stereophonic broadcasting standards for compatible systems	Q. 199 S.P. 163	—
237	India	Information regarding high-frequency directional antennae used by radio-communication services in India	Circ. AC/55	III, XII

Doc.	Origin	Title	Reference	Other Study Groups concerned
238	U.S.S.R.	VHF FM stereophonic broadcasting	Q. 199 S.P. 163	—
261	U.S.S.R.	Bibliographic references for inclusion in Annex 10/23 to Doc. 10	—	—
269	Italy	Measurement of modulation levels in sound broadcasting	Q. 151 S.P. 109	—
271	U.R.S.I.	Long-distance directivity of HF antennae	Circ. AC/55	III, VI
282	Study Group X	Summary record of the first meeting	—	—
309	E.B.U.	Choice of a standardized system of stereophonic broadcasting on metric waves	Q. 199 S.P. 163	—
315	Sub-Group X-C	Audio-frequency parameters for stereophonic reproduction of sound	Draft Rep. S.P. 163	—
324	Sub-Group X-C	Standards for frequency-modulation sound broadcasting in the VHF (metric) band	Q. 150	—
325	Sub-Group X-C	Simultaneous transmission of two sound channels in television	Draft Q.	—
382	Sub-Group X-A	Measurement of programme level in sound broadcasting	Draft Rep.	—
383	Sub-Group X-A	Measurement of wow and flutter in recording equipment and in sound reproduction	Draft Rec.	—
384	Sub-Group X-A	Sound recording for the international exchange of programmes	Draft Rec.	—
388	Sub-Group X-A	Recording of monochrome television signals on magnetic tape	Draft Rep.	—
397	Sub-Group X-B	Compatible single-sideband (CSSB) transmission for amplitude-modulated sound broadcasting services	Draft S.P.	—
398	Sub-Group X-B	Compatible single-sideband transmission (CSSB) for amplitude-modulation sound broadcasting services	Draft Rep.	—
438	Study Group X	Summary record of the second meeting	—	—
451	Sub-Group X-C	Stereophonic broadcasting for frequency-modulated sound systems using a maximum frequency deviation of 75 kc/s	Draft Rec.	—
452	Sub-Group X-A	Recording standards for the international exchange of television programmes	Draft Rep.	—
453	Sub-Group X-A	Draft revision of Recommendations 264 and 265	Draft Rec.	—
454	Sub-Group X-A	Draft Resolution	Draft Res.	—
456	Sub-Group X-B	Protection ratios for amplitude-modulated sound broadcasting	Draft S.P.	—

Doc.	Origin	Title	Reference	Other Study Groups concerned
457	Working Party X-B-1	Presentation of the results of subjective measurements on protection ratios for amplitude-modulated sound broadcasting	Draft Rec.	—
458	Sub-Group X-B	Amplitude-modulated sound broadcasting	Draft Q.	—
475	Sub-Group X-B	High-frequency broadcasting—Directional antenna systems	Draft Rep.	—
483	Sub-Group X-B	Directional antennae	Draft Rec.	—
494	Sub-Group X-B	Technical standards for use in the frequency planning of amplitude-modulated sound broadcasting	Draft Res.	—
495	Sub-Group X-B	Protection ratios for amplitude-modulated sound broadcasting—Modification to Annex 10/21 to Doc. 10	Draft Rep.	—
588	Study Group X	Summary record of the third meeting	—	—
599	Study Group X	Stereophonic broadcasting	Draft Rep.	—
619	Study Group X	Summary record of the fourth and last meeting	—	—
2153	Drafting Committee	Measurement of wow and flutter in recording equipment and in sound reproduction	Rec. 409	—
2154	„ „	Audio-frequency parameters for stereophonic reproduction of sound	Rep. 293	—
2155	„ „	Measurement of programme level in sound broadcasting	Rep. 292	—
2156	„ „	Sound recording for the international exchange of programmes	Rec. 407	—
2157	„ „	Simultaneous transmission of two sound channels in television	Q. 265	—
2158	„ „	Standards for frequency-modulation sound broadcasting in the VHF (metric) band	Rec. 412	—
2159	„ „	Standards of sound recording for the international exchange of programmes	Rep. 291	—
2160	„ „	High-frequency broadcasting reception	Rec. 411	—
2161	„ „	High-frequency broadcasting	Rec. 410	—
2162	„ „	Standards for stereophonic recording on 6·25 mm (1·4 in.) two-track tape for the international exchange of broadcast programmes	Rec. 408	—
2163	„ „	Protection ratios in amplitude modulation sound broadcasting	Q. 262	—
2164	„ „	Recording of television signals on magnetic tapes	S.P. 266A	—

Doc.	Origin	Title	Reference	Other Study Groups concerned
2165	Drafting Committee	High-frequency broadcasting	Rep. 297	—
2166	„ „	High-efficiency transmitting antennae for low and medium-frequency broadcasting	Q. 264	—
2369	„ „	Protection ratios for amplitude-modulated sound broadcasting	Rep. 298	—
2370	„ „	Recording of television signals on magnetic tapes	Q. 266	—
2371	„ „	Recording of monochrome television signals on magnetic tape	Rep. 295	—
2372	„ „	Recording standards for the international exchange of television programmes on film	Rep. 294	—
2373	„ „	Recording standards for the international exchange of television programmes	Rec. 264	—
2374	„ „	Report ... (Annex 10/19) and Report ... (Doc. 452)	Op. 17	—
2375	„ „	Compatible single-sideband (CSSB) transmission for amplitude-modulated sound broadcasting services	S.P. 205A	—
2376	„ „	Compatible single-sideband transmission (CSSB) for amplitude-modulation sound broadcast services	Rep. 299	—
2377	„ „	Amplitude-modulated sound broadcasting	Q. 263	—
2378	„ „	Protection ratios for amplitude-modulated sound broadcasting	S.P. 262A	—
2379	„ „	Presentation of the results of subjective measurements on protection ratios for amplitude-modulated sound broadcasting	Rec. 413	—
2380	„ „	High-frequency broadcasting—Directional antenna systems	Rep. 296	—
2381	„ „	Directional antennae	Rec. 414	—
2382	„ „	Stereophonic broadcasting	Rep. 300	—
2387	„ „	Revision of Recommendation 265	Rec. 265	—
2395	„ „	Technical standards for use in the frequency planning of amplitude-modulated sound broadcasting	Op. 18	—

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QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO STUDY GROUP XI (TELEVISION); OPINIONS AND RESOLUTIONS OF INTEREST TO THIS STUDY GROUP

STUDY GROUP XI

(Television)

Terms of reference

Technical aspects of television.

Chairman : Mr. E. ESPING (Sweden)
Vice-Chairman : Mr. G. HANSEN (Belgium)

INTRODUCTION BY THE CHAIRMAN, STUDY GROUP XI

1. The terms of reference of Study Group XI are " Television ".

The main problems it has to study are:

television standards;

ratio of the wanted to the unwanted signal in television ;

assessment of the quality of television pictures.

In connection with these problems, there are many others that the Group has to study, e.g. long-distance television transmission, exchanges of television programmes, the minimum field-strength to be protected when establishing frequency plans for television, television standards conversion, insertion of special signals in the vertical blanking interval, stereoscopic television, etc.

2. Television standards

2.1 At the interim meeting, Bad Kreuznach 1962, the *Report on characteristics of monochrome television systems* was brought up to date and was adopted at the Xth Plenary Assembly without modification. In the tables of the document details of the different monochrome television systems in use are given.

2.2 The question of *colour television standards* in bands IV and V is the most important study that the Group has to do at present. At the interim meeting, Moscow 1958, this question was brought a good step forward, when all European countries stated that they were prepared to adopt an 8-Mc/s channel spacing to have a uniform channelling and, in consequence, a more efficient use of the frequency spectrum. Many countries, now using other than the 625-line standard in bands I and III, will use 625-lines in bands IV and V, or are considering the use of 625-line standard there. Some countries have stated that they are ready to adopt a value of 4·43 Mc/s for the colour sub-carrier frequency.

At the interim meeting, Bad Kreuznach 1962, a draft Report was drawn up *on the standards for colour television.* On the basis of this draft, the Xth Plenary Assembly formulated and adopted a Report enumerating the conditions which a colour television system should fulfil.

However, all countries were not prepared to adopt a common standard at the Xth Plenary Assembly. One considered that further studies had to be done. Such studies are now in progress and it is hoped that the interim meeting of Study Group XI in Vienna, 1964 can adopt a standard for the European countries.

2.3 At the Plenary Assembly, a *Report on stereoscopic television* was adopted, in which Report the experimental methods used in the United States and the U.S.S.R. are described.

2.4 For *television transmission*, the Plenary Assembly adopted a Report and a Study Programme on *long-distance television transmission*. Here, cooperation takes place with the C.M.T.T. (Commission mixte de Transmission télévisuelle). The *Study Programme* refers to equipment and methods for the *remote monitoring* of qualitative parameters of television chains.

For *colour television transmissions*, the Report gives the specifications which the transmissions should satisfy.

2.5 For *international exchange of television programmes*, France and the I.B.T.O. proposed a standardization of the 625-line video frequency signal and a Report on this very important question was agreed upon during the Xth Plenary Assembly.

2.6 With respect to *the conversion of television standards*, this problem was studied at Bad Kreuznach. On the basis of the document from Bad Kreuznach, a Report was adopted by the Plenary Assembly giving the present state of the matters.

2.7 Regarding *the insertion of special signals in the field-blanking interval*, the Geneva meeting adopted a Recommendation, giving the data for a special signal to be inserted in the field-blanking interval for the international transmission of 625-line television signals.

3. Ratio of the wanted to unwanted signal in television

3.1 For monochrome television, the Xth Plenary Assembly adopted a Recommendation which gives the *protection ratios to be used when drawing up plans*. For the *minimum field-strength to be protected* when planning for television, a Recommendation was also adopted.

4. Assessment of the quality of television pictures

A *Study Programme* and a *Report*, drawn up at Bad Kreuznach, were adopted at the Plenary Assembly. The Study Programme concerns subjective test methods for the appraisal of picture quality and the Report gives a list of documents relating to the question.

5. Conclusions

As seen from the above there are many problems which are to be solved within the Study Group. Important Recommendations, Reports, etc. are adopted. On the other hand, there are still many problems which have not yet been solved. Among these, there is the very important question of a colour television standard but, as said above, it is expected that this question will be solved at the Interim Meeting of Study Group XI, Vienna 1964.

QUESTION 118(XI) *

COLOUR TELEVISION STANDARDS

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING

(a) that Question 64 does not cover all aspects of the problems arising in the standardization of colour television;

(b) that, in Europe at least, the situation in bands I and III differs from that in bands IV and V, and that, in deciding on colour systems for bands I and III, individual Administrations may find it convenient to use systems compatible with their monochrome systems already working in these bands;

(c) that, as bands IV and V have not yet been exploited in many countries, it is desirable and theoretically possible for these countries to achieve a common standard for these bands;

(d) that, in choosing a colour system for bands IV and V, Administrations may well be influenced by any colour systems which they may have adopted for bands I and III, and that this possibility complicates the choice of common standards;

DECIDES that the following question should be studied:

what standards can be recommended for colour television for public broadcasting? Account should be taken of such points as:

— satisfactory picture (colour and monochrome) and sound quality;
— economical use of bandwidth;
— reliable receivers of reasonable cost;
— operation of studio, transmitting and relaying equipment;
— susceptibility to interference;
— compatibilities;**
— frequency planning;
— international exchange of programmes;
— scope for development;
— the differences between bands I and III, as compared with bands IV and V.

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* This Question replaces Question 64 and Study Programme 37.

** A compatible colour television system is one that produces acceptable monochrome versions of the colour pictures on existing monochrome receivers. A reverse compatible colour television system is one that produces acceptable monochrome pictures on colour receivers from existing monochrome transmissions: in either case, bandwidths of the colour and monochrome systems may be the same or different.

STUDY PROGRAMME 118A(XI) *

STANDARDS FOR VIDEO COLOUR TELEVISION SIGNALS **

The C.C.I.R. *(Approved at Brussels, 1955)*

DECIDES that the following studies should be carried out:

1. the preferred colorimetric parameters for representing the television picture;
2. the scanning standards that can be recommended, e.g. sequential (field, line, dot), simultaneous or mixed;
3. comparison of the various methods of coding and decoding the colour picture information;
4. the minimum acceptable bandwidths for the signal components, corresponding to these parameters.

STUDY PROGRAMME 118B(XI) ***

STANDARDS FOR RADIATED COLOUR TELEVISION SIGNALS

The C.C.I.R. *(Approved at Brussels, 1955)*

DECIDES that the following study should be carried out:

comparison of different colour television systems, in terms of the criteria listed in the text of Question 118 (XI). These comparisons should pay particular attention to colour television systems which are either in operation, or which are, or have been, the subject of experiment.

STUDY PROGRAMME 118C(XI) ****

CONSTITUTION OF A SYSTEM OF STEREOSCOPIC TELEVISION

The C.C.I.R., *(Approved at Moscow, 1958)*

CONSIDERING

(a) the possible future development of stereoscopic television broadcasting;

(b) the great utility this form of television may have;

DECIDES that the following studies should be carried out:

1. Stereoscopic monochrome television

1.1 investigation into the development of methods of providing stereoscopic television, not requiring the use of spectacles;

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* This Study Programme was previously designated " Study Programme 80 (XI) ".

** The answers to Question 153(XI), with studies and experience of colour television systems, should be taken into account.

*** This Study Programme was previously designated " Study Programme 81 (XI)."

**** This Study Programme was previously designated " Study Programme 117 (XI)."

1.2 study of the possibility of decreasing the bandwidth of stereoscopic television broadcasting, e.g., by transmitting one picture of the stereoscopic couple with the full standardized bandwidth and the other with a reduced bandwidth on a sub-carrier within the first frequency spectrum;

1.3 study of the influence of noise on stereoscopic television pictures and determination of the permissible signal-to-noise ratio;

1.4 investigation of the design of receivers with direct reproduction of stereoscopic pictures, e.g., by taking the structure of receiving-tube displays as a basis for the lay-out of the phosphorescent elements;

2. Stereoscopic colour television

2.1 the carrying out of tests, to assess the quality of colour reproduction with binocular mixing of its components, in respect of the stability of picture detail (" field-clash ");

2.2 study of the possibility of decreasing the frequency band for stereoscopic colour television, e.g., by transmitting the green field of the stereoscopic couple with the full standardized band, the red and blue fields being transmitted by means of a sub-carrier within the first frequency spectrum;

2.3 research into the design of receivers for the direct reproduction of stereoscopic colour television.

QUESTION 120(XI)

EXCHANGE OF TELEVISION PROGRAMMES

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING

(a) that it is desirable to exchange television programmes between countries;

(b) that a variety of television standards is in use;

DECIDES that the following question should be studied:

what methods can be used to enable television programmes to be exchanged between countries:

1. when the nominal field frequencies are the same, but the numbers of lines are different, or *vice versa ;*

2. when both the nominal field frequencies and the numbers of lines are different;

3. when the nominal field frequencies are the same and the numbers of lines are the same, but the synchronizing signals are different in form?

Note.—Programme exchanges between different monochrome systems, between different colour systems, and between monochrome and colour systems should be considered.

QUESTION 152(XI) *

ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

The C.C.I.R., (Geneva, 1951 — Warsaw, 1956)

CONSIDERING

(a) that appreciable discrepancies may exist between assessments by different experts 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 should be studied:

what standardized methods and means of test, independent of the television standards which may be employed, can be used to measure accurately, and whenever possible, objectively, the deterioration introduced into monochrome and colour pictures by television, taking into account the system, the equipment and the transmission processes?

STUDY PROGRAMME 152A(XI)

SUBJECTIVE ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that subjective methods of testing are frequently necessary, to assess the relative quality of television pictures and the effect of interference and other impairments upon them;

(b) that many different methods of subjective testing are possible;

(c) that the results of subjective tests depend on the conditions under which they are carried out;

(d) that the results of subjective tests can be interpreted in many ways;

(e) that it is highly desirable to standardize the methods of subjective testing and the interpretation of the results, so that true comparisons may be made between results obtained at different times;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. on the methods of subjective testing best suited to the assessment of the relative quality of television pictures and of the effects of interference and other impairments upon them, taking particular account of:

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* This Question replaces Question 65.

— the use of full-range opinion-rating methods and the scales to be used and, alternatively, the use of comparison methods of assessment;
— the selection of test pictures;
— the viewing conditions;
— the selection and number of observers;
— the instructions to observers before tests;

2. on the analysis and presentation of the results obtained.

QUESTION 153(XI) *

RESOLVING POWER AND DIFFERENTIAL SENSITIVITY OF THE HUMAN EYE

The C.C.I.R., (Geneva, 1951 — Warsaw, 1956)

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 accurate and sufficient data on the resolving power of the human eyes are available for still pictures, but insufficient data are available for the case of animated pictures;

(d) 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 should be studied:

1. what is the resolving power of the human eye, expressed in minutes of angle, for values of contrast, luminance, colour and distance, normally encountered when observing animated pictures;

2. what is the differential sensitivity of the human eye to:

— a change of luminance,
— a change of shade in the same colour,

for values of contrast, luminance, colour and distance, normally encountered when observing television pictures?

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* This Question replaces Question 68.

QUESTION 267(XI) *

RATIO OF THE WANTED-TO-UNWANTED SIGNAL IN TELEVISION

The C.C.I.R., (Approved at Brussels, 1955 - Geneva, 1963)

CONSIDERING

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;

UNANIMOUSLY DECIDES that the following question should be studied:

1. determination of the protection ratio**, when two television transmitters are operating:
- in the same channel,
- in adjacent channels,
- with dissimilar but partially overlapping bandwidths;

2. determination of the protection ratios *** against services, other than television, in the shared bands.

Note. — The reply to the Question should give the protection ratios required when the transmitters are radiating monochrome signals, or colour signals, and when the one is radiating a monochrome and the other a colour signal; and it should take into account all the different signal standards that may be used and should also indicate percentage of time during which protection is desired. Separate answers may be required for various grades of service.

STUDY PROGRAMME 267A(XI) ****

RATIO OF THE WANTED-TO-UNWANTED SIGNAL IN TELEVISION

Use of the offset method, when there are great differences between the carrier-frequencies of the interfering stations

The C.C.I.R., (Los Angeles, 1959 — Geneva, 1963)

CONSIDERING

(a) that, when there is partial overlapping of the channels occupied by a wanted and an unwanted signal, offset operation makes it possible to reduce the protection ratios for monochrome television ***** and thus facilitate the planning of television networks over territories where different television standards are used;

(b) that a similar advantage may possibly be obtained for colour television;

UNANIMOUSLY DECIDES that the following study should be carried out:

an investigation of the extent to which offset working can be used in colour television, when there are large differences between the carrier frequencies of the wanted and unwanted signals.******

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* This Question replaces Question 119.

** See Recommendation 418 for monochrome television and Report 306 for colour television.

*** See Report 307 for protection against radionavigation transmitters.

**** This Study Programme replaces Study Programme 166.

***** See Recommendation 418.

****** See Report 306 for information on protection ratios for colour television, when the carrier frequency differences between wanted and unwanted signals are small.

STUDY PROGRAMME 36(XI) *

CONVERSION OF A TELEVISION SIGNAL FROM ONE STANDARD TO ANOTHER

The C.C.I.R., (Geneva, 1951)

UNANIMOUSLY DECIDES that the following studies should 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 the field frequency and the number of lines are different in the two standards.

STUDY PROGRAMME 110(XI) *

DISTORTION OF TELEVISION SIGNALS DUE TO THE USE OF VESTIGIAL-SIDEBAND TRANSMISSION

The C.C.I.R., (Warsaw, 1956)

CONSIDERING

(a) that vestigial-sideband transmission of television signals is accepted practice in broadcasting;

(b) that this method of transmission results in overall distortion, which is a combination of:

— quadrature distortion inherent in the method,

— distortion caused by non-uniformity of group-delay in transmitter circuits,

— distortion caused by non-uniformity of group-delay in receiver circuits;

(c) that the importance of the individual contributions listed in *(b)*, in respect of the overall degradation of the received picture, has not been established;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the quantitative assessment of the respective distortions introduced in a television system using vestigial-sideband transmission, due to:

   — quadrature error,

   — group-delay error at the transmitter,

   — group-delay error at the receiver;

2. suitable methods to be adopted for measuring and correcting such distortions;

3. the extent to which such corrections should be introduced at the transmitter.

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* This Study Programme does not arise from any Question at present under study.

STUDY PROGRAMME 119(XI) *

REDUCTION OF THE CHANNEL CAPACITY REQUIRED FOR A TELEVISION SIGNAL

The C.C.I.R., *(Approved at Moscow, 1958)*

CONSIDERING

(a) that the large channel capacity required for the transmission of television signals introduces problems which are both technical and economic;

(b) that the need for large channel capacity limits severely the maximum distance over which television signals can be transmitted by radio;

(c) that all present-day methods of transmitting and receiving television signals are wasteful, in that they require a channel capacity greatly exceeding that which is necessary to transmit the essential information contained in a television picture and which can be recognized by the human eye;

DECIDES that the following studies should be carried out:

1. the methods which can be used to reduce the required channel capacity for a television signal without reducing perceptibly the quality of the reproduced picture;
2. the way in which removal of redundancy (signal compression) can best be exploited to reduce the bandwidth required for transmission;
3. the possibility of transmitting a signal from point to point, by converting it into another (intermediate) signal which has been processed to have a bandwidth smaller than that of the original signal in keeping with a reduction of channel capacity;
4. the best method of exploiting signal compression to increase the range over which television signals can be transmitted, taking into account that, for a fixed rate of information, it is in general possible to exchange bandwidth and signal-to-noise ratio;
5. the ways in which knowledge of the characteristics of the human eye can be used, to reduce to a minimum the amount of information which it is required to transmit to reproduce a satisfactory television picture.

STUDY PROGRAMME 177(XI) **

INSERTION OF SPECIAL SIGNALS IN THE FIELD-BLANKING INTERVAL OF A TELEVISION SIGNAL

The C.C.I.R., *(Adopted by correspondence, 1962)*

CONSIDERING

(a) that it is already current practice in a number of countries to insert special signals in the field-blanking interval of a television signal;

* This Study Programme, which replaces Study Programme 35, does not arise from any Question at present under study.

** This Study Programme does not arise from any Question at present under study.

(b) that such signals can be used for checking the performance of the circuits over which the television signal is transmitted;

(c) that such signals might be used for supervision or various control purposes;

DECIDES that the following studies should be carried out:

1. can special signals be inserted in, and removed from, the field-blanking interval of the television signal, without detriment to the quality of the television picture itself;

2. for what purposes should such signals be used internationally;

3. at which points in the international television connection should these signals be inserted and, possibly, be removed again;

4. what provisions must be made to avoid confusion between signals for national and international use;

5. what forms of special signal can be recommended for international use;

6. at which point in the field-blanking interval should such signals be inserted?

LIST OF DOCUMENTS OF THE Xth PLENARY ASSEMBLY CONCERNING STUDY GROUP XI

Doc.	Origin	Title	Reference	Other Study Groups concerned
11	Chairman, Study Group XI	Report by the Chairman, Study Group XI (Mr. E. Esping)	—	—
19	Belgium	Protection for television in the shared bands—Protection against radionavigation transmitters operating in the band 582 to 606 kc/s	Draft Rep.	—
57	France	Use of identification signals in test-lines	S.P. 177	—
58	France	Exchange of television programmes—Characteristics of an international 625-line video frequency signal	Q. 120 Rep. 124	—
129	C.C.I.R. Secretariat	Bibliographic references in the volumes of the C.C.I.R.	—	I-XIV
170	U.S.S.R.	Transmission of two independent television programmes on a common channel without increase in bandwidth	S.P. 119	—
180	Japan	Waveforms of special signals and their points of insertion in the field-blanking interval of a television signal	S.P. 177	—
181	Japan	Colour television system with separately generated luminance signal	S.P. 80	—
211	I.B.T.O.	Draft I.B.T.O. Recommendation 3-III —Basic parameters of test-line signals for international programme exchange	S.P. 177	—
212	I.B.T.O.	Selection of axes for the two components of colour signal	Q. 118	—
213	I.B.T.O.	Experimental establishment of tolerances for level dependent phase	Q. 128	—
214	I.B.T.O.	Experimental establishment of admissible phase tolerances for colour signals	Q. 118	—
217	Japan	Annex 11/9 to Doc. 11	—	—
230	I.B.T.O.	To the Chairman of Study Group XI of the C.C.I.R.	Rep. 124	—
241	P. R. of Poland	Typical monochrome television receivers	Circ. AC/65	II
254	I.B.T.O.	Automatic remote monitoring of fundamental qualitative indices of television chains	Draft Q.	CMTT
255	I.B.T.O.	Automatic remote monitoring of fundamental qualitative indices of television chains	Draft S.P.	—

Doc.	Origin	Title	Reference	Other Study Groups concerned
256	I.B.T.O.	Method of automatic remote monitoring and measurement of television chains	Draft Q.	CMTT
266	E.B.U.	The present position of standards conversion	Q. 120 S.P. 36	—
267	E.B.U.	Insertion of special signals in the field-blanking interval of a television signal	S.P. 177	—
276	United States of America	United States practice in the use of test and reference signals in the vertical blanking interval	S.P. 177	—
327	Study Group XI	Summary record of the first meeting	—	—
537	Sub-Group XI-A	Insertion of special signals in the field-blanking interval of a 625-line television signal—Draft Recommendation	Q. 121 S.P. 177	—
538	Sub-Group XI-A	Insertion of special signals in the field-blanking interval of a television signal —Draft Report	S.P. 177	—
539	Sub-Group XI-A	Choice of standards for colour television in the European area—Draft Report	Q. 118 S.P. 80 & 81	—
540	Sub-Group XI-A	Video characteristics of a 625-line monochrome television system proposed for the international exchange of programmes—Draft Report	Q. 120	—
554	Sub-Group XI-A	The present position of standards conversion—Draft Report	Q. 120 S.P. 36	—
555	Sub-Group XI-A	Reduction of the channel capacity required for a television signal	S.P. 119	—
558	Sub-Group XI-A	Amendments to Doc. 11/9	—	—
573	Sub-Group XI-A	Final report	—	—
608	Study Group XI	Amendments to Docs. 213 and 214	—	—
616	Study Group XI	Summary record of the second and last meeting	—	—
2236	Drafting Committee	Automatic remote monitoring of fundamental qualitative parameters of television chains	S.P. 121A (CMTT)	CMTT
2237	„ „	Requirements for the transmission of colour television signals over long distances	Rep. 316	CMTT
2249	„ „	Automatic remote monitoring of fundamental qualitative parameters of television chains	S.P. 121A (CMTT)	CMTT
2321	„ „	Minimum field strengths for which protection may be sought in planning a television service	Rec. 417	—

Doc.	Origin	Title	Reference	Other Study Groups concerned
2322	Drafting Committee	Ratio of the wanted to the unwanted signal in monochrome television	Rec. 418	—
2323	„ „	Directivity of antennae in the reception of broadcast sound and television	Rec. 419	—
2324	„ „	Ratio of the wanted to the unwanted signal in television	Q. 267	—
2325	„ „	Ratio of the wanted to the unwanted signal in television	S.P. 267 A	—
2326	„ „	Subjective assessment of the quality of television pictures	S.P. 152 A	—
2327	„ „	Ratio of the wanted-to-unwanted signal for colour television in bands IV and V	Rep. 306	—
2328	„ „	Protection ratios for television in the shared bands	Rep. 307	—
2329	„ „	Characteristics of monochrome television systems	Rep. 308	—
2330	„ „	Constitution of a system of stereoscopic television	Rep. 312	—
2331	„ „	Assessment of the quality of television pictures	Rep. 313	—
2332	„ „	Insertion of special signals in the field-blanking interval of a 625-line television signal	Rec. 420	—
2333	„ „	Insertion of special signals in the field-blanking interval of a television signal	Rep. 314	—
2334	„ „	Choice of standards for colour television in the European area	Rep. 309	—
2335	„ „	Video characteristics of a 625-line monochrome television system proposed for the international exchange of programmes	Rep. 310	—
2336	„ „	The present position of standards conversion	Rep. 311	—
2337	„ „	Reduction of the channel capacity required for a television signal	Rep. 315	—

QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO STUDY GROUP XII (TROPICAL BROADCASTING); OPINIONS AND RESOLUTIONS OF INTEREST TO THIS STUDY GROUP

STUDY GROUP XII

(Tropical broadcasting)

Terms of reference

To study standards required for good quality service in the tropical zone, and for tropical broadcasting systems; interference in the shared bands; power requirements for acceptable service; design of suitable antennae for short-distance tropical broadcasting; optimum conditions for the utilization of frequency bands used for broadcasting in the tropical zone; other associated questions.

Chairman : Mr. N. V. GADADHAR (India).
Vice-Chairman : ——*

INTRODUCTION BY THE CHAIRMAN, STUDY GROUP XII

1. The C.C.I.R., in recognition of the problems of broadcasting peculiar to the tropics, established Study Group XII at its Vth Plenary Assembly, Stockholm, 1948, to deal with problems connected with the planning of tropical broadcasting services. The main differences in propagation in the tropical regions as compared with temperate regions, makes it necessary to lay down special standards for the planning of tropical broadcasting systems to ensure their satisfactory operation. The studies undertaken by this Group are therefore directed towards determination of these standards.

Apart from scientific considerations, it also happens that most of the new and developing countries are situated in the tropical regions. These countries suffer from the lack of an adequate number of broadcast receivers, making radio out of the reach of the average citizen. A UNESCO survey revealed that about 400 million cheap radio sets would be necessary to ensure that every family in the new and developing countries possess a radio receiver. Study Group XII was assigned the problem of drawing up performance specifications for cheap radio receivers to assist manufacturers in the production of suitable receivers, having an agreed standard of performance at the lowest possible cost.

2. Brief survey of studies

The problems dealt with by Study Group XII may be broadly classified under the following headings:

2.1 *Assessment of field-strengths produced by tropical broadcasting transmitters*

This study arises from Question 154 (XII). The assessment of field strengths is particularly useful in the planning of new tropical broadcasting services and the allocation of frequencies to services in the tropical zone. The present state of knowledge in this work is given in Report 305. Based on the comparison of the measured values, with calculated values obtained by the C.R.P.L., S.P.I.M., RPU9, D.S.I.R. and the A.I.R. methods, the document concludes that the values calculated by the A.I.R. and D.S.I.R. methods are in close agreement with the measured values of the field strength.

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* The resignation of Mr. Ramchandani, subsequent to the closure of the Xth Plenary Assembly, and the consequent advancement of Mr. Gadadhar to the Chairmanship, leave the position of Vice-Chairman, Study Group XII vacant. This post will be filled by election at the next meeting of Study Group XII.

2.2 *Interference in the bands shared with tropical broadcasting and assessment of minimum protection ratios against A1, A2 and A3 emissions*

Studies are in progress under Question 102(XII) and Study Programmes 102B(XII) and 102C(XII). The studies aim at the determination of the minimum permissible protection ratio for broadcasting services from other emissions. The work done so far is given in Report 302. This Report gives the protection ratios required to provide acceptable service of tropical broadcasting in the presence of A1, A2 and A3 emissions, with carrier-frequency separation up to 10 kc/s. Apart from this, Recommendation 48 (Choice of frequency), Recommendation 49 (Choice of site and antenna), Recommendation 214 (Limitation of transmitter power in the tropical zone) and Recommendation 216 (Minimum permissible protection ratio), are very important guides to avoid interference in the bands shared with tropical broadcasting in the planning of tropical broadcasting systems.

2.3 *Design of transmitting and receiving antennae for tropical broadcasting*

Recommendation 139 indicates some basic points for the design of antenna systems for tropical broadcasting. The same Recommendation requests Administrations and organizations, to forward to the C.C.I.R., reports on the operation of such antennae for compilation of practical operational data concerning them. Recommendation 140 recommends for broadcast reception, an " L " type antenna with horizontal and vertical limbs, each 4·8 m long. Further, Report 301 gives some typical designs of antennae and their electrical characteristics. Studies for improved designs are continuing under Question 156 (XII).

2.4 *Assessment of fading allowances for tropical broadcasting*

The results of studies under Question 157 (XII) are outlined in Report 304. The signal degradation caused by equatorial flutter appears to be a very serious factor in the tropical regions.

2.5 *Determination of noise level for tropical broadcasting*

Studies arising from Question 155(XII) have resulted in the adoption of Report 303. The Report gives the minimum signal required for satisfactory listening, during the various seasons and at different times of the day for some locations in India. Further, the Report also briefly describes the Objective Method of Measurement of Atmospheric Radio Noise, using the Automatic Radio Noise Recorder (Type ARN-2) developed by the CRPL, U.S.A. Data are being collected with such recorders by several Administrations at latitudes in the various regions of the world. Based on the data collected in the last few years, Report 322 on world-wide noise data is being revised. It has been suggested, however, that the data contained in the revised Report should be used with some caution in predicting noise conditions in tropical countries. Further, for continuation of this study, the Xth Plenary Assembly adopted Question 268 (XII).

2.6 *Specifications of low-cost sound broadcasting receivers*

Recommendations 415 and 416 give the performance specifications for low-cost sound broadcasting receivers and low-cost sound broadcasting receivers for community listening. The specifications for low-cost sound broadcasting receivers are given for 3 types—Type A, Type B and Type C. The Type A receiver is a low sensitivity MF receiver, Type B receiver is a medium sensitivity receiver, covering both the MF and HF ranges and the Type C receiver is a VHF receiver for operation in band 8.

The community-listening receiver provides, perhaps, the cheapest means of making broadcasting available to a group of people, such as those that could be found in a typical village. It is normal to operate this receiver at a central place in a village to provide listening facilities for a group of persons. The receivers are provided for both battery operation and mains power operation, with the ability to select one out of a few (say three) programmes.

QUESTION 102(XII) *

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING **

The C.C.I.R., (Stockholm, 1948 — Geneva, 1951 — London, 1953 — Geneva, 1963)

CONSIDERING

Recommendation No. 3 of the Administrative Radio Conference, Geneva, 1959, and the studies pursued at the Plenary Assemblies of the C.C.I.R.;

DECIDES that the following question should be studied:

what is the minimum permissible protection ratio for broadcasting signals, when measured at the output of a receiver fitted with a filter having an audio-frequency cut-off of 5 kc/s and to what minimum value of the wanted field should this ratio be maintained? ***

ANNEX

1. The permissible frequency tolerances for broadcasting stations would permit variations in frequency of broadcasting stations up to about 250 c/s until 1953 and up to about 150 c/s after that date. The corresponding tolerances for fixed stations would allow maximum frequency changes of about 500 c/s and 150/s respectively. The tolerances permitted to mobile stations would be initially about 2500 c/s and later about 1000 c/s. These tolerances are very large in relation to the possible spacing between broadcast carrier-frequencies in the shared bands and, for a consideration of the problem, it is therefore necessary to assume a frequency spacing between such broadcast carriers.

2. If it is assumed that the stations of other services will be located only on frequencies centrally located between the broadcast carriers, and if it is further assumed that the broadcast carrier frequencies will be separated by not more than 10 kc/s, then the maximum frequency spacing between a fixed or mobile station and a broadcasting station would be 5 kc/s. From this consideration it will be seen that the permissible tolerances represent a very large proportion of the spectrum space between a broadcasting carrier and a sharing service carrier and that the possible heterodyne frequency will be such that a receiver giving adequate broadcasting reception would not eliminate it. At the present time, great increases in the stability of mobile transmitters would seem very difficult and it is therefore suggested that a case exists for recommending to Administrations in tropical zones that the minimum number of mobile stations should be assigned in the shared bands. For fixed stations it would seem that, since by 1953 fixed stations in these bands will have to maintain the same frequency tolerances as broadcasting stations, as specified in App. 3 to the Radio Regulations, Geneva, 1959, it would be advisable to request Administrations to expedite improvement in the frequency stability of fixed stations in bands shared with broadcasting and that the minimum number of fixed stations in tropical zones might be assigned in these shared bands, unless they do meet the requirements laid down for frequency tolerance for broadcasting stations.

3. If it is not possible to eliminate mobile stations entirely from the shared bands in the tropical zones, then it might be recommended that every effort should be made to eliminate the use

* This Question replaces Question 4.

** The reasons justifiying this Question will be found in the Annex.

*** Practical consideration of the frequency separation of adjacent channels requires the use of an audio-frequency cut-off of 5 kc/s in the measurement, in preference to 6·4 kc/s, appropriate corrections being applied, if considered necessary, to correspond to an audio-frequency cut-off of 6·4 kc/s.

of mobile stations using A3 type of transmission in these bands. As, in other services, fully adequate telephony quality is maintained with a reduced audio-frequency bandwidth, it might be recommended that the audio bandwidth transmitted by mobile stations, when operating in the tropical zones, should be limited to 3000 c/s.

4. In Doc. 110 of Stockholm, 1948, it is recommended that power limitations should be placed on broadcasting stations operating in these bands. It is generally admitted that the field-strength required for an adequate telegraph service is of the order of 10% of the field-strength required for an adequate signal on a broadcasting service. There would seem, therefore, to be a logical case to put a restriction on the power to be used by other services in the shared bands. All voice transmission in this band might possibly be carried out on power limits not exceeding those laid down for broadcasting stations in Doc. 110.

5. A recommendation might be made in accordance with No. 695 of the Radio Regulations, Geneva, 1959, that the use of directional antennae should be followed in all possible cases to reduce mutual interference between services.

6. As is pointed out in Doc. 21 of Stockholm, 1948, page 5, the permissible interference level for ordinary telephony with noise reducers is + 32 db and for ordinary telephony without noise reducers is + 42 db. For broadcasting use, higher signal-to-noise ratios are suggested. It is felt, however, that it would be a matter of considerable difficulty under tropical conditions to obtain a signal-to-noise ratio greater than 40 db with respect to the local noise. Such a level has been taken as a reasonable maximum in Doc. 110. It is considered, therefore, that it is not justifiable to specify limits of interference more stringent than that imposed by a protection ratio of 40 db between the wanted signal and the interference. It might be suggested, therefore, that an undesired signal should be defined as causing interference to a broadcasting service, only when its effective level in the output of an ordinary receiver, having an audio passband of 6·4 kc/s, is less than 40 db below the desired signal level within the defined service area of the broadcasting station.

7. To minimize the effect of interference, a recommendation might be made that spurious radiation, key-clicks, sideband spread and other forms of interference-producing radiation, should be kept to a minimum in all transmitters used in tropical zones on the shared bands.

8. While it is considered that, under normal conditions, a modulation band of 6400 c/s is desirable in the interests of quality, it is recognized that, in the tropical zones, the levels of atmospheric noise in the tropical broadcasting bands and the possibilities of interference due to the difficulty of accommodating all stations in these bands are such that a modulation band of 5000 c/s may have to be accepted.

STUDY PROGRAMME 102A(XII) *

SHORT-DISTANCE HIGH-FREQUENCY BROADCASTING IN THE TROPICAL ZONE (TROPICAL BROADCASTING) **

(Question 27 — Recommendation 215)

The C.C.I.R., (Geneva, 1951 — Warsaw, 1956 — Geneva, 1963)

CONSIDERING

(a) that little data exist on the determination of the power required for a given grade of tropical broadcasting service;

* This Study Programme was previously designated " Study Programme 112(XII)."

** This service is defined in the " considerings " of Question 27 reproduced in the Annex.

(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. 7, No. 425 of the Radio Regulations, Geneva, 1959);

UNANIMOUSLY DECIDES that the following studies should 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 antennae 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 215 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 antennae;

   — the characteristics of the receiver used.

   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;

   — methods of analysis;

   — location of the transmitter;

   — distance from the transmitter at which measurements are made;

   — radiated carrier power;

   — polar diagram of the transmitting antenna (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.

ANNEX

Considerings of Question 27 (Maximum power for short-distance high-frequency broadcasting in the tropical zones):

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 ;*

. . . .

STUDY PROGRAMME 102B(XII) *

INTERFERENCE IN THE FREQUENCY BANDS USED FOR TROPICAL BROADCASTING

The C.C.I.R., (Warsaw, 1956)

CONSIDERING

(a) that the limited data available on the measured field-strength of tropical broadcasting transmitters operating in the bands 2300 kc/s to 5060 kc/s, and in the high-frequency broadcasting bands above 5060 kc/s normally used for tropical broadcasting, are insufficient to arrive at the minimum signal to be protected, as required in Question 102(XII);

(b) that the method of propagation affecting the field-strength values is not clearly known;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. extensive field-strength data should be collected on tropical broadcast transmissions in the bands 2300 kc/s to 5060 kc/s and in the high-frequency broadcasting bands above 5060 kc/s
   — about 50 km;
   — 200 to 300 km;
   — 400 to 600 km;
   — 800 to 1200 km and, if possible, at appreciably greater distances from the transmitters;
2. measurements as in § 1 above shall be carried out simultaneously with experimental observation of signal-to-noise ratios.

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* This Study Programme was previously designated " Study Programme 114 (XII)."

STUDY PROGRAMME 102C(XII) *

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

(Recommendation 216)

The C.C.I.R., (London, 1953 — Warsaw, 1956 — Los Angeles, 1959)

CONSIDERING

(a) that Recommendation 216 does not provide a final answer to § 6, Question 102(XII) and recommends a further study, to determine finally a value for the minimum permissible protection ratio for broadcasting services operating in the tropical zone in the shared bands;

(b) that sufficient new data are not yet available to answer § 6, Question 102(XII);

UNANIMOUSLY DECIDES that the following study should be carried out:

1. experimental determination of the minimum protection ratio to be provided for a broadcasting station, operating in the shared bands in the tropical zone, against interference from telegraphy (A1 and A2) and telephony (A3) emissions when:

— the interference is caused by one of these three types of emission;

— the interference is caused by two or more types of emission at the same time;

1.1 this study should be carried out taking into account transmitter frequency variations (up to and including those equal to the sum of the permissible frequency tolerances), of the tropical broadcasting services and other services sharing the bands as laid down in the current Radio Regulations;

1.2 measurements should be carried out at the output of a receiver fitted with a simple filter ** having an audio-frequency cut-off of 5 kc/s;

1.3 measurements should also be carried out for cut-off frequencies of 6, 7, 8 and 9 kc/s;

1.4 measurements should be carried out for carrier frequencies separated by 0, 1, 2, ... 10 kc/s;

1.5 the results should be expressed in terms of percentage of listener satisfaction, as well as of percentage of time during which the satisfaction is achieved;

2. experimental determination of the minimum field-strength to which a protection ratio, as defined in § 1 above, should relate (taking into account the nature, intensity and distribution of noise levels in different parts of the tropical zone).

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* This Study Programme was previously designated " Study Programme 167 (XII)."

** The characteristics of the filter employed should be given.

QUESTION 154(XII) *

BEST METHOD FOR CALCULATING THE FIELD-STRENGTH PRODUCED BY A TROPICAL BROADCASTING TRANSMITTER **

(Question 27)

The C.C.I.R., (Geneva, 1951 — Warsaw, 1956 — Geneva, 1963)

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 broadcasting services and the allotment of frequencies to services in the tropical zone;

(c) that little basic data exist concerning ionospheric absorption for the tropical zone, and its dependence upon the time of day, the season and the sunspot cycle;

(d) that the relation between ionospheric absorption at oblique incidence and 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 should 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 4,000 km, by a transmitter situated in the " tropical zone " (as defined in App. 24 of the Radio Regulations, Geneva, 1959), radiating a power of 1 kW from a half-wavelength dipole situated $\frac{1}{4}$ and $^{7}/_{16}$ 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. 7, No. 425, and the general broadcasting bands below 15 450 kc/s, listed in the Table of Frequency Allocations, Art. 5, Radio Regulations, Geneva, 1959), at any season, and for sunspot numbers of about 5, 60 and 125, respectively, during normal listening hours (approximately 0600 to 2400 local time);

2. what is the probable error in the proposed method of calculation;

3. what basic data should be used in the proposed method of calculation;

4. what is the probable statistical distribution of the fading of the signal?

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* This Question replaces Question 69. (See Report 305.)

** As this service is defined in the considerings of Question 27 reproduced in the Annex to Study Programme 102A (XII), page 238.

QUESTION 156(XII) *

DESIGN OF TRANSMITTING ANTENNAE FOR TROPICAL BROADCASTING

The C.C.I.R., (Geneva, 1951 — London, 1953 — Warsaw, 1956)

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 antennae 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 antennae for transmission would permit the use of transmitters of lower power;

(d) the importance of reducing interference to a minimum between services which share frequency bands, as provided by Nos. 425 and 426 of the Radio Regulations, Geneva, 1959;

(e) the provisions of No. 695 of the Radio Regulations, Geneva, 1959;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what factors determine the best position of the transmitting antennae, with respect to the area to be served, to concentrate the energy received by reflection from the ionosphere within the desired service area and to reduce to a minimum 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 antennae for tropical broadcasting, to concentrate the energy received by reflection from the ionosphere within the desired service area and to reduce to a minimum the energy received outside the broadcast service area; in particular, what steps can be taken to reduce low-angle radiation to a minimum?

QUESTION 157(XII)

FADING ALLOWANCES FOR TROPICAL BROADCASTING

The C.C.I.R., (Warsaw, 1956)

CONSIDERING

(a) that Recommendation 164 and Study Programme 3A(III), treat the allowances for protection of fading signals for broadcasting in general only;

(b) that tropical broadcasting has special characteristics which are different from those of high-frequency broadcasting for long distances;

(c) that the nature, type and intensity of fading of broadcasting emissions under tropical conditions of propagation are peculiar and require further study;

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* This Question replaces Question 103. See also Report 301.

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the different types and characteristics of fading encountered in tropical zones;
2. what is the annoyance value to reception from the point of view of listener satisfaction;
3. what allowances should be provided for planning tropical broadcasting services?

QUESTION 268(XII) *

DETERMINATION OF THE EFFECTS OF ATMOSPHERIC NOISE ON THE GRADE OF RECEPTION IN THE TROPICAL ZONE

(Geneva, 1951 — Warsaw, 1956 — Geneva, 1963)

The C.C.I.R.,

CONSIDERING

that the determination of the transmitter power required depends in part upon the value of the signal-to-atmospheric noise ratio, regarded as being the minimum for an acceptable broadcasting service in the tropical zone,

UNANIMOUSLY DECIDES that the following question should be studied:

1. what characteristics of atmospheric noise are important in determining the response of a typical broadcast receiver and to what extent do they affect the grade of reception;
2. what average value of signal-to-atmospheric noise ratio is required to ensure satisfactory reception for at least 90% of the total time?

STUDY PROGRAMME 170(XII) **

SPECIFICATIONS FOR LOW-COST SOUND BROADCASTING RECEIVERS

(Recommendation No. 7 of the Administrative Radio Conference, Geneva, 1959)

The Administrative Radio Conference, Geneva, 1959,

CONSIDERING

(a) that the advantages of broadcasting should be made more easily available to the populations of the countries where at present the density of receivers is particularly low due to economic, geographic or technical reasons;

(b) that to this end, it is desirable that efficient broadcasting receivers should be available at prices low enough to secure their wide distribution in these countries;

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* This Question replaces Question 155.

** This Study Programme, which does not arise from any Question under study, also concerns Study Group II, the Chairman of which should be kept informed of the results obtained by Study Group XII as they become available.

(c) that general agreement on the performance of suitable broadcasting receivers would prove most useful to radio receiver manufacturers, by assisting them to produce suitable receivers having an agreed adequate standard performance at the lowest possible cost;

INVITES THE C.C.I.R.

1. to draw up performance specifications for one or more types of sound broadcasting receivers, suitable for production in large quantities at the lowest possible cost, the receivers to meet the requirements of listeners in the countries mentioned in § *(a)* above. These specifications should cover receivers for amplitude-modulated transmissions in the low, medium, and/or high-frequency bands (bands 5, 6 and/or 7), as well as those for frequency-modulated transmissions in the VHF band (band 8), according to the needs of the countries;

2. to avoid duplication of effort, and to complete the work in as short a time as possible, collaboration should be maintained with other international bodies working in this field;

AND REQUESTS THE SECRETARY-GENERAL

to communicate the result of this study, together with suggestions as to the action to be taken, to the Director-General of UNESCO.

LIST OF DOCUMENTS OF THE Xth PLENARY ASSEMBLY CONCERNING STUDY GROUP XII

Doc.	Origin	Title	Reference	Other Study Groups concerned
12	Chairman, Study Group XII	Report by the Chairman, Study Group XII (Mr. A. C. Ramchandani) *	—	—
87	India	Determination of noise level for tropical broadcasting	Q. 155 Rep. 120	—
94	India	Determination of the protection required for a broadcast signal in the presence of interference	Q. 102 S.P. 167 Q. 202	X
97	India	Best method for calculating the field-strength produced by a tropical broadcasting transmitter—Draft Report	Q. 154 Rep. 128	—
98	India	Best method for calculating the field-strength produced by a tropical broadcasting transmitter	Q. 154 S.P. 144 (VI)	VI
127	India	Determination of noise level for tropical broadcasting—Draft Report	Q. 155 Rep. 120	—
129	C.C.I.R. Secretariat	Bibliographic references in the volumes of the C.C.I.R.	—	I-XIV
153	C.C.I.R. Secretariat	Refinement of I.F.R.B. technical standards	—	I, II, III, V, VI, X, XIII
162	India	Atmospheric radio noise over tropical land masses	S.P. 154 (VI) Res. 51 Q. 155	VI
171	Netherlands	Specifications for low-cost sound broadcasting receivers	S.P. 170	—
172	Netherlands	Specifications for low-cost broadcasting receivers for community listening	S.P. 170	—
191	C.C.I.R. Secretariat	High-frequency directional antennae—Replies to C.C.I.R. Circular AC/55	Circ. AC/55	III, X
236	India	Measurement of atmospheric radio noise	Rec. 315 S.P. 154 (VI) Q. 155	VI
237	India	Information regarding high-frequency directional antennae used by radiocommunication services in India	Circ. AC/55	III, X
279	India	Comments on Annex 12/1 and Annex 12/2	S.P. 170	—
328	Sub-Group XII-A	Draft amendment — Report 127 — Interference in the bands shared with broadcasting	Q. 102 S.P. 167	—
335	Sub-Group XII-A	Interference in the bands shared with broadcasting	Rep. 127	—

* Mr. Ramchandani was Chairman, Study Group XII, at the time of the Xth Plenary Assembly, but subsequently resigned, his place being taken by Mr. N. Gadadhar.

Doc.	Origin	Title	Reference	Other Study Groups concerned
357	Study Group XII	Summary record of the first meeting	—	—
372	Study Group XII	Performance specifications for low-cost sound broadcasting receivers	Draft Rec.	—
408	Study Group XII	Summary record of the second meeting	—	—
422	Study Group XII	Performance specifications for low-cost sound broadcasting receivers for community listening	Draft Rec.	—
505	Study Group XII	Summary record of the third meeting	—	—
591	Study Group XII	Summary record of the fourth and last meeting	—	—
2116	Drafting Committee	Determination of the effects of atmospheric noise on the grade of reception in the tropical zone	Q. 268	—
2117	„ „	Interference in the bands shared with broadcasting	Rep. 302	—
2118	„ „	Best method for calculating the field-strength produced by a tropical broadcasting transmitter	Rep. 305	—
2119	„ „	Design of transmitting antennae for tropical broadcasting	Rep. 301	—
2120	„ „	Fading allowances for tropical broadcasting	Rep. 304	—
2234	„ „	Performance specifications for low-cost sound broadcasting receivers	Rec. 415	—
2235	„ „	Performance specifications for low-cost sound broadcasting receivers for community listening	Rec. 416	—
2259	„ „	Interference in the bands shared with broadcasting	Rep. 302	—
2260	„ „	Determination of noise level for tropical broadcasting	Rep. 303	—

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QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO THE C.M.T.T. (C.C.I.R./C.C.I.T.T. JOINT STUDY GROUP FOR TELEVISION TRANSMISSIONS); OPINIONS AND RESOLUTIONS OF INTEREST TO THIS STUDY GROUP

C.M.T.T.

(C.C.I.R./C.C.I.T.T. Joint Study Group for Television Transmissions—Opinion 19)

Terms of reference

To study, in co-operation with the Study Groups of the C.C.I.R. and the C.C.I.T.T., the specifications to be satisfied by telecommunication systems for the transmission of monochrome and colour television signals over long distances.

Chairman : Professor Y. ANGEL (France)
Vice-Chairman : Mr. R. H. FRANKLIN (United Kingdom)

INTRODUCTION BY THE CHAIRMAN OF THE C.M.T.T.

1. General

To facilitate the settlement of Question 121 drawn up by Study Group XI in Brussels, 1955, the VIIIth Plenary Assembly, Warsaw, 1956, issued Resolution 32 whereby a *Joint C.C.I.R./C.C.I.T.T. Study Group for television transmission (C.M.T.T.)* was set up.

The C.M.T.T. is administered by the C.C.I.R. and works in conformity with the system adopted for the Study Groups of that organ.

Its original terms of reference were briefly:

1.1 To examine the possibility of transforming C.C.I.R. Report 84 (Warsaw, 1956) into a Recommendation of the two C.C.I.'s proposing transmission standards for the various monochrome television systems on the hypothetical reference circuit of 2500 km recommended by the C.C.I.T.T.

1.2 To study the establishment of similar standards for colour television transmissions.

As a result of new Questions referred to it by participating Administrations and by other Study Groups, the field of activity of the C.M.T.T. is now somewhat wider than that prescribed by the original terms of reference.

The stage reached with the texts and the work at the end of the Xth Plenary Assembly of the C.C.I.R.R. is described below. The documents referred to are classified according to the subject dealt with.

2. Transmission standards for 2500 km

2.1 *Question 121* (C.M.T.T.) and *Opinion 19* (Basic texts); *Recommendation 421 :* this recommendation replaces C.C.I.R. Recommendation 267 and C.C.I.T.T. Recommendation J. 61.

Requirements for the transmission of monochrome television signals over long distances

Recommendation 421 replies to § 1.1 of the above Question concerning transmission over the hypothetical reference circuit of 2500 km with two intermediate video points; in addition, it indicates, in its Annex V, the characteristics of circuits, shorter or longer than the hypothetical reference circuit.

This text could most certainly be adapted to keep abreast of technical development and could be extended further; however, no serious amendments are envisaged.

2.2 *Report 316*

Requirements for the transmission of colour television signals over long distances

This Report must be regarded as far from final and further study is required for the clarification of several points. As a final stage, the C.M.T.T. would like to have a single Recommendation drawn up to cover transmissions of both colour and monochrome television.

2.3 *Question 166 (C.M.T.T.) Study Programme 166A (C.M.T.T.)*

Single value of the signal-to-noise ratio for different television systems

This Question and this Study Programme, originally formulated by Study Group XI, have been referred to the C.M.T.T. They relate to both monochrome and colour television. Partial replies are already to be found in Recommendation 421 and Report 316. Nevertheless, further studies should be made, particularly with regard to colour television.

2.4 *Study Programme 121A (C.M.T.T.)*

Automatic remote monitoring of fundamental qualitative parameters of television chains

A new question for joint study with Study Group XI.

3. Transmission over circuits longer than 2500 km

3.1 *Question 269 (C.M.T.T.)*

Definition of the hypothetical reference circuits for television

Application to real circuits longer than 2500 km

A new Question arising out of the difficulty of deducing the characteristics of a long circuit from those of short circuits. It should be noted that Annex V to Recommendation 421 already gives some information on the matter.

3.2 *Question 222 (C.M.T.T.)*

Standards of transmission quality for television circuits substantially longer than 2500 km

This Question, which emanates from Study Group XI, relates to the establishment of standards for the quality of transmission independent of the length of the circuit. It broaches, using a different approach, the problem raised by the earlier Question.

3.3 *Question 270 (C.M.T.T.)*

Time differences between the sound and vision components of a television signal

A new Question, stemming frcm the fact that transmission by means of satellite-relays over very long distances may lead to unusually long transmission times. It may be regarded as representing a specific aspect of the transmission standards dealt with in the earlier Question.

OPINION 19 *

TRANSMISSION OF MONOCHROME AND COLOUR TELEVISION OVER LONG DISTANCES

The C.C.I.R., (Warsaw, 1956 — Geneva, 1963)

CONSIDERING

(a) Resolution 32 (Warsaw, 1956);

(b) the evolution of the work of the C.M.T.T.;

IS UNANIMOUSLY OF THE OPINION

that the terms of reference of the C.M.T.T. should be:

To study, in cooperation with the Study Groups of the C.C.I.R. and C.C.I.T.T., the specifications to be satisfied by telecommunication systems for the transmission of monochrome and colour television signals over long distances.

QUESTION 121(C.M.T.T.)

TRANSMISSION OF MONOCHROME AND COLOUR TELEVISION SIGNALS OVER LONG DISTANCES

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING

(a) that all the information required by the C.C.I.R. and the C.C.I.T.T., relating to the requirements for the transmission of monochrome television signals over long distances, is not yet available;

(b) that it is necessary to study, without delay, the problems that may arise in the future, concerning the transmission of colour television signals, whatever form these signals may take;

(c) that the choice of a standard colour television system must certainly take into account the possibility of transmitting the signals over existing links, as well as the requirements that may be imposed on future circuits;

(d) that the adoption of a hypothetical reference circuit 2500 km long for the presentation of the results of studies, as proposed by the C.C.I.T.T. for cable circuits, is acceptable and useful;

DECIDES that the following question should be studied:

for the transmission of monochrome or colour television signals over a hypothetical reference circuit (2500 km):

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* This Opinion replaces Resolution 32.

1. what are the characteristics of the signal and of the circuit that must be considered, what are their recommended values and what tolerances must be imposed to ensure satisfactory transmission;
2. how do these characteristics and their values and tolerances differ as between the requirements for the transmission of monochrome signals and of colour signals;
3. what methods of measurement and what test signals can be recommended for checking the characteristics?

STUDY PROGRAMME 121A(C.M.T.T.)

AUTOMATIC REMOTE MONITORING OF THE FUNDAMENTAL QUALITATIVE PARAMETERS OF TELEVISION CHAINS

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that one method of automatic remote monitoring is based on the use of narrow-band pilot signals obtained, for example, by converting broadband information on the test-line signals into narrow-band information * (of the order of a few cycles per second);

(b) that with this method, a permanent record of the converted test signals can be obtained;

(c) that the application of this method is based on the transmission of information on the test signals over telephone circuits;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. methods of automatic remote monitoring and control of television signals, for example, using the conversion of broadband information on test-line signals into narrow-band information, for pilot signals;
2. the optimum conversion time of the test line;
3. the design of recording equipment for routine recording of the waveform and amplitude relationships of the test signals.

QUESTION 166(C.M.T.T.) **

SINGLE VALUE OF SIGNAL-TO-NOISE RATIO FOR DIFFERENT TELEVISION SYSTEMS

The C.C.I.R., *(Approved at Moscow, 1958)*

CONSIDERING

(a) that it is desirable to devise a method for the objective assessment of the signal-to-noise ratio valid for all television systems, with the object of recommending a single value for the

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* See Doc. 256 of Geneva, 1963.

** This Question replaces Question 117.

tolerable signal-to-random noise ratio in television and especially for the international exchange of programmes;

(b) that the relation between the peak value of the signal and the r.m.s. or quasi-peak noise does not necessarily indicate the visibility of the noise on the pictures received;

(c) that the method of assessing the signal-to-noise ratio, by means of a weighting network producing a mean objective curve of the weighting of the various frequency components, leads to a more objective assessment of the ratio;

DECIDES that the following question should be studied;

1. is it possible to recommend an objective mean curve for the weighting of the noise components as a function of frequency and also to recommend a weighting network to produce this curve giving a figure for the signal-to-noise ratio indicating the visibility of the noise on the pictures;
2. is there any other measurement method producing the same result that could be recommended;
3. is it possible, using the method or methods thus recommended, to adopt a single figure for the tolerable signal-to-random noise ratio in television, especially for the international exchange of programmes?

STUDY PROGRAMME 166A(C.M.T.T.) *

SINGLE VALUE OF THE SIGNAL-TO-NOISE RATIO FOR DIFFERENT TELEVISION SYSTEMS

The C.C.I.R., *(Approved at Moscow, 1958)*

CONSIDERING

(a) that a method of measuring the signal-to-noise ratio, capable of giving a figure showing the visibility of noise on the pictures received, has already been indicated and appears in the documents of the C.C.I.R., C.C.I.T.T. and C.M.T.T.;

(b) that this method implies the adoption of a weighting curve for the various noise components as a function of frequency;

(c) that this method also requires the adoption of a weighting network to transform noise in such a way that the measured signal-to-noise ratio shall give a valid indication of the visibility of the noise;

(d) that the various television systems, because of differing standards, have different requirements including different frequency bands;

DECIDES that the following studies should be carried out:

1. what should be the weighting curve for the various noise components as a function of frequency, if the measured value is to be representative of the visibility of noise on the pictures received;
2. what weighting network can be recommended to produce this weighting curve;
3. what should be the characteristics of the equipment ** associated with the weighting network in measuring the signal-to-noise ratio;
4. is it possible to obtain a single measuring apparatus by means of interchangeable subsidiary components, meeting the different requirements of the various television systems;

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* This Study Programme was previously designated " Study Programme 116(XI)."

** One of the possible devices for measuring signal-to-noise ratio is described in Doc. XI/25 (U.S.S.R.) of Moscow, 1958.

5. what general conditions and parameters should be standardized in the experimental determination of the form of the weighting curve and what uniform method of expressing the results should be used;

6. with colour television, what should be the forms of the weighting curves for the red, green and blue colours on the screen?

QUESTION 222(C.M.T.T.)

STANDARDS OF TRANSMISSION QUALITY FOR TELEVISION CIRCUITS SUBSTANTIALLY LONGER THAN 2500 km

The C.C.I.R., *(Adopted by correspondence, 1962)*

CONSIDERING

that there is a need to relate long-distance transmission requirements, not only to the hypothetical reference circuit, but also to existing and future circuits of substantially longer length;

DECIDES that the following question should be studied:

1. is it practicable to establish standards of transmission quality for the overall long-distance circuit, between the video input and output terminals, without regard to the length of the circuit;

2. if so, what are the characteristics to be considered and what values should be specified?

QUESTION 269(C.M.T.T.)

DEFINITION OF HYPOTHETICAL REFERENCE CIRCUITS FOR TELEVISION

For application to real circuits longer than 2500 km

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that, in some parts of the world, very long television circuits, considerably longer than 2500 km, either exist or are under consideration;

(b) that such circuits may have many intermediate video connection points;

UNANIMOUSLY DECIDES that the following question should be studied:

1. is the definition of the existing hypothetical reference circuit for monochrome television (2500 km, with two intermediate video points), adequate to ensure satisfactory results on long real circuits;

2. if not, what addition or modifications should be made to the existing definition?

QUESTION 270(C.M.T.T.)

TIME DIFFERENCES BETWEEN THE SOUND AND VISION COMPONENTS OF A TELEVISION SIGNAL

The C.C.I.R., (Geneva, 1963)

CONSIDERING

(a) that the time of transmission of television signals, over a communication-satellite system, is not negligible;

(b) that, if the sound and vision signals are transmitted by different methods or routes, there may be an error of timing between the sound and vision signals at the receiving end.

UNANIMOUSLY DECIDES that the following question should be studied:

what differences of delay can be accepted between the sound and vision components of a television signal?

Note : A similar problem exists in connection with sound and picture recording on the same base (see Recommendation 265, § 3.3.2).

LIST OF DOCUMENTS OF THE Xth PLENARY ASSEMBLY CONCERNING THE C.M.T.T.

Doc.	Origin	Title	Reference	Other Study Groups concerned
15	Chairman, C.M.T.T.	Report by the Chairman, C.M.T.T. (Mr. Y. ANGEL)	—	—
124	Japan	Comparison of the visibility of random noise in different television systems	Q. 166(XI)	XI
125	Canada	Single value of signal-to-noise ratio for different television systems—Video noise-weighting	Q. 166(XI) S.P. 116(XI) Rec. 267	XI
126	United Kingdom	Active earth-satellite communication systems for television—The effects of Doppler frequency shifts, transmission time-delays and switching discontinuities on monochrome television signals	Q. 209 & 213(IV)	IV
215	I.B.T.O.	I.B.T.O. Study Question 22-III—Methods of remote monitoring of the basic qualitative parameters of television chains during transmission	Q. 121	—
254	I.B.T.O.	Automatic remote monitoring of fundamental qualitative indices of television chains	Draft Q.	XI
255	I.B.T.O.	Automatic remote monitoring of the fundamental qualitative indices of television chains	Draft S.P.	XI
256	I.B.T.O.	Method of automatic remote monitoring and measurement of television chains	Draft Q.	XI
258	Canada	Requirements for the transmission of monochrome television signals over long distances	—	—
287	C.M.T.T.	Summary record of the first meeting	—	—
371	C.M.T.T.	Requirements for the transmission of colour television signals over long distances	Draft Rep.	—
399	Sub-Group CMTT-D	Automatic remote monitoring of fundamental qualitative indices of television chains	Draft S.P.	—
504	C.M.T.T.	Summary record of the second meeting	—	—
515	C.M.T.T.	Definition of the hypothetical reference circuits for television	Q. 269	—
541	C.M.T.T.	Summary record of the third meeting	—	—
546	C.M.T.T.	Summary record of the fourth and last meeting	—	—
576	C.M.T.T.	Note for the attention of Study Group IV	—	IV
614 (Rev.)	Organization Committee	Transmission of monochrome and colour television over long distances	Op. 19	—

Doc.	Origin	Title	Reference	Other Study Groups concerned
2236	Drafting Committee	Automatic remote monitoring of fundamental qualitative parameters of television chains	S.P. 121A	XI
2237	„ „	Requirements for the transmission of colour television signals over long distances	Rep. 316	XI
2238	„ „	Requirements for the transmission of monochrome television signals over long distances	Rec. 421	—
2245	„ „	Definition of the hypothetical reference circuits for television	Q. 269	—
2249	„ „	Automatic remote monitoring of fundamental qualitative parameters of television chains	S.P. 121A	XI
2251	„ „	Time differences between the sound and vision components of a television signal	Q. 270	—

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