INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

C.C.I.R.

DOCUMENTS OF THE

XIth PLENARY ASSEMBLY

OSLO, 1966

VOLUME V

SOUND BROADCASTING
TELEVISION

Published by the
INTERNATIONAL TELECOMMUNICATION UNION
GENEVA, 1967

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ADDENDUM No. 1

to
VOLUME V OF THE DOCUMENTS
OF THE XIth PLENARY ASSEMBLY OF THE C.C.I.R.
Oslo, 1966

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

1. Subsequent to the publication of Volume V (Broadcasting and Television) of the documents of the XIth Plenary Assembly of the C.C.I.R., two new texts concerning broadcasting or television have been submitted, with a view to their adoption by correspondence, in accordance with Article 14, § 2(1) of the International Telecommunication Convention, Montreux, 1965.

   Each of these texts has received more than the twenty approvals, necessary for their adoption from the Members and Associate Members of the I.T.U. and they have, in consequence, now become official Questions and Study Programmes of the C.C.I.R. (see Administrative Circular AC/112 of 10 January 1968).

   These texts are:

   — *Question 13/XI.* This text is reproduced on a separate sheet numbered 347 *a*.

   — *Study Programme 7A/XII.* This text is reproduced on a separate sheet numbered 374.

2. Furthermore, the Director, C.C.I.T.T. has transmitted to the C.C.I.R. seven new texts concerning the transmission of sound signals, requesting that they be studied as a matter of urgency by the CMTT, in accordance with § 2(1) of the International Telecommunication Convention, Montreux, 1965.

   These texts are connected with Questions 4/CMTT and 5/CMTT. Although they were presented by the C.C.I.T.T. in the form of Questions, they have therefore been considered as Study Programmes of the C.C.I.R. and have been drafted as such.

   These texts are:

   — *Study Programmes 4A/CMTT, 5A/CMTT, 5B/CMTT, 5C/CMTT, 5D/CMTT, 5E/CMTT* and *5F/CMTT.* These texts are reproduced on separate sheets numbered 382*a* to 382*n*.

3. Advantage has been taken of the issue of this Addendum to notify the following corrections to be made to Volume V:

   Page 59. In the footnote to Fig. 5, replace " e_s " by " e_3 ".

   Page 91. In § 4.1, replace " *B* " by " *A* " and replace " *W* " by " *B* ".

   Page 94. In §§ 2.1 and 2.3, replace " *B* " by " *A* " and replace " *W* " by " *B* ".

   Page 102. In Fig. 8, replace " Frequency (kHz) " by " Frequency (MHz) ".

   Page 129. In § 2.2.2.2., sixth line from bottom, replace " Figs. 4 and 5 " by " Figs. 6 and 7 ".

   Page 213. In § 4.1, last line on page, replace " Fig. 4 " by " Fig. 5 ".

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Recommendations of Sub-section E.1: Audio-frequency and recording

Recommendations of Sub-section E.2: Radio-frequency

Recommendations of Sub-section E.3: Tropical broadcasting

Recommendations of Sub-section E.4: Television

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Reports of Sub-section E.3: Tropical broadcasting

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Questions and Study Programmes allocated to Study Group XI (Television); Opinions and Resolutions of interest to this Study Group; Lists of documents

Questions and Study Programmes allocated to Study Group XII (Tropical broadcasting); Opinions and Resolutions of interest to this Study Group; Lists of documents

Questions and Study Programmes allocated to the CMTT (C.C.I.R./C.C.I.T.T. Joint Commission for television transmissions); Opinions and Resolutions of interest to this Commission; Lists of documents

DISTRIBUTION OF THE TEXTS OF THE XIth PLENARY ASSEMBLY OF THE C.C.I.R. AMONG VOLUMES I-VI

— Volumes I to VI of the documents of the XIth Plenary Assembly contain all the C.C.I.R. texts at present in force.

— For Questions and Study Programmes, the final (Roman) numeral indicates the Study Group to which the text has been assigned. The plan on page 5 shows the Volume in which the various texts of that Study Group can be found.

— Recommendations, Reports, Opinions and Resolutions which have been amended by the XIth Plenary Assembly, have retained their original number, followed by the indication 1 (e.g.: Recommendation 326-1), which is not shown in the Table below. Further details on the numbering system appear in Volume VI.

1. Recommendations

Number	Volume	Number	Volume	Number	Volume
45	III	237	I	313	II
48, 49	V	239	I	314	IV
75–77	III	240	III	325–334	I
80	V	246	III	335–349	III
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106	III	261, 262	V	368–373	II
136	V	264–266	V	374–379	III
139, 140	V	268	IV	380–406	IV
162	III	270	IV	407–421	V
166	III	275, 276	IV	422, 423	III
168	II	279	IV	425	III
182	III	281–283	IV	427–429	III
205	V	289, 290	IV	430–433	I
212	V	297–300	IV	434, 435	II
214–216	V	302	IV	436–443	III
218, 219	III	304–306	IV	444–446	IV
224	III	310, 311	II	447–451	V

2. Reports

Number	Volume	Number	Volume	Number	Volume
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32	V	195–198	III	297–316	V
42	III	200–203	III	318–320	III
79	V	204–219	IV	321	I
93	III	222–224	IV	322	(1)
106, 107	III	226	IV	323–335	I
109	III	227–239	II	336–339	II
111, 112	III	241–266	II	340	(1)
122	V	267	III	341–344	II
130	IV	269–273	III	345–373	III
134	IV	275–282	III	374–397	IV
137	IV	283–290	IV	398–412	V
				413–415	(1)

(1) Published separately.

3. Opinions

Number	Volume	Number	Volume	Number	Volume
1, 2	I	12–14	IV	21	III
3	IV	15–17	V	22, 23	II
11	III	19	V	24–30	III
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4. Resolutions

Number	Volume	Number	Volume	Number	Volume
1	III	12, 13	II	26, 27	VI
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7, 8	II	19, 20	III	32	V
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ARRANGEMENT OF VOLUMES I TO VI OF THE DOCUMENTS OF THE XIth PLENARY ASSEMBLY OF THE C.C.I.R.

(Oslo, 1966)

VOLUME I	Emission. Reception. Vocabulary (Sections A, B, 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 and Radioastronomy (Sections F and L and Study Groups IX and IV).
VOLUME V	Sound broadcasting and Television (Section E, Study Groups X, XI and XII and the CMTT).
VOLUME VI	List of participants. Minutes of the Plenary Meetings. Resolutions of a general nature. Reports to the Plenary Assembly. List of documents in numerical order.

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 XIth Plenary Assembly of the C.C.I.R. and the participation at this meeting on 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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Rec. 368	Propagation below 10 MHz	II
Rec. 370	Propagation between 40 and 1000 MHz	II
Rep. 228	Measurement of field strength	II
Rep. 240	Propagation between 50 and 1000 MHz (Africa)	II
Rep. 264	Ionospheric propagation between 150 and 1500 kHz	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

RECOMMENDATIONS OF SECTION E (SOUND BROADCASTING AND TELEVISION)

E. 1: Audio-frequency and recording

RECOMMENDATION 261-1

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

Single-track recording on magnetic tape

The C.C.I.R. (1951—1953—1956—1959—1966)

UNANIMOUSLY RECOMMENDS

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

1. **Speed of tape**

Primary speeds $\left\{\begin{array}{l}38\cdot1 \text{ cm/s (15 in./s) nominal value}\\ 19\cdot05 \text{ cm/s (} 7\tfrac{1}{2} \text{ in./s) nominal value}\end{array}\right.$

Secondary speed *: 76·02 cm/s (30 in./s) nominal value

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

2. **Width of tape**

6·25 $\pm$ 0·05 mm (0·246 $\pm$ 0·002 in.).

3. **Strength of tape**

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

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.

The part of the tape carrying the beginning of the programme should be on the outside.

5. **Hubs and spools**

For the international exchange of programmes the following types of hubs and spools, conforming to I.E.C. Publication 94, should be used:

European type hubs;
U.S.A. type hubs and flanges;
Flanged cine type spools with 127 and 178 mm (5 and 7 in.) nominal diameter.

As far as possible, flanged spools or hubs with flanges should be used for transit.

6. **Maximum diameter of a full spool**

for the European type hub: 290 mm (11·5 in.)
(In France, the maximum diameter is 270 mm.)
for the U.S.A. type hub: 267·5 mm (10·5 in.).

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

7. Tape leader

There should be a non-magnetic identification strip or a length of unrecorded tape at least 1 m long at the beginning of each reel.

8. Programme identification

At least the reference number of the programme and the reel number should be given either on the leader or on the spool. If this information is carried on the leader, it should be on the side continuous with the non-magnetic 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.

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 38·1 cm/s (15 in./s) and 76·2 cm/s (30 in./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.

For a tape speed of 19·05 cm/s (7½ in./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 70 μs.

Note on use of reproducing characteristics. — In France, for 19.05 cm/s (7½ in./s) tape speed a time constant of 50 μs has been adopted. In the U.S.A., a 50 μs + 3180 μs (see I.E.C. Publication 94) reproducing characteristic is used for both 38·1 and 19·05 cm/s (15 and 7½ in./s) tape speed. The differences between this nominal characteristic and those of the C.C.I.R are less than the tolerances stated in § 9.2.

9.2 *Tolerances*

Tapes for international programme interchange should be recorded so that they conform to the recording characteristic tolerances given in the current I.E.C. Publication 94.

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 (here, the term " surface induction " means the normal 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 a factor which is almost independent of wavelength. Under these circumstances, the relative surface inductions at different frequencies can be measured by at least three methods that are described in the Annex to the current edition of I.E.C. Publication 94. 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.

RECOMMENDATION 264-1

INTERNATIONAL EXCHANGE OF MONOCHROME TELEVISION PROGRAMMES ON FILM

The C.C.I.R. (1956—1959—1963—1966)

UNANIMOUSLY RECOMMENDS

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

1. 35 COMOPT
2. 16 COMOPT
3. 16 COMMAG
4. 16 SEPMAG
5. 35 MUTE
6. 16 MUTE
7. 35 SEPMAG
8. 16 SEPDUMAG
9. 35 COMMAG

in accordance with the definitions and standards given in Recommendation 265-1.

Films of types 1 to 6 are primary standards and these films may be exchanged without preliminary advice. Films of types 7, 8 and 9 are secondary standards and cannot be exchanged until there is agreement between the organizations concerned.

RECOMMENDATION 265-1

STANDARDS FOR THE INTERNATIONAL EXCHANGE OF MONOCHROME TELEVISION PROGRAMMES ON FILM

The C.C.I.R. (1956—1959—1963—1966)

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 referred to in Recommendation 264-1 are designated by code words as defined below. The code words should be placed on the identification leader of each film and should be used in any related correspondence. A code word consists of a number (or numbers) followed by two of three syllables. The number, usually 16 or 35, indicates the width of the film in millimetres. The first syllable indicates either a combined sound and picture recording by the letters COM, or separate sound and picture by the letters SEP. The second syllable indicates whether the sound recording is magnetic (MAG) or optical (photographic) (OPT).

1.1 35-mm picture film with a photographic sound track is 35 COMOPT.

16-mm picture film with a magnetic sound track is 16 COMMAG.

16-mm picture film with sound on a separate magnetic film is 16 SEPMAG.

1.2 If the picture and sound films have the same width, this is indicated by a single number. If not, then two numbers separated by an oblique stroke are used, the first indicating the width of the picture film; for example:

35-mm picture film with magnetic sound track on 16-mm film is 35/16 SEPMAG.

1.3 If the sound is recorded on a separate film using two tracks, the syllable DU is inserted between the two syllables of the code word as in the following example:

16-mm picture film with two magnetic sound tracks on a separate 16-mm film is 16 SEPDUMAG.

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

2. Standards common to all films

2.1 Safety film must be used.

2.2 Normally the image on the film should be a photographic positive.

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

2.4 The areas of the picture which are to be faithfully reproduced should have an optimum density range of 1·6. The density corresponding to television white level should be 0·25 to 0·35 above base density of the film. For dyed-base film the total density corresponding to television white level should not exceed 0·5.

Except where special effects are desired, picture areas portraying human faces should have a density between 0·2 and 0·5 higher than the density corresponding to television white value.

Note. — All film densities stated above are measured only with singly diffused light.

2.5 The dimensions of the films and images recorded thereon should conform to appropriate international (see ISO R 73 (35-mm film) and ISO R 359 (16-mm film)) or national standards.

2.6 When films are produced for television by conventional cinematographic methods, allowances should be made for losses of picture area that occur both in film scanning and in domestic receivers. The television scanned area, the action field and the title area should conform with appropriate international or national standards.

2.7 Film splices should be carried out in accordance with appropriate international or national standards.

2.8 A leader for protection and identification should be attached to each film.

2.8.1 The leader should end on a line separating frames (see Fig. 1 and Report 294-1).

When joined 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 earlier in time sequence.

When used with separate sound and picture film, 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.

2.8.2 The minimum length of the protection and identification leader should be 3 m (10 ft).

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

- name of sending organization,
- title of programme,
- code word (see § 1),
- programme duration and picture frame rate,
- total number of reels,
- reel number,
- duration or length of the reel.

2.8.4 The identification leader should have the same type of base as the film to which it is attached. Leaders should be attached to the film in such a manner that the emulsion on both leader and film is on the same side.

2.9 Films may be transported on flanged reels or on flangeless hubs as specified in the appropriate international or national standards. The boxes in which films are transported should be identified with labels carrying the same information as the corresponding film leader (see § 2.8).

2.10 The diameter of a flanged reel or the outer diameter of the film on a flangeless hub should not exceed 380 mm (15 in.). It is desirable that 16-mm films exceeding 300 m (1000 ft) in length should be on flanged reels.

3. Special standards for certain types of film

3.1 *35 COMOPT*

Location and dimensions of picture frames and sound track should conform with appropriate international (see ISO R 73 and ISO R 70) or national standards.

3.2 *16 COMOPT*

Location and dimensions of picture frames and sound track should conform with appropriate international (see ISO R 359 and ISO R 71) or national standards.

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 $\pm$ 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 0·02 mm (0·0008 in.).

3.3.5 If a balancing magnetic stripe is used it should have the same composition and thickness as the main magnetic stripe. No recording should be made on the balancing stripe.

3.3.6 The recording and reproducing characteristics should be that standardized by the C.C.I.R. for magnetic tape for a speed of 19·05 cm/s, (7½ in./s) except for the time constant, which is 100 μs (see Recommendation 261-1).

3.4 *16 SEPMAG and 16 SEPDUMAG*

3.4.1 Two primary standards for SEPMAG are used:

— a 5·1 mm (200 mil) centre track, according to Fig. 3, commonly used in Europe;

— a 5·1 mm (200 mil) edge track, according to ASA PH 22.97, commonly used in the U.S.A. and Canada.

Note. — This type of track may also be reproduced by a magnetic head designed for 16 COMMAG or 16 SEPDUMAG track No. 2 (see Fig. 3).

3.4.2 A type of 16 SEPMAG using a single 2·5 mm (100 mil) (nominal) edge track may be used as secondary standard (see track 2 in Fig. 3).

3.4.3 16 SEPDUMAG may be used as a secondary standard (see Fig. 3).

3.5 *35 SEPMAG*

3.5.1 The second (sound) film should be a standard 35-mm magnetic film.

3.5.2 The position of the sound tracks is specified in ISO R 162. If only one sound track is used, it should be track No. 1 (see Fig. 4).

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

3.5.4 The COM and SEP types 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.

3.5.5 The recording and reproducing characteristics should be that standardized by the C.C.I.R. for magnetic tape for a tape speed of 38·1 cm/s (15 in./s) (see Recommendation 261-1).

3.6 *35 COMMAG*

3.6.1 The dimensions and position of the magnetic stripe should be as given in Fig. 5.

3.6.2 The sound record should be 28 ± ½ frames behind the centre of the corresponding picture.

3.6.3 The magnetic stripe should be on the side of the film towards the lens of a projector arranged for direct projection on to a reflecting screen.

3.6.4 If a balancing stripe is used outside the sprocket holes, it should have the same thickness as the main magnetic stripe. The dimensions and position of the main magnetic stripe should be as given in Fig. 1. No recording should be made on the balancing stripe.

3.6.5 The recording and reproducing characteristics should be that standardized by the C.C.I.R. for magnetic tape for a tape speed of 38·1 cm/s (15 in./s) (see Recommendation 261-1).

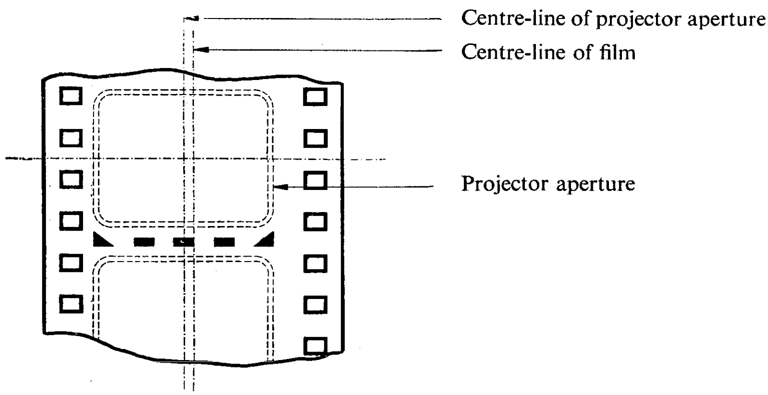
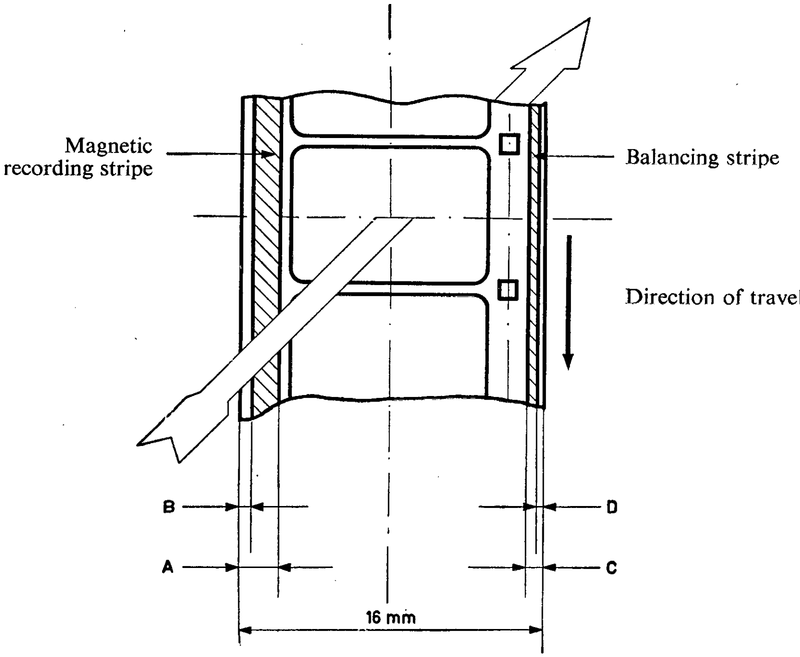


FIGURE 1

End of the identification leader

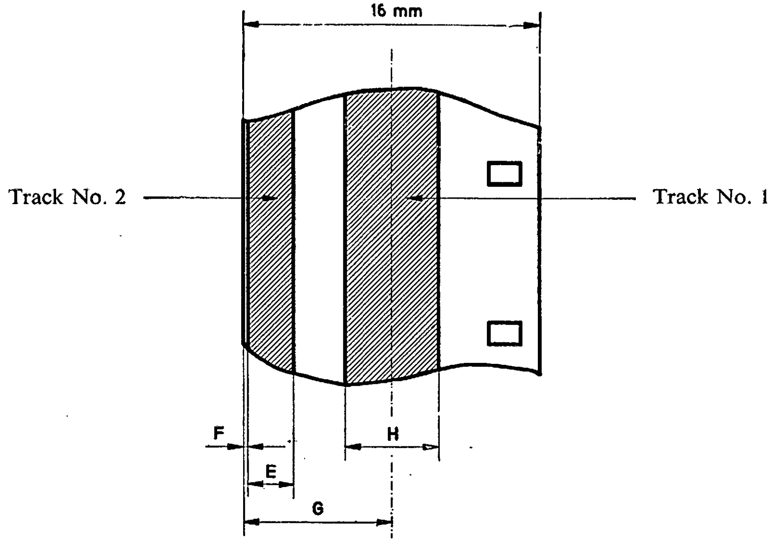


Dimensions

	Millimetres	Inches
A	$2{\cdot}5\ ^{+0{\cdot}15}_{-0}$	$0{\cdot}100\ ^{+0{\cdot}004}_{-0{\cdot}002}$
B	0·127 max.	0·005 max.
C	$0{\cdot}8\ ^{+0}_{-0{\cdot}1}$	$0{\cdot}031\ ^{+0}_{-0{\cdot}005}$
D	0·05 max.	0·002 max.

FIGURE 2

Sound recording on film type 16 COMMAG

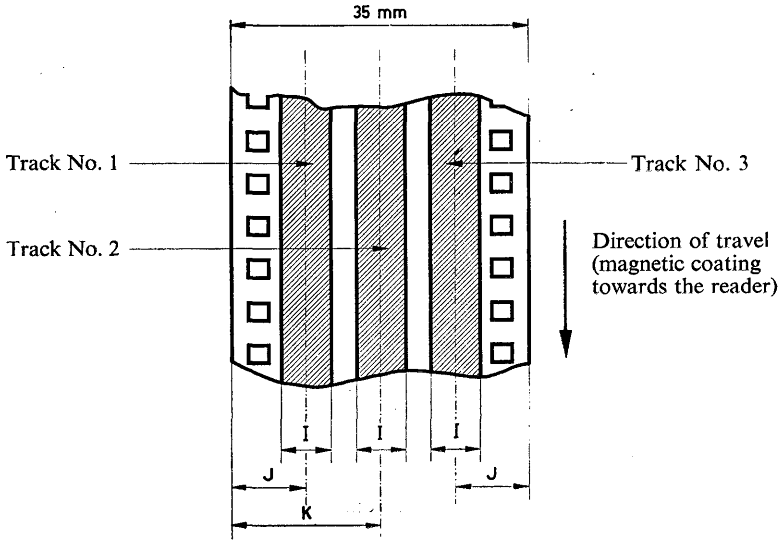


Dimensions

	Millimetres	Inches
E	2·54 $^{+0·127}_{-0}$	0·100 $^{+0·005}_{-0}$
F	0·127 $^{+0}_{-0·127}$	0·005 $^{+0·005}_{-0}$
G	8·00 ±0·10	0·315 ±0·004
H	5·08 ±0·05	0·200 ±0·002

FIGURE 3

Sound recording on film type 16 SEPDUMAG

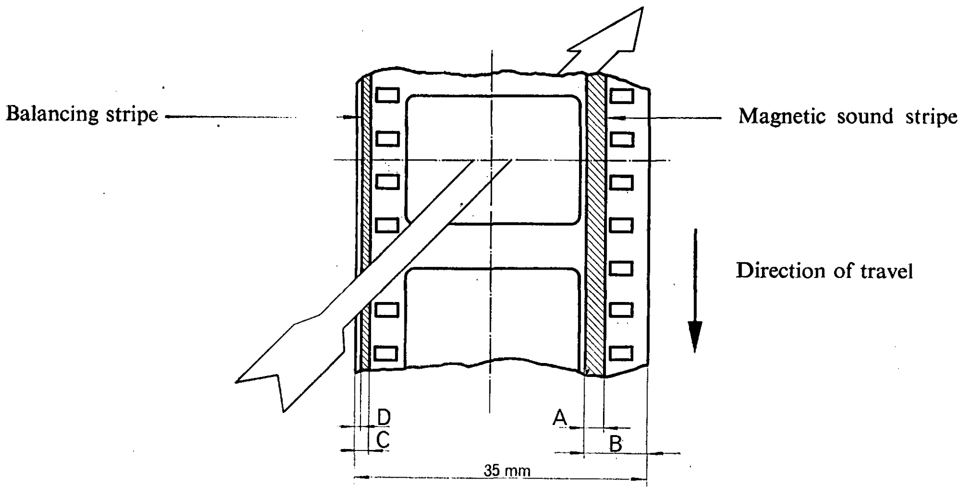


Dimensions

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

FIGURE 4

Sound recording on film type 35 SEP with one or more tracks



Photographic emulsion in front, magnetic coating behind

Dimensions

	Millimetres	Inches
A	$2.5 \begin{smallmatrix}+0.1 \\ -0\end{smallmatrix}$	0.100 ± 0.002
B	$7.6 \begin{smallmatrix}+0.1 \\ -0\end{smallmatrix}$	$0.300 \begin{smallmatrix}+0.002 \\ -0\end{smallmatrix}$
C	$1.8 \begin{smallmatrix}+0 \\ -0.25\end{smallmatrix}$	$0.07 \begin{smallmatrix}+0 \\ -0.01\end{smallmatrix}$
D	0·25 max.	0·01 max.

FIGURE 5

Sound recording on film type 35 COMMAG

RECOMMENDATION 407-1

SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Questions 42 and 63)

The C.C.I.R. (1951—1953—1956—1959—1963—1966)

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 261-1;
2. two-track magnetic recording of stereophonic signals as specified in Recommendation 408-1;
3. monophonic and stereophonic discs of Types III, IV, V and VI as specified in I.E.C. Publication 98, Part D.

Note 1. — In the U.S.A., monophonic and stereophonic discs for broadcast purposes will conform to the current N.A.B. disc standards.

Note 2. — In the O.I.R.T., there are standards for monophonic and stereophonic magnetic tape recording (Recommendation No. 33 of the O.I.R.T.).

RECOMMENDATION 408-1

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

Two-track stereophonic recording on magnetic tape

(Question 200 and Report 293-1)

The C.C.I.R. (1963—1966)

UNANIMOUSLY RECOMMENDS

that, for the international exchange of stereophonic sound broadcast programmes the provisions of Recommendation 261-1 should apply together with the following:

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.) (In France, an unrecorded space of 2 mm is used);

Note. — 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.

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 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 409-1

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

(Study Programme 1A/X)

The C.C.I.R. (1956—1963—1966)

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 Hz;

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

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 measuring equipment should have the following specifications:

5.1 frequency of measurement: 3000 Hz (a frequency of 3150 Hz, corresponding to the proposed ISO Recommendation 402, could also be used);

5.2 response curve:

as specified in Table I and Fig. 1, giving a value which corresponds closely to the subjective impression (an additional response curve, " flat " at least between 0·2 and 200 Hz would provide useful information about sources of wow and flutter. Tolerances and dynamic characteristics are not specified for the " flat " curve).

5.3 *Dynamic characteristics (with weighting)*

For short unidirectional deviations of the frequency of measurement (rectangular pulses of a duration A) with a repetition rate of 1 Hz, the meter should indicate the percentage B of the reading obtained with a sinusoidal frequency-modulation of 4 Hz having a peak-to-peak deviation equal to the frequency swing of the pulse:

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

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

5.4 *Indication*

The meter should measure peak-to-peak values, but the reading should indicate the wow in per cent or parts per thousand of 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 (Hz)	Attenuation (dB)	Tolerances on attenuation (dB)	
0·2	−30·6	At 0·2 Hz	: +10; −4
0·315 0·4	−19·7 −15·0	From 0·315 to 0·5 Hz	: ±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 Hz	: ±2
4·0	0	At 4 Hz	: 0
6·3 10 20 40	− 0·9 − 2·1 − 5·9 −10·4	From >4 to 50 Hz	: ±2
63 100 200	−14·2 −17·3 −23	From 50 to 200 Hz	: ±4

* In Japan, the following technical specifications are applied when measuring r.m.s. values:
- measurement frequency: 3000 Hz,
- response curve: same as specified in § 5.2,
- characteristics of rectifier: square-law type with an exponent of 2 ± 0·1,
- dynamic characteristics: for unidirectional pulses with duration *A*, the meter should indicate the following percentage *B* of the reading obtained with a 5s pulse:

A duration of pulse (s)	0·5	1	2	5
B indication (%)	36 ± 5	78 ± 5	83 ± 5	100 ± 5

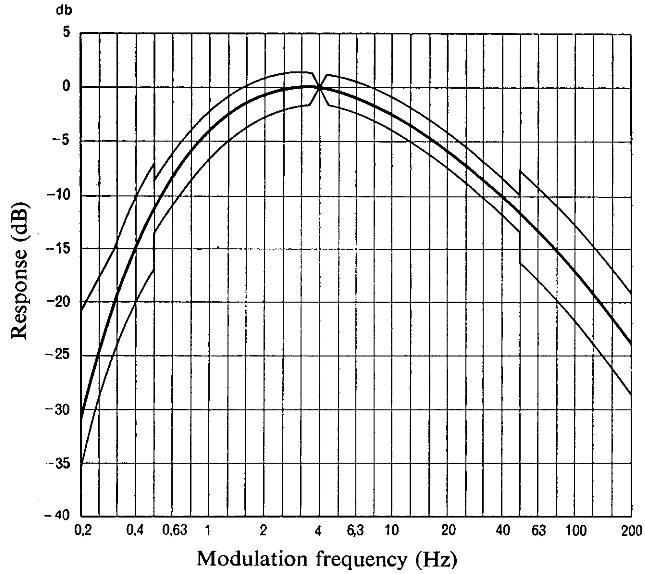


FIGURE 1

Frequency-response curve of weighting network

E. 2: Radio-frequency

RECOMMENDATION 80

HIGH-FREQUENCY BROADCASTING

Directional antennae

(Question 14/X)

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

CONSIDERING

(a) that the result of a series of laboratory experiments (see Doc. 305, 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 by the C.C.I.R. Secretariat 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 205-1

HF BROADCASTING

Use of synchronized transmitters

The C.C.I.R. (1953—1956—1966)

UNANIMOUSLY RECOMMENDS

that 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 transmission paths, corresponding to the antennae.

These considerations become more critical as the transmission distance increases.

RECOMMENDATION 262-1

HF BROADCASTING

Effects of closer spacing between carriers

(Question 8/X)

The C.C.I.R. (1959—1966)

UNANIMOUSLY RECOMMENDS

that at least with the majority of receivers in use, the radio-frequency wanted-to-interfering signal ratio to give satisfactory reception (see Note), when two transmitters use carrier frequencies 5 kHz apart, should not be considered to be less than when the transmitters use the same frequency (within 50 Hz).

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

RECOMMENDATION 410 *

HF BROADCASTING

Use of more than one frequency per programme

The C.C.I.R., (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 411-1

HF BROADCASTING

Conditions for satisfactory reception

The C.C.I.R., (1963—1966)

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.

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)	*1*	*2*	*3*	*4*
Radio-frequency signal-to-interference	10	13	23	16
Wanted signal-to-atmospheric noise	6	16	22	17
Wanted signal-to-industrial noise	6	10	16	12

Column 1 : 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 2 : the long-term fading allowance which must be made to ensure that the steady-state ratio is achieved for 90% of the hours in any one month at a particular time of day in 90% of the cases.

Column 3 : the sum of the values in columns *1* and *2* 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 4 : the square root of the sum of the squares of the values (in dB) given in columns *1* and *2* 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

The C.C.I.R. (1956—1959—1963)

UNANIMOUSLY RECOMMENDS

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

1. the maximum frequency deviation should be either $\pm$ 75 kHz or $\pm$ 50 kHz;

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;

3. in the absence of interference from industrial and domestic equipment, a field strength (measured 10 m above ground level) of at least 50μV/m can be considered to give an acceptable service;

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

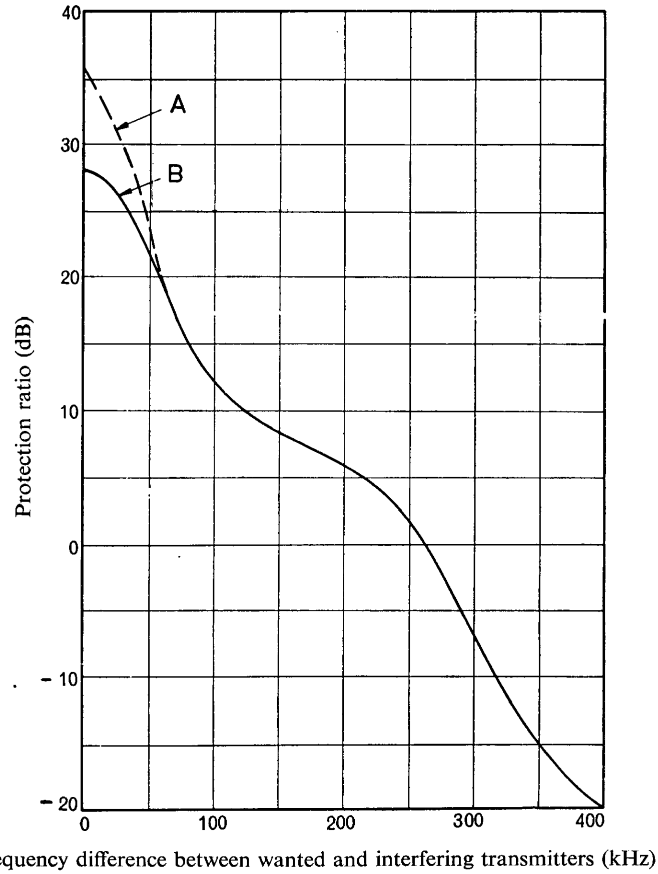


FIGURE 1

Protection ratios required by VHF broadcasting services at frequencies between 87·5 MHz and 108 MHz using a maximum frequency deviation of ± 75 kHz

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

4. in the presence of interference from industrial and domestic equipment, a satisfactory service requires a median field-strength (measured 10 m above ground level) 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 kHz, 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 kHz are given in Fig. 2.

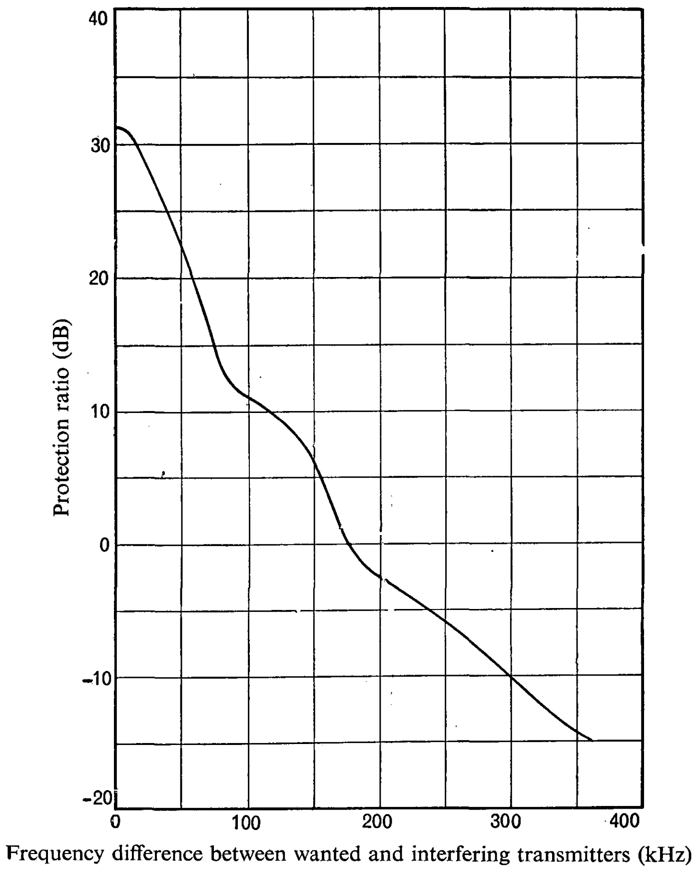


FIGURE 2

Protection ratios required by VHF-FM sound broadcasting services at frequencies below 87·5 MHz using a maximum frequency deviation of ± 50 kHz

(Tropospheric interference, 99% of the time)

RECOMMENDATION 413-1

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

(Question 8/X and Question 10/X)

The C.C.I.R., (1963—1966)

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 radio-frequency protection ratio between two stable amplitude-modulation broadcast signals, should be presented in terms of the following parameters:
   - separation, Δf, between the carrier-frequencies (kHz) (Δf should lie between 0 and at least 10 kHz),
   - 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, ΔRF,
   - 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 (kHz)	k	b (kHz)	Programmes (wanted and unwanted)	Input voltage of the wanted signal (RF)	ΔRF (kHz)	Overall frequency response	Listener satisfaction (%)
0 (1) 5 9 10	0·8	±10	Light music	0·1–1 mV (2)	5 at the 6 dB points	Flat within ±3 dB up to 2·5 kHz	50

(1) Within ±20 Hz.
(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.

3. that the measuring technique should be indicated (subjective or objective).

RECOMMENDATION 414

DIRECTIONAL ANTENNAE

Presentation of antenna diagrams

(Question 14/X)

The C.C.I.R. (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):

$$0, 1, 2, 3, 4, 6, 8, 10, 13, 16, 20, 25, 30, 40 \text{ and } \infty$$

or at least for some of these values, preferably:

$$0, 3, 6, 10, 20, 40 \text{ and } \infty.$$

RECOMMENDATION 447

SIGNAL-TO-INTERFERENCE RATIOS IN AMPLITUDE-MODULATION SOUND BROADCASTING

Definitions

(Question 8/X)

The C.C.I.R. (1966)

UNANIMOUSLY RECOMMENDS

that when considering problems of interference in sound broadcasting, the following definitions should be used:

1. *the audio-frequency signal-to-interference ratio* is the ratio, expressed in dB, between the values of the voltage of the wanted signal and the voltage of the interference, measured under specified conditions, at the audio-frequency output of the receiver.

This ratio corresponds closely to the difference in volume of sound (expressed in dB) between the wanted programme and the interference.

2. *The audio-frequency protection ratio* is the agreed minimum value of the audio-frequency signal-to-interference ratio considered necessary to achieve a subjectively defined reception quality.

This ratio may have different values according to the type of service desired.

3. *The radio-frequency wanted-to-interfering signal ratio* is the ratio, expressed in dB, between the values of the radio-frequency voltage of the wanted signal and the interfering signal, measured at the input of the receiver under specified conditions.

For example, in the case of wanted and interfering transmissions of the classical type (carrier with double sideband), the chosen values will be the effective radio-frequency voltages that correspond to the wanted and interfering carriers.

4. *The radio-frequency protection ratio* is the value of the radio-frequency wanted-to-interfering signal ratio that enables, under specified conditions, the audio-frequency protection ratio to be obtained at the output of a receiver.

These specified conditions include such diverse parameters as spacing Δf of the wanted and interfering carrier, emission characteristics (type of modulation, modulation depth, etc.), receiver input and output levels as well as the receiver characteristics (selectivity and susceptibility to cross-modulation, etc.).

RECOMMENDATION 448

LF/MF SOUND BROADCASTING
Radio-frequency protection ratio

(Question 8/X)

The C.C.I.R., (1966)

CONSIDERING

that frequency assignment conferences should base their work on a generally agreed value of radio-frequency protection ratio which may also be applied in the examination of cases of interference;

UNANIMOUSLY RECOMMENDS

that the radio-frequency protection ratio (as defined in Recommendation 447), for co-channel transmissions (± 50 Hz), on hectometric and kilometric waves, should be 40 dB when both the wanted and the unwanted signals are stable (ground wave).
When the wanted signal is stable and the unwanted signal fluctuates (sky wave), the radio-frequency protection ratio should be 40 dB at midnight for at least 50% of the nights of the year.

ANNEX

This value of 40 dB takes account of the subjective effect of short-term fluctuations of the unwanted signal (see also Report 298-1, § 2.2 and Report 264-1, § 2.3.2) and corresponds to the ratio of the wanted field-strength and the annual median value of the hourly medians of the interfering field-strength at 2400 hours local time at the midpoint of the path.

The protection so defined is provided;

— for 50% of the nights at 2400 hours local time;

— for more than 50% of the nights between sunset and midnight and between 0300 hours and sunrise; and

— for 100% of the days during daylight hours.

Note 1. — The minimum field strength to which this protection ratio of 40 dB applies varies in the different regions and with frequency. Within the European zone this minimum field is of the order of 1 mV/m.

Note 2. — In the U.S.A., when the wanted and unwanted signals are stable (ground-wave), the radio-frequency protection ratio for co-channel transmissions is 26 dB. When the unwanted signal is fluctuating (sky-wave) the same protection ratio is applied for 90% of the nights of the year, computed for the second hour after sunset. The minimum field protected is either 100 μV/m or 500 μV/m, depending upon the class of service.

RECOMMENDATION 449

AMPLITUDE-MODULATION SOUND BROADCASTING

Radio-frequency protection-ratio curves

(Question 8/X)

The C.C.I.R. (1966)

UNANIMOUSLY RECOMMENDS

that the radio-frequency protection ratios (See Recommendation 447), as a function of the carrier-frequency spacing of a stable wanted signal and a stable or fluctuating unwanted signal, once a value for the radio-frequency co-channel protection (which is equal to the audio-frequency protection ratio) has been agreed, be given:

— by curve *A* of Fig. 1, when a limited degree of modulation compression is applied at the transmitter input, such as in good quality transmissions;

— by curve *B* of Fig. 1, when a high degree of modulation compression (at least 10 dB greater than in the preceding case) is applied by means of an automatic device.

The curves *A* and *B* are valid only when the wanted and unwanted transmissions are compressed to the same extent.

ANNEX

The shape of the radio-frequency protection-ratio curves depends on the receiver selectivity and also on the ratio of the energy of the carrier and of the sidebands. This latter phenomenon is most important between 250 Hz and 5 kHz approximately, where the disturbance is essentially due to the whistle produced by the carrier-frequency beat. It results therefore that the shape of the curves depends on the average modulation depth and on the dynamic compression of the modulation signals.

Curve *A* represents average values obtained by tests made with various receivers and with " average " degrees of modulation compression, such as that currently applied in the studios, i.e. with compression permitting a maximum dynamic range of at least 30 dB.

Curve *B* applies to the use of compression at least 10 dB higher than in the preceding case.

It should be noted that, in some circumstances, listeners are able to reduce the disturbance of an unwanted transmission spaced by more than 3 kHz approximately, by adjusting their receiver (slight detuning, selectivity control, tone control, etc.). Under these conditions the curves of the attached figure are no longer applicable for spacings of more than about 3 kHz. However, this practice leads to distortion and cannot be used when approximately equal interfering transmissions are present, on both sides of the wanted carrier frequency. Moreover, many receivers are not equipped with a selectivity control or a tone control.

Note. — In addition to the relative radio-frequency protection ratios given in this Recommendation there are other factors of importance in determining optimum frequency-spacings (see Question 9/X).

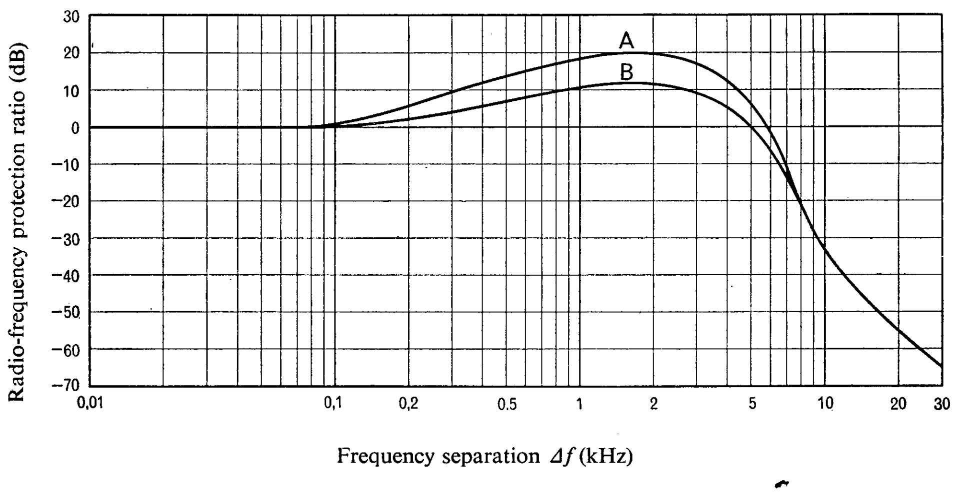


FIGURE 1

Relative value of the radio-frequency protection as a function of the frequency separation between a stable wanted and a stable or fluctuating unwanted signal

RECOMMENDATION 450

STEREOPHONIC SYSTEMS FOR VHF FREQUENCY-MODULATION BROADCASTING

The C.C.I.R., (1966)

CONSIDERING

(a) that it is technically possible to transmit stereophonic programmes by a single frequency-modulation transmitter;

(b) that, as far as possible, the introduction of these transmissions should not impair any aspects of existing monophonic reception;

(c) that such transmissions should be capable of rendering a high quality of stereophonic reproduction;

(d) that several systems exist that fulfil these requirements and are compatible within the definition contained in Question 15/X;

(e) that theoretical studies as well as experiments have been carried out with a number of these systems;

(f) that favourable operational results have been obtained with only two of the systems (see Report 300-1);

(g) that international standardization would enhance the development of stereophonic broadcasting;

UNANIMOUSLY RECOMMENDS

that VHF stereophonic transmissions should be made, using one of the two systems defined by the following specifications which concern components of the signal used to frequency-modulate the transmitter;

1. Polar-modulation system

(maximum frequency deviation: ± 50 kHz or ± 75 kHz).

1.1 a compatible signal, *M*, equal to one half of the sum of the left-hand signal, *A*, and the right-hand signal, *B*, produces deviation of the main carrier by not more than 80% of the maximum frequency deviation for monophonic transmission;

1.2 a signal, *S*, equal to one half the difference between the left-hand and right-hand signals is used to obtain the sidebands of an amplitude-modulated partly suppressed sub-carrier;

1.3 the frequency of the sub-carrier is 31·250 kHz ± 2 Hz;

1.4 the maximum modulation depth of the sub-carrier, before its suppression, is 80%;

1.5 the suppression ratio of the sub-carrier is −14 dB, the suppression is effected by a resonant circuit having a Q-factor of 100;

1.6 the residual sub-carrier produces a deviation of the main carrier which is 20% of the maximum frequency deviation for the monophonic transmission;

2. Pilot-tone system

(maximum frequency deviation: ± 75 kHz or ± 50 kHz).

2.1 a compatible signal, *M*, equal to one half 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;

2.2 a signal, S, equal to one-half the difference between the left-hand and right-hand signals is used to obtain the sidebands of an amplitude-modulated suppressed sub-carrier. The sum of these sidebands produces a peak deviation of the main carrier of the same amount as the signal S would give if applied to the channel, M. The peak deviation is not more than 90% of the maximum frequency deviation for monophonic transmission;

2.3 the frequency of the sub-carrier is 38 000 $\pm$ 4 Hz;

2.4 the residual sub-carrier produces a deviation of the main carrier of not more than 1% of the maximum frequency deviation for monophonic transmission;

2.5 a pilot signal having frequency equal to one half of that of the sub-carrier produces a deviation of the main carrier between 8% and 10% of the maximum frequency deviation for monophonic transmission;

2.6 the pre-emphasis of the signal S is identical with that of the compatible signal M;

2.7 the phase relationship 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. The phase tolerance of the pilot signal should not exceed $\pm$ 3° from the above state. Moreover, a positive value of the multiplex signal corresponds to a positive frequency deviation of the main carrier;

2.8 if it is desired to transmit a supplementary monophonic programme simultaneously with a stereophonic programme and the maximum frequency deviation is $\pm$ 75 kHz, the following additional specification applies:

2.8.1 the stereophonic multiplex signal deviates the main carrier by not more than 90% of the maximum frequency deviation for monophonic transmission;

2.8.2 the instantaneous frequency of the frequency-modulated supplementary sub-carrier is within the range of 53 to 75 kHz;

2.8.3 the modulation of the main carrier by the supplementary sub-carrier is not more than 10%.

Note. — (Added at the request of the Administration of Sweden). Countries which find it essential to use a stereophonic system capable of transmitting two separate monophonic programmes when the equipment is not used for stereophony (see Report 300-1, § 2.8), may also take into consideration the FM/FM compressor/expandor system described in § 3.3 of the same Report.

E. 3: Tropical broadcasting

RECOMMENDATION 48

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

(Question 1/XII)

The C.C.I.R., (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 1/XII)

The C.C.I.R., (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

The C.C.I.R., (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 301-1 gives the principles on which antennae for tropical broadcasting should be designed and constructed;

(d) that it is desirable to obtain as many 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 301-1 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

The C.C.I.R., (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 m).

RECOMMENDATION 214 *

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

(Question 1/XII)

The C.C.I.R., (1951—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;

(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, see P.F.B. Doc. 712, 14 February, 1950);

(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.

* This Recommendation replaces Recommendation 47.

RECOMMENDATION 215 *

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

(Questions 27 and 1/XII, Study Programme 112, Recommendation 214)

The C.C.I.R., (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 presupposes 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 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 kHz and in the HF (decametric) broadcast bands above 5060 kHz;

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 kHz used in tropical broadcasting for such ranges;

* 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, for this service.

1.3 for frequencies above 5060 kHz, 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 ensure 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 BAND SHARED WITH TROPICAL BROADCASTING

(Report 302, Question 1/XII)

The C.C.I.R., (1951—1953—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 kHz separation makes it difficult to measure the protection ratio with a receiver having an audio-frequency cut-off in excess of 5 kHz;

(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, Mexico City, 1948/49 and Doc. 43, Washington, 1950, which refers in particular to the effect of long and short term fading);

* This Recommendation replaces Recommendation 138.

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 kHz;

Note. — Practical consideration of the frequency separation of adjacent channels requires the use of an audio-frequency cut-off of 5 kHz in the measurement in preference to 6·4 kHz, appropriate corrections being applied, if considered necessary, to correspond to an audio-frequency cut-off of 6·4 kHz.

3. that, for the present, the protection ratio, as defined in § 1, 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.

RECOMMENDATION 415

PERFORMANCE SPECIFICATIONS FOR LOW-COST SOUND-BROADCASTING RECEIVERS

(Study Programme 6A/XII)

The C.C.I.R., (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 receiver should be available for either mains or battery operation. For battery operation, all three types of receiver should be fully transistorized to ensure economy of power consumption. For mains operation, either valves or transistors may be used, consideration 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 (see Recommendation 237).

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.

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 kHz

2.2 Sensitivity for 50 mW output 30% modulation at 400 Hz: 5 mV/m (with a built-in antenna with facilities for using an external antenna).

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 kHz
	at − 20 dB points	passband not greater than ± 10 kHz
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 Hz, within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–4000 Hz within 12 dB limits (in a graphical presentation 400 Hz 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 MHz B2 0·525–1·605; 2·3–21·75 MHz The receiver shall be provided with adequate mechanical and/or electrical means for easy tuning

3.2	Sensitivity for 50 mW output 30% modulation at 400 Hz	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 kHz
	at − 20 dB points	passband not greater than ± 10 kHz
	at − 40 dB points	passband not greater than ± 20 kHz
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
3.7	Overall fidelity including acoustic response of loudspeaker	250–3150 Hz within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–4000 Hz within 12 dB limits (in a graphical presentation 400 Hz 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 MHz
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 MHz
4.5	Amplitude-modulation suppression ratio	20 dB
4.6	Power output	not less than 0·1 W
4.7	Overall selectivity	− 30 dB at ± 300 kHz
4.8	Overall fidelity including acoustic response of loudspeaker	200–5000 Hz within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–5000 Hz within 6 dB limits (in a graphical presentation 400 Hz 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 kHz and ± 75 kHz with a modulation frequency of 400 Hz 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 6A/XII)

The C.C.I.R., (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 receivers should be simple, robust and well protected against dust. They 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 receiver 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, consideration 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 (see Recommendation 237).

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.

2. Specification for MF/HF community receiver

(Two types, differing only in frequency range)

2.1	Frequency coverage (MHz)	*(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 Hz	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 mW (at the nominal battery voltage less 30%)
2.5	Overall selectivity	
	at — 6 dB points	passband not less than ± 3 kHz
	at — 20 dB points	passband not greater than ± 10 kHz
	at — 40 dB points	passband not greater than ± 20 kHz
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 MHz)
	Image response ratio	not less than 5 dB (HF up to 21·75 MHz)
2.7	Overall fidelity including acoustic response of loudspeaker	250–3150 Hz within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–4000 Hz within 12 dB limits (in a graphical presentation 400 Hz 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 MHz (provision must be made for one or more channels to be pre-selected).
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 MHz
3.5	Amplitude-modulation suppression ratio	24 dB
3.6	Power output	Not less than 900 mW (at nominal mains or battery voltage) and not less than 400 mW (at the nominal battery voltage less 30%)
3.7	Overall selectivity	– 30 dB at ± 300 kHz
3.8	Overall fidelity including acoustic response of loudspeaker	200–5000 Hz within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100–5000 Hz within 6 dB limits (in a graphical presentation 400 Hz 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 kHz and ± 75 kHz with a modulation frequency of 400 Hz and an output power of 50 mW
3.11	Frequency stability	Must be such that the receiver does not require frequent retuning.

E. 4: Television

RECOMMENDATION 212 *

TELEVISION STANDARDS

The C.C.I.R., (1951—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 MHz from one edge and the sound carrier being 0·25 MHz 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 MHz 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., (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 to 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 417-1

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

The C.C.I.R. (1963—1966)

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 (O.I.R.T.) 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. — Further information concerning the planning of television services for sparsely populated regions is contained in Report 409.

Note 3. — 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 418-1

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

(Question 4/XI)

The C.C.I.R. (1963—1966)

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 Hz 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 (O.I.R.T.) system.

2. Interference within the same channel

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

2.1.1 *Carriers separated by less than 1000 Hz but not synchronized :*
Protection ratio: 45 dB *

2.1.2 *Carriers separated by less than 50 Hz, 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 $\pm$ 2·5 Hz.

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-modulated 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 Hz, but not synchronized :*

Protection ratio: 45 dB.

2.2.2 *Carriers separated by less than 50 Hz, 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 kHz :*
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 hertz is maintained at an appropriate multiple of the frame frequency with a variation in carrier-frequency difference less than 1·5 Hz.

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

sound carrier frequency is 1·5 MHz 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 MHz channel: – 6 dB.

For the various 625-line systems proposed for use in 8 MHz channels in bands IV and V, the table below 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 (See Report 308–1)	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 MHz 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, relative 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.

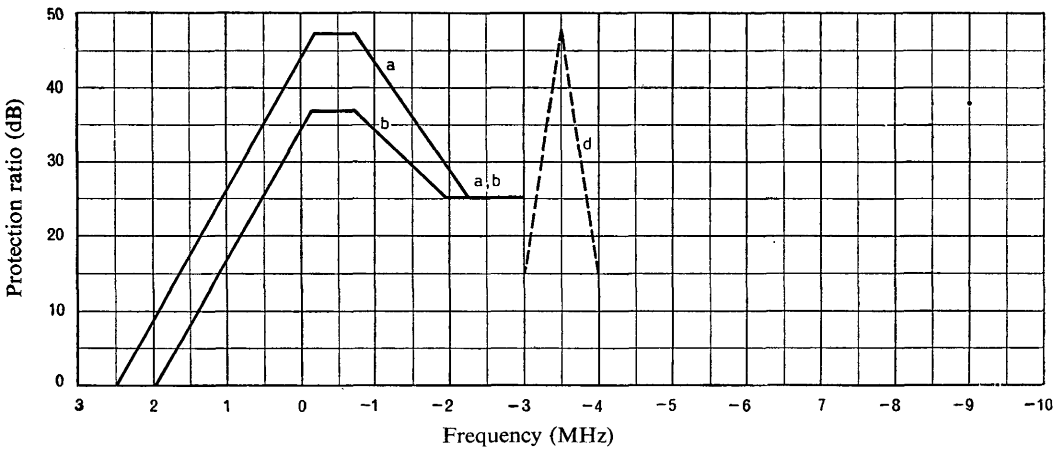
3.3 *Upper * adjacent-channel interference — bands I, III, IV and V*

Protection ratio: — for system *K*: 4 dB;
— for all other systems: – 12 dB.

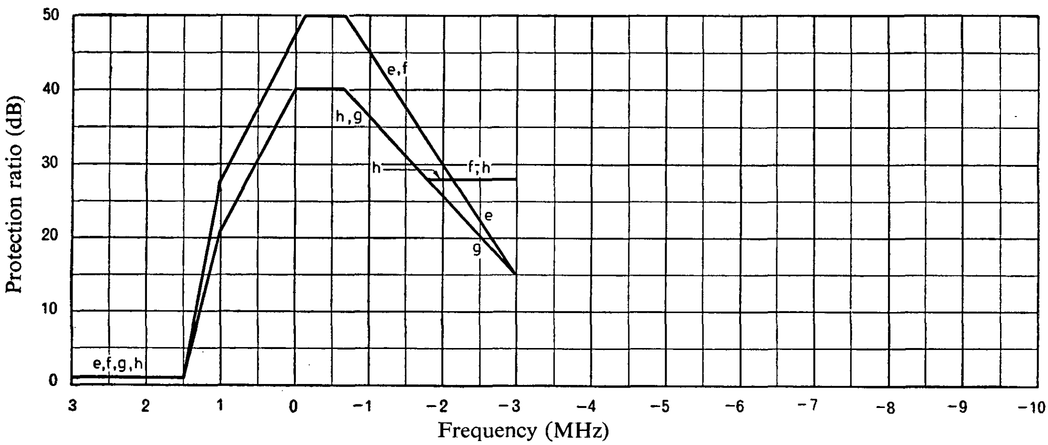
4. Overlapping-channel interference

Figs. 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.

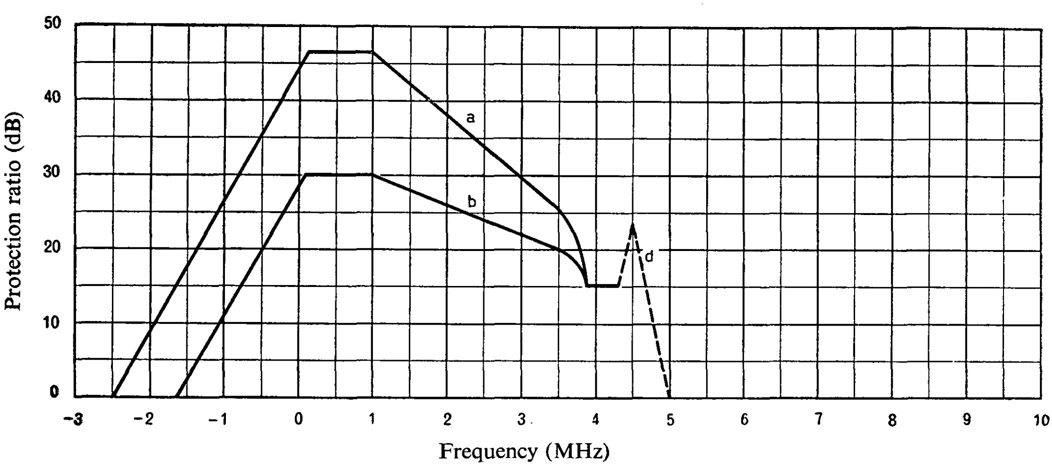
* Lower, for system *A* in bands I and III.



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



Protection ratio (dB)
50
40
30
20
10
0
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 (MHz)



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

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 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 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 Hz) plus or minus 3 to 5 kHz. 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, 5062·5 Hz.

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, 5062·5 Hz.

FIGURE 3

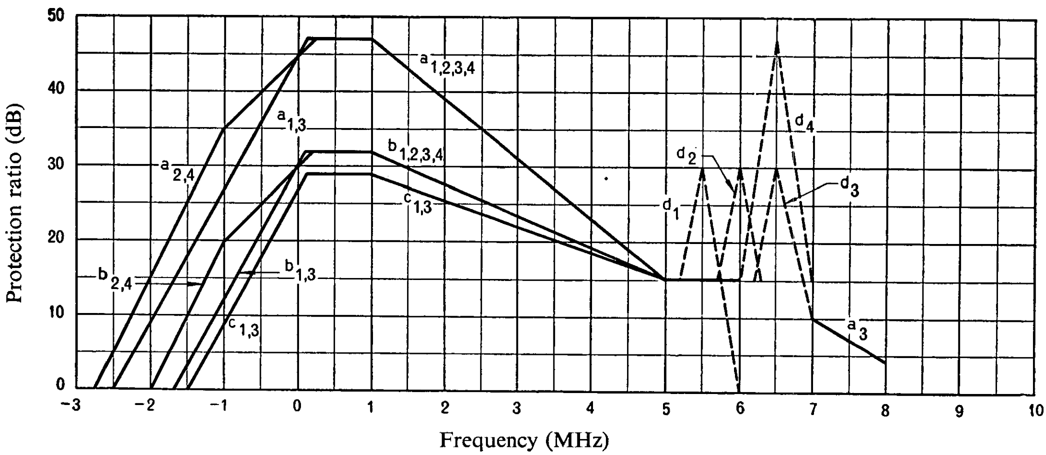
System M. Protection from vision signal interference

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

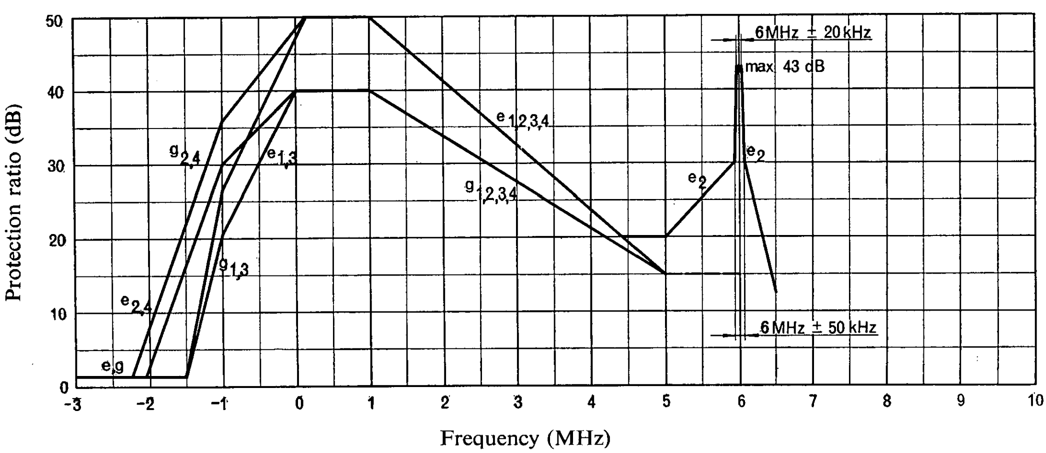
Curve *a* — Interference to vision from another 525-line vision signal with no special control of the nominal frequency difference between the carriers of the wanted and unwanted signals.

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 kHz) plus or minus one-third of the line-frequency (5·25 kHz).

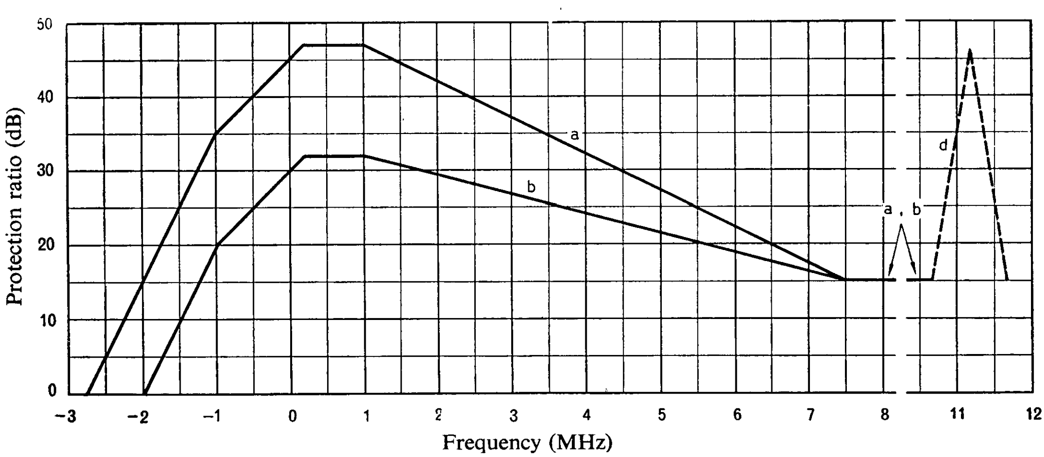
Curve *d* — Interference to sound signal from a 525-line vision signal.



Protection ratio (dB)
Frequency (MHz)
$a_{1,2,3,4}$
$a_{1,3}$
$a_{2,4}$
$b_{1,2,3,4}$
$b_{2,4}$
$b_{1,3}$
$c_{1,3}$
d_1
d_2
d_3
d_4
a_3



Protection ratio (dB)
Frequency (MHz)
6 MHz ± 20 kHz
max. 43 dB
$e_{1,2,3,4}$
$g_{2,4}$
$e_{1,3}$
$g_{1,2,3,4}$
e_2
$g_{1,3}$
$e_{2,4}$
e,g
6 MHz ± 50 kHz



Protection ratio (dB)
Frequency (MHz)
a
b
d
a , b

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 Hz), plus or minus one-third of the line-frequency (5208 Hz).

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 (7812·5 Hz).

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

* If a vestigial sideband of 1·25 MHz 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.

In the case of curve e_2, for the special case of interference from sound signals that conform to the frequency limits quoted in § 6 of this Recommendation the protection ratios quoted therein apply.

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 (7812·5 Hz).

* If a vestigial sideband of 1·25 MHz is used in system *K*, curves e_4, and g_4 should be used instead of curves e_3 and g_3.

FIGURE 6

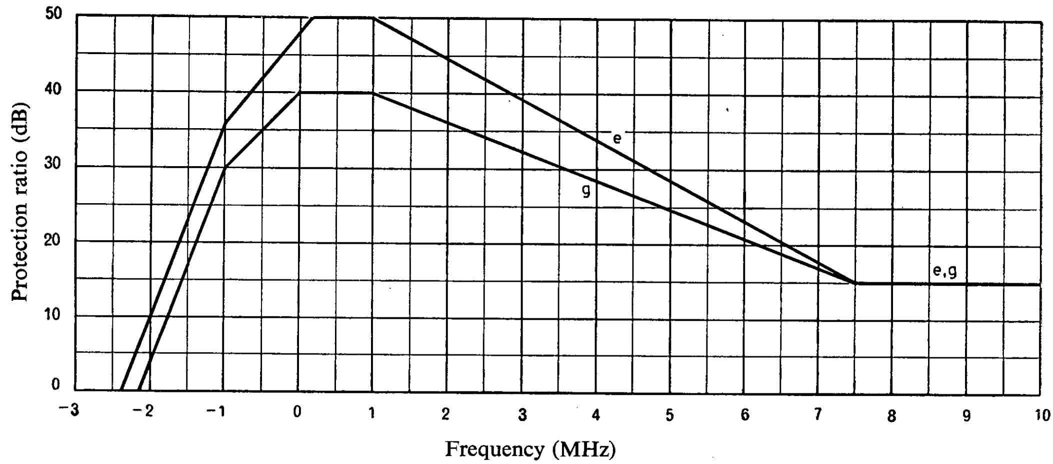
System E. Protection from vision-signal interference

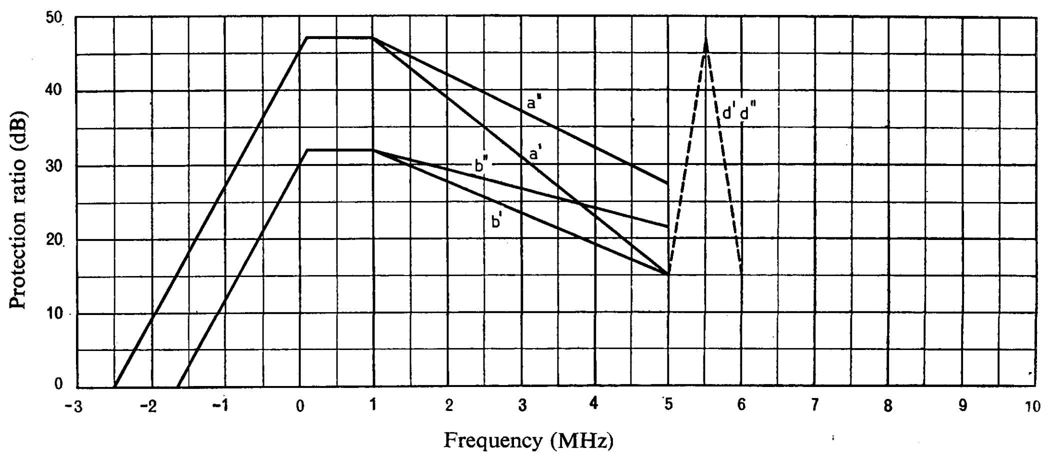
In all cases in this figure, the ratios quoted are those between the wanted and unwanted vision levels.

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 und 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 Hz), plus or minus one-third of the line-frequency (6825 Hz).

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


Protection ratio (dB)
e
g
e,g
Frequency (MHz)


Protection ratio (dB)
a"
a'
b"
b'
d' d"
Frequency (MHz)

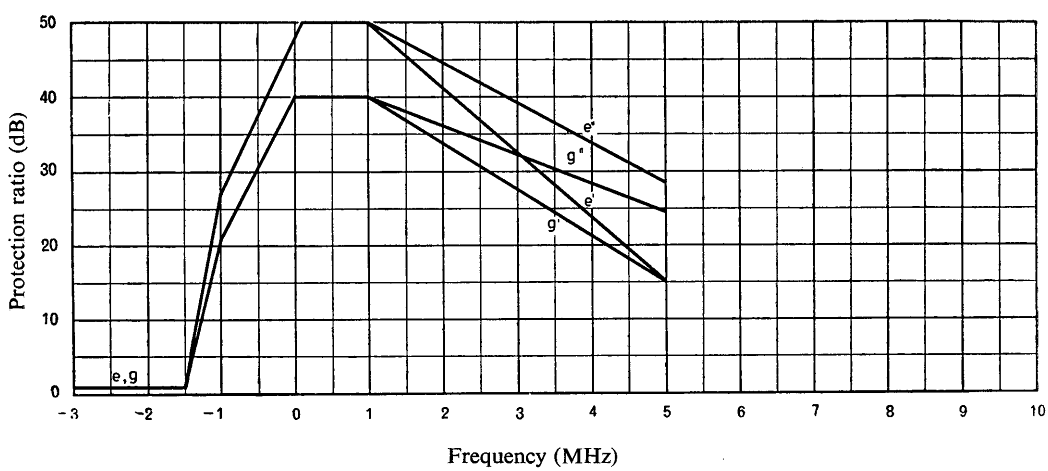

Protection ratio (dB)
e"
g"
e'
g'
e,g
Frequency (MHz)

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 (10 237·5 Hz).

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 Hz), plus or minus one-third of the line-frequency (5208 or 6825 Hz).

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 (7812·5 or 10 237·5 Hz).

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 purpose 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 O.I.R.T. 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 Hz: 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 Hz: 40 dB;
— for carriers separated by 25 kHz: 30 dB;
— for carriers separated by 50 kHz: 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. (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 ofvertical or horizontal polarization, when both the wanted and the unwanted signals 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.

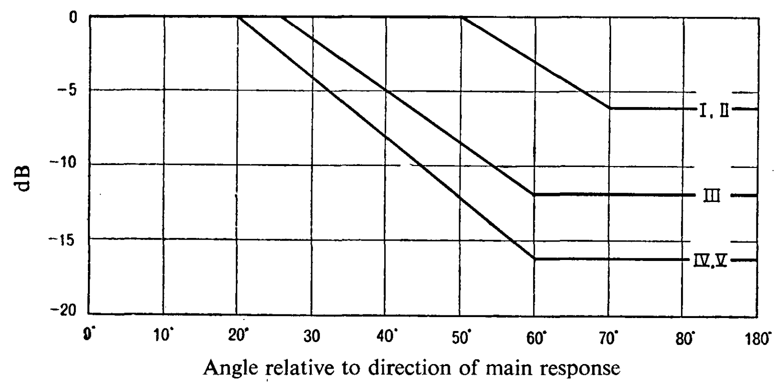


FIGURE 1

Discrimination obtained by the use of directional receiving antennae in broadcasting

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

RECOMMENDATION 420-1

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

(Question 1/CMTT and Study Programme 12A/XI)

The C.C.I.R., (1963—1966)

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 should be inserted in the field-blanking interval, made up as follows (Fig. 1):

1.1 *Bar signal*

- amplitude: white 0·7 ± 0·007 V
- duration: 5 H/32.
- rise and fall times: approximately 100 ns or alternatively may be derived from the shaping network of the sine-squared pulse.

1.2 *Sine-squared pulse*

- half-amplitude duration: 180 ± 20 ns.

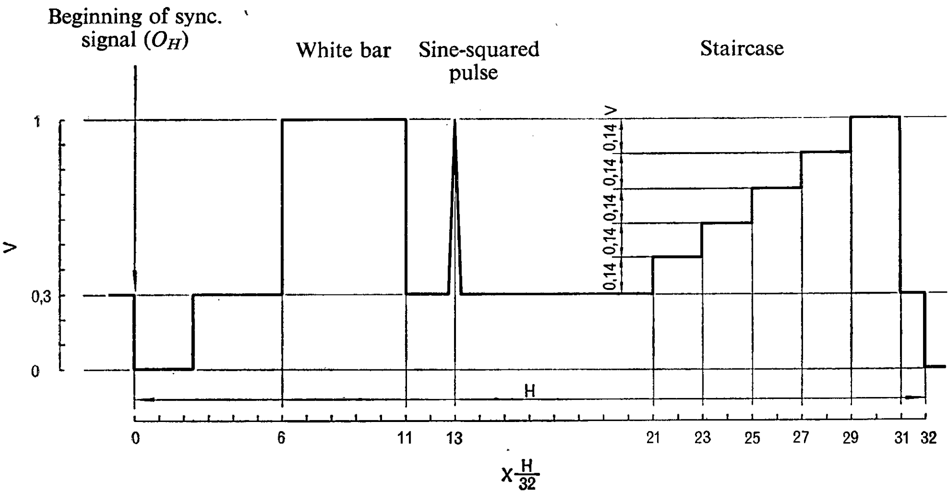
1.3 *5-riser staircase signal*

- height of risers = 0·14 V approximately;

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 308-1, 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 be removed or replaced only 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.



Beginning of sync. signal (O_H)
White bar
Sine-squared pulse
Staircase
1
0,3
0
V
0,14 0,14 0,14 0,14 0,14 V
H
0
6
11
13
21
23
25
27
29
31
32
$X\frac{H}{32}$

FIGURE 1

RECOMMENDATION 421-1

REQUIREMENTS FOR THE TRANSMISSION OF TELEVISION SIGNALS OVER LONG DISTANCES (SYSTEM I EXCEPTED)

The C.C.I.R., (1959—1963—1966)

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 television transmissions over long distances, common to the C.C.I.R. and the C.C.I.T.T.,

UNANIMOUSLY RECOMMENDS

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

1. Definitions

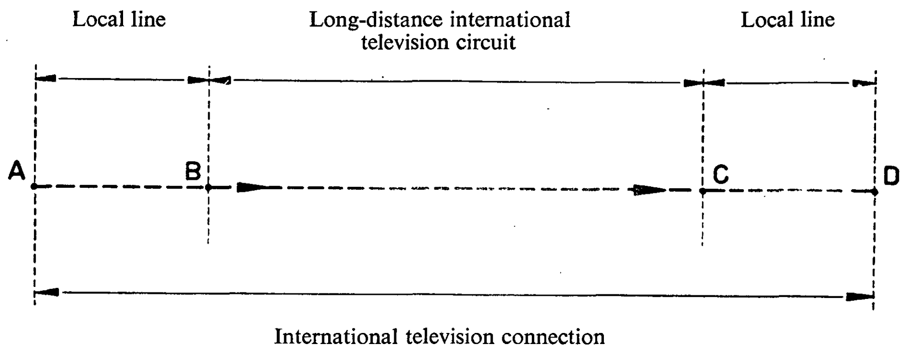


FIGURE 1

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 IV gives a provisional indication of the characteristics of circuits with more or fewer video sections 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 2500-km portion 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. (The return loss, relative to 75 Ω, of an impedance Z is

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

Note 1. — 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.

Note 2. — In some countries, impedance is specified in term of " waveform return loss " (see Docs. CMTT/9 (O.I.R.T.), 1963-1966 and Recommendation 451).

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).

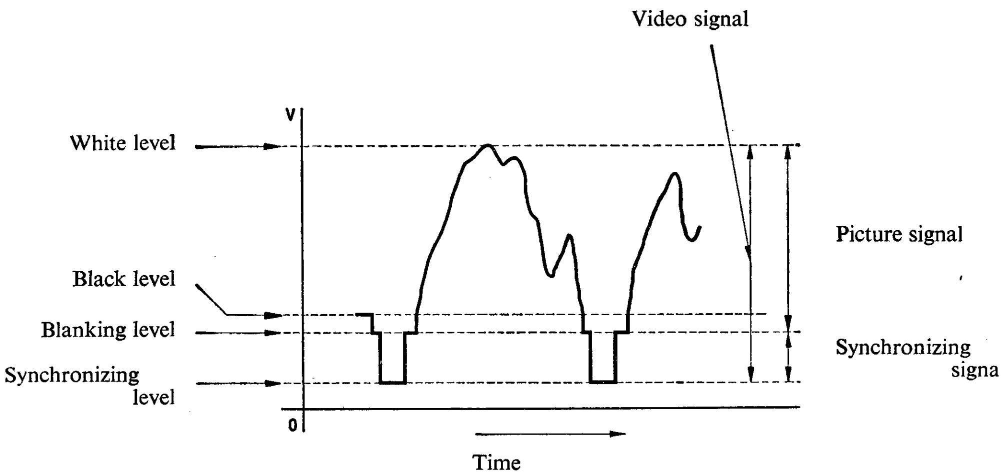


FIGURE 2

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).

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 1. — 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.

Note 2. — For colour in system M (Japan), the above specification applies to the luminance and synchronizing signals. For the chrominance signal, further study is required.

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: $\pm$ 0·3 dB ($\pm$ 0·2 dB in Canada and the U.S.A.),

— medium-period (e.g. 1 hr) variations: $\pm$ 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 kHz 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 1

System (See Report 308–1)	*M* (Canada and USA)	*M* (Japan) monochrome and colour	*B, C, G, H*	*D, K, L*	*F*	*E*
Number of lines	525	525	625	625	819	819
Nominal upper limit of video frequency band f_c (MHz)	4	4	5	6	5	10
Signal-to-weighted-noise ratio X (dB)	56	52	52	57	52	50

* 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.

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 II, 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 fall neither 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 Docs. XI/25, Moscow, 1958, CMTT/23, Monte Carlo, 1958, and CMTT/3, Paris, 1962, presented by the U.S.S.R.

TABLE II

System	*M* (Canada and U.S.A.)	*M* (Japan)	*B, C, G, H*	*D, K, L*	*F*	*E*
Number of lines	525	525	625	625	819	819
Nominal upper limit of video frequency band f_c (MHz)	4	4	5	6	5	10
Signal-to-noise ratio (dB) for power-supply hum (including the fundamental frequency and lower-order harmonics) (1)	35	30	30	30	30	30
Signal-to-noise ratio (dB) for single-frequency noise between 1 kHz and 1 MHz	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 MHz and f_c	43 (4)	30 (6)	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 kHz and 2 MHz.

(3) For system *E* for frequencies below 1 kHz 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 kHz and 45 dB at 100 Hz and between the values 45 dB at 100 Hz and 30 dB at 50 Hz.

(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 MHz and f_c.

(5) For system *E* this figure is reached at a frequency of 7 MHz and remains constant between 7 MHz and f_c (10 MHz)

(6) For colour in system *M* (Japan), the signal-to-noise ratio should not be less than 50 dB at 3·6 MHz.

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 noises 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.

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

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 system *M* (Canada and the U.S.A.), for which the requirement is 11 dB.

3.3.4 *Crosstalk :*

this matter is still under study

3.4 *Non-linearity distortion*

Non-linearity distortion affects both the picture and the synchronizing signals.

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.

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.

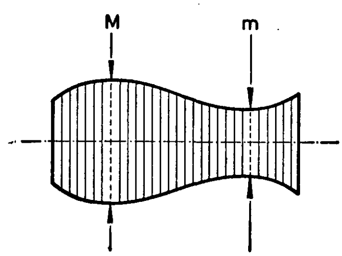


FIGURE 3

* The corresponding terms in French are respectively: distorsion de non-linéarité aux fréquences très basses, aux fréquences moyennes, aux fréquences élevées.

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 the form $(20 \log_{10} M/m)$ and for the hypothetical reference circuits should not exceed 2 dB.

For system *M* (Canada and the U.S.A.), the non-linearity distortion is measured with a superimposed sine-wave of 0·143 V peak-to-peak at 3·6 MHz and the results are expressed either as a percentage or in dB and should not be more than 13% or 1·2 dB respectively. For colour in system *M* (Japan), using the same test signal, the differential gain should not exceed 10%, and the differential phase should not exceed 5°.

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 Systems *B, C, D, E, F, G, H, K, L*

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.

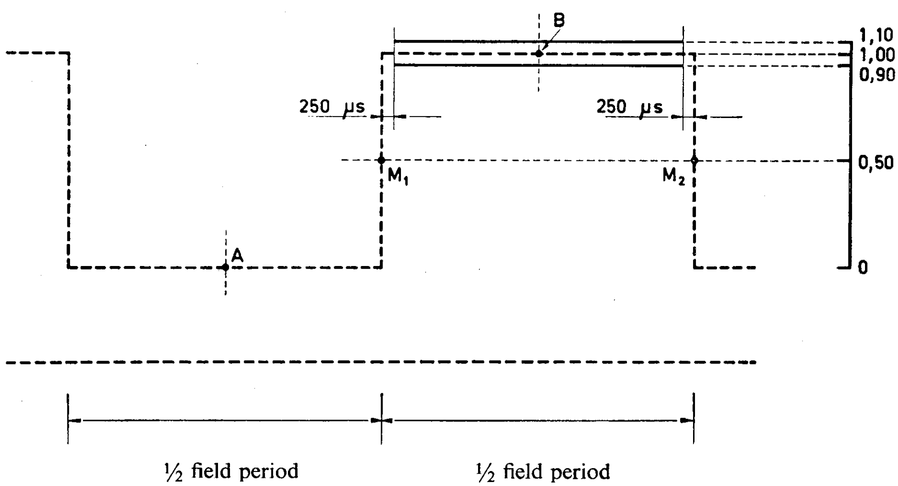


FIGURE 4

Waveform response to Test Signal No. 1

* In several countries, such measurements are at present being made using Test Signal No. 3 with a higher value than 0·2 f_c for the frequency of the superimposed sine-wave (see Doc. CMTT/41, Monte Carlo, 1958— Chairman's report).

3.5.1.2 System *M*

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 625- and 819-line systems.

3.5.2 *Line-time waveform distortion*

3.5.2.1 System *M*

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.

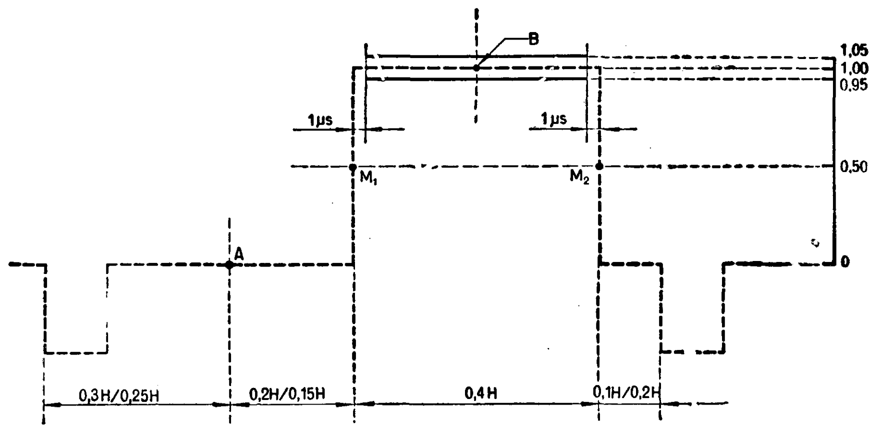


FIGURE 5

Waveform response to Test Signal No. 2

3.5.2.2 Systems *B, C, D, E, F, G, H, K, L*

For the hypothetical reference circuit, using Test Signal No. 2 (described in Annex I), with a rise-time of T (it may be necessary to use a rise-time of $2T$ for circuits which cut off sharply close to the nominal upper video-frequency limit), 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 System *M*

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-overshoot 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 systems *B, C, D, E, F, G, H, K, L*, the response being observed by means of the mask shown in Fig. 6. For the chrominance channel, further study is required.

μs	Upper limit	Lower limit
0·12	120	90
0·35	109	91
$\geqslant 1$	105	95

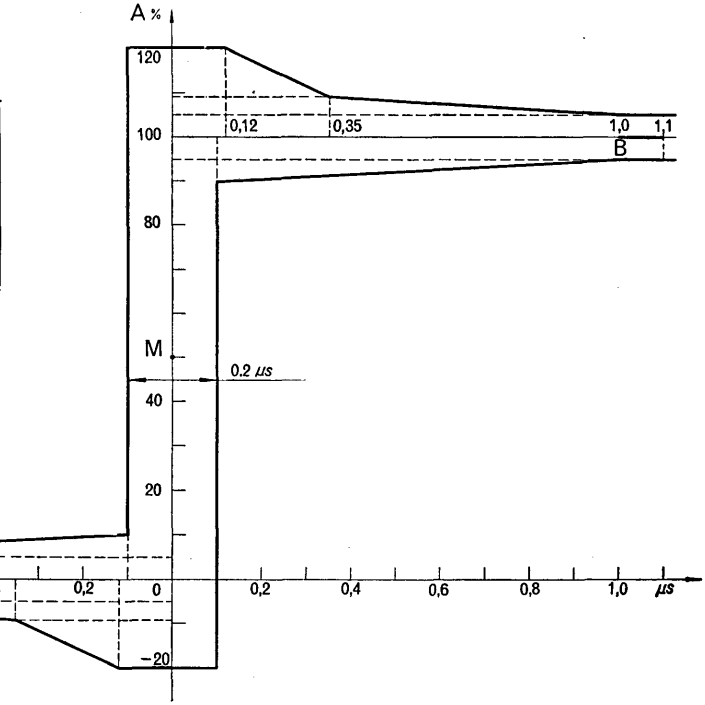


FIGURE 6

Mask for waveform response to Test Signal No. 2 for system M (Japan)

3.5.3.2 Systems *B, C, D, E, F, G, H, K, L*

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

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 be within the limits of the appropriate mask as follows:

— Fig. 7 for systems *D, K*.

— Fig. 8 for systems *B, C, E, F, G, H* (see Note).

Note. — For system *L*, 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 MHz).

3.6 *Steady-state characteristics*

3.6.1 System *M*

In Canada and the U.S.A., the design-objective limits are shown by the lines B in Figs. 10 and 11, the lowest frequency to which these limits apply being 0·0025 f_c.

μs	Upper limit	Lower limit
0·08	120	90
0·28	109	91
> 1	105	95

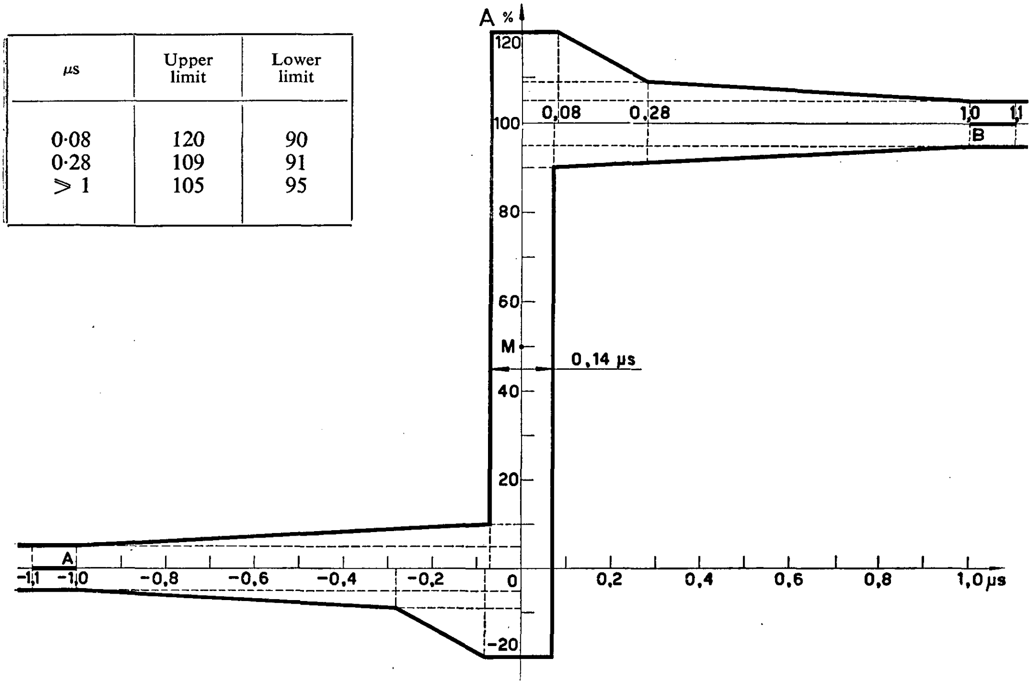


FIGURE 7

Provisional mask for waveform response to Test Signal No. 2 for systems D, K

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

Rise time (τ_e)	
System	τ_e (μs)
B, C, G, H	0·16
F	0·16
E	0·11

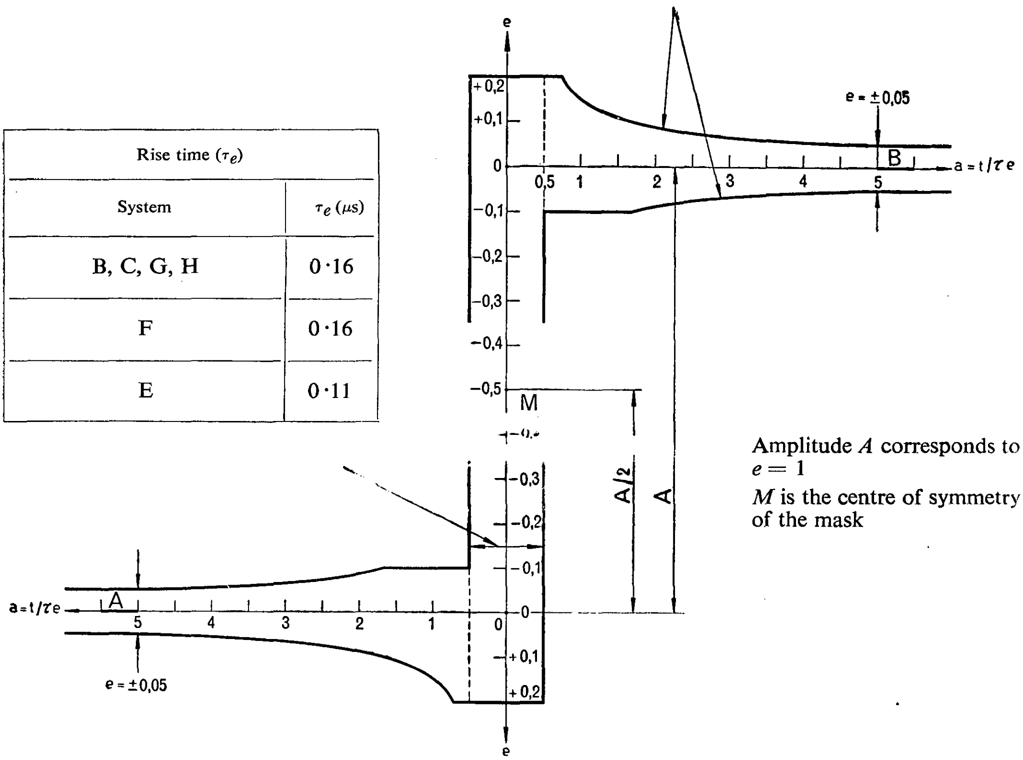


FIGURE 8

Mask for waveform response to Test Signal No. 2 of systems B, C, E, F, G, H

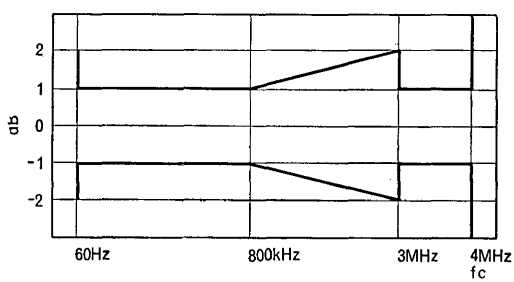


FIGURE 9

Limit for the attenuation/frequency characteristics of System M for colour television (Japan)

f_c: nominal upper limit of video-frequency band

In Japan the limits are as indicated below for the 625-line and 819-line systems, the appropriate value of f_c being 4 MHz. For colour, the attenuation/frequency limits are indicated in Fig. 9; the envelope-delay/frequency limits require further study.

3.6.2 Systems *B, C, D, E, F, G, H, K, L*

For the hypothetical reference circuit, the limits of the attenuation/frequency and envelope-delay/frequency characteristics given in Figs. 10 and 11 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).

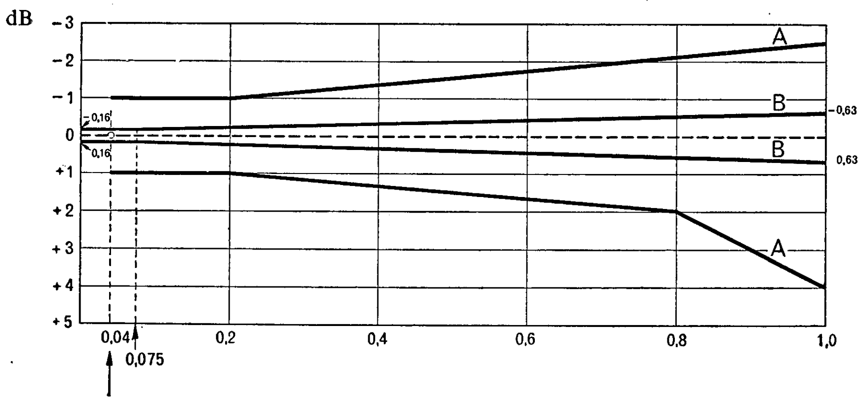


FIGURE 10

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

Curves A: With nominal upper limits of the video-frequency band f_c = 4 MHz, system *M* (Japan); 5 MHz, systems *B, C, F, G, H*; 6 MHz, systems *D, K, L*; 10 MHz, system *E*.

Curves *B*: For system *M* (Canada and the U.S.A.), f_c = 4 MHz.

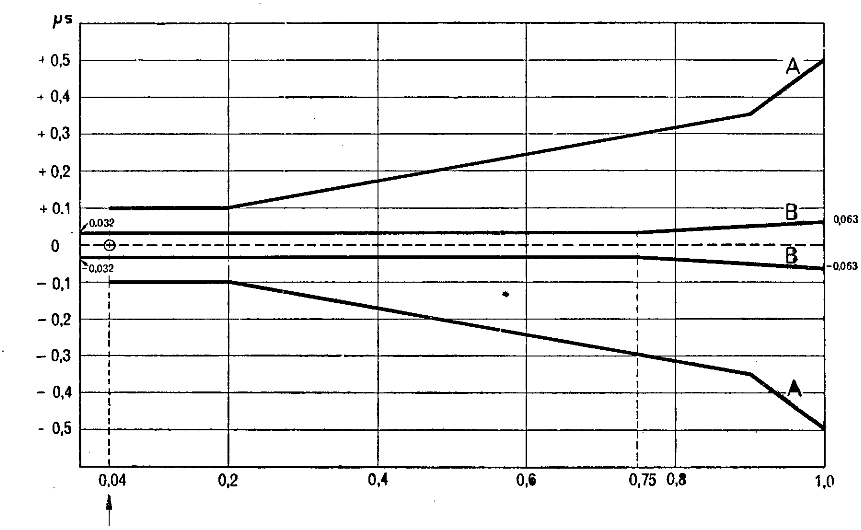


FIGURE 11

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

Curves *A*: With nominal upper limits of the video-frequency band f_c = 4 MHz, system *M* (Japan); 5 MHz, systems *B, C, F, G, H*; 6 MHz, systems *D, K, L*; 10 MHz, system *E*.

Curves *B*: For system *M* (Canada and the U.S.A.), f_c = 4 MHz.

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. 12 below, it comprises a square wave of field frequency superimposed upon line-synchronizing and blanking pulses. If desired, a field-synchronizing signal may be included and the pedestal may be omitted.

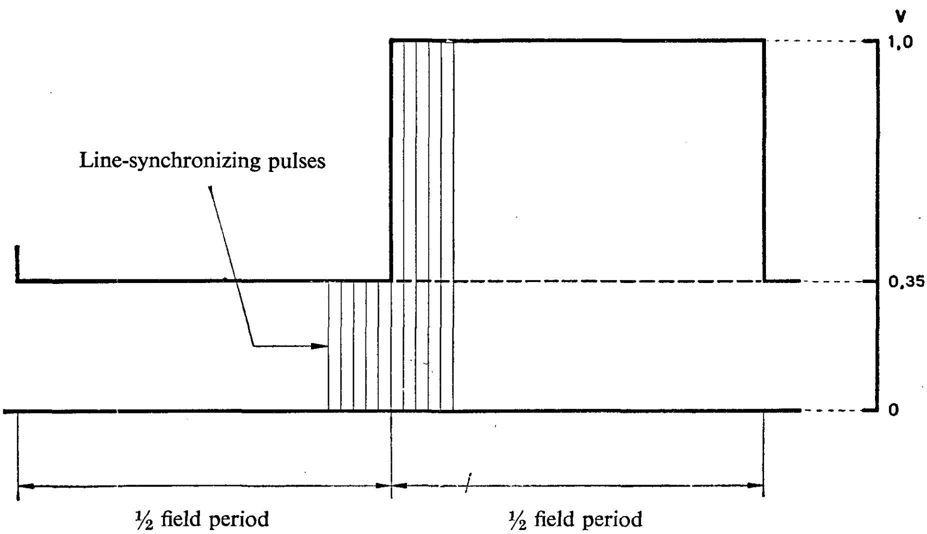


FIGURE 12

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. 13, 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. (Annex IV of the paper by Thomson contains a description of the appropriate network.)

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. For systems D and K, a sine-squared pulse of half-amplitude duration T or $2T$ is used.

* 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, Paris, 1962).

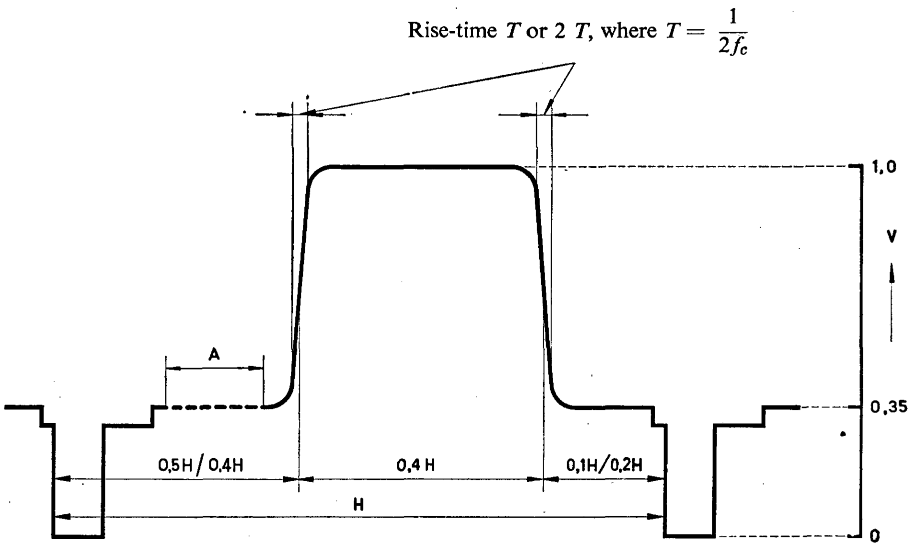


FIGURE 13

Test signal No. 2

3. Test signal No. 3 *

Test signal No. 3 is used in the measurement of non-linearity distortion. As shown in Fig. 14, it is a signal in which the " picture " portion of every fourth line consists of a

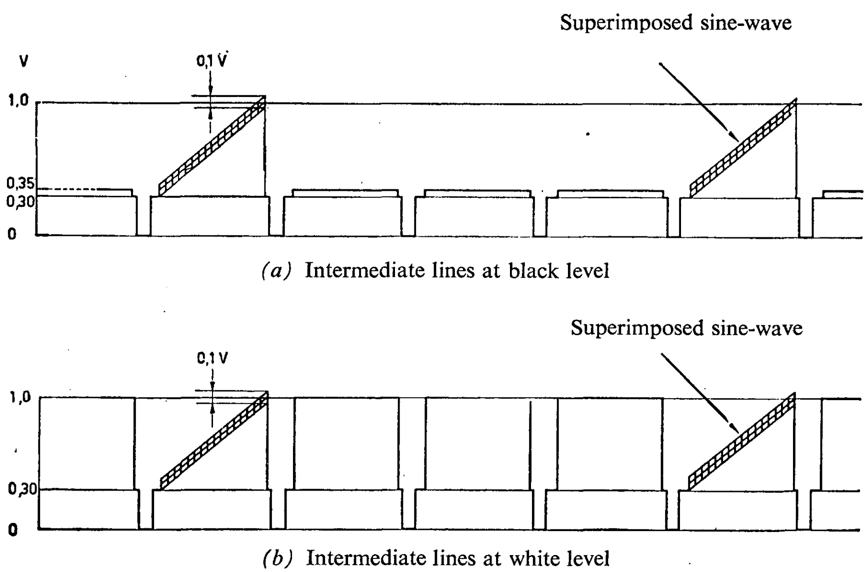


FIGURE 14

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, 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

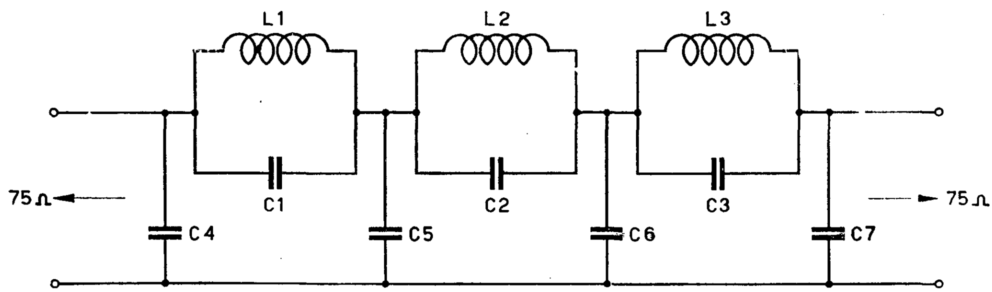
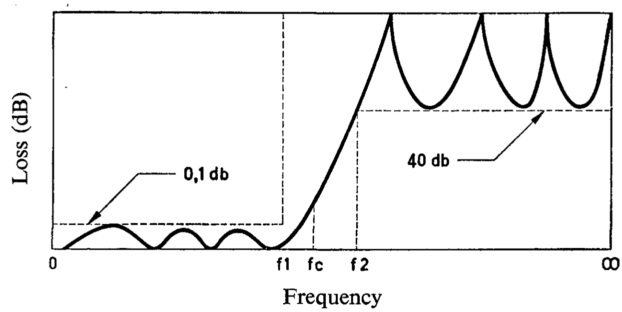


FIGURE 15

	Nominal upper video-frequency limit: f_c (MHz) *		
	L (μH)	C (pF)	f (MHz)
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		$1297/f_c$	

* For system M (Canada and the U.S.A.), a value of $f_c = 4{\cdot}2$ MHz is adopted for the design of the low-pass filter used for noise measurement.

f/fc	dB	f/fc	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.
$f_1 = 0{\cdot}9807\, f_c$
$f_2 = 1{\cdot}0897\, f_c$

FIGURE 16

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

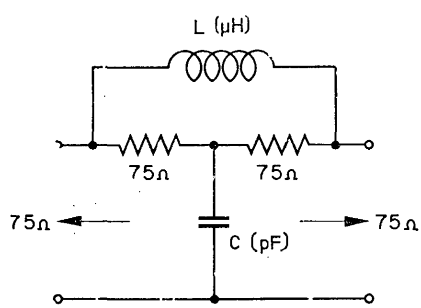
Note 2. — Each inductor should be adjusted to make the insertion loss a maximum at the appropriate indicated frequency, f (MHz).

Note 3. — The theoretical insertion loss curve above corresponds to an infinite Q-factor. In practice, Q should be at least of the order of 100 at frequency f_c.

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



$L\,(\mu\text{H}) = 75\,\tau\,(\mu\text{s})$; $C\,(\text{pF}) = [\tau\,(\mu\text{s})/75] \times 10^6$
Insertion loss (dB) $= 10 \log_{10} [1 + (2\pi\tau f)^2]$

FIGURE 17

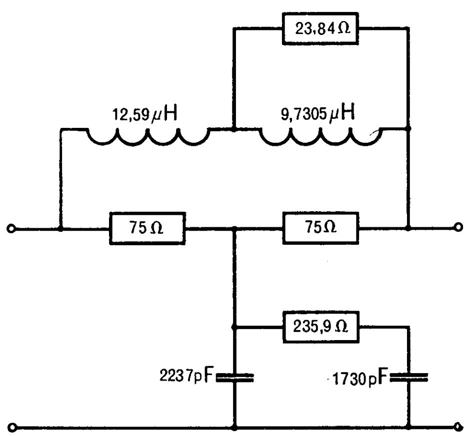
System	f_c(1) (MHz)	τ (μs)	τf_c	Theoretical weighting (dB), for:	
				" White " noise	" Triangular " noise
M (Canada and U.S.A.)		see Note 1		6·1	10·2
M (Japan)	4	0·415	1·66	8·5	16·3
B, C, G, H	5	0·33	1·66	8·5	16·3
D, K, L	6	0·33	2·0	9·3	17·8
F	5	0·33	1·66	8·5	16·3
E	10	0·166	1·66	8·5	16·3

(1) f_c is the nominal upper video-frequency limit of the system (MHz).

Note 1. — For system *M* (Canada and the U.S.A.), the following weighting characteristic is used:

Frequency (MHz)	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:

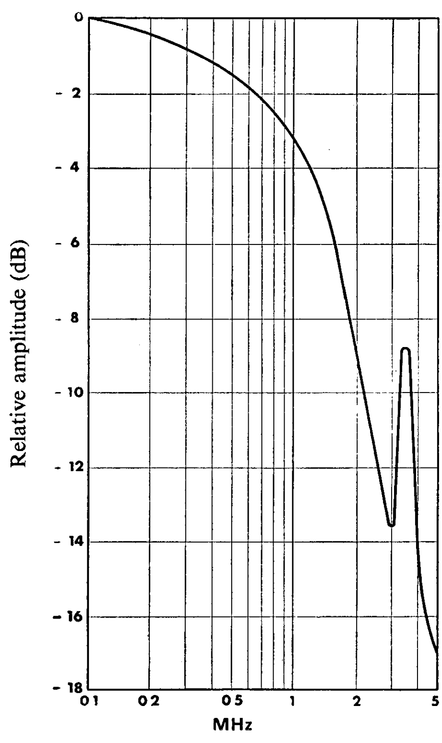


$$\text{Insertion loss (dB)} = 10 \log_{10} \{[1 + (f/f_1)^2]\,[1 + (f/f_2)^2]/[1 + (f/f_3)^2]\}$$

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

FIGURE 18

Note 2. — For system *M* (Japan), the weighting curve of Fig. 19 is used for colour (see WATANABE, K. Effects of continuous random noise on colour television pictures. Electrical Telecomm. Laboratory. Report No. 1528, N.T.T. Japan (1964).



Video frequency (MHz)

FIGURE 19

Weighting curve for continuous random noise of a 525-line television system

ANNEX IV

CIRCUITS HAVING MORE OR FEWER VIDEO SECTIONS THAN THE HYPOTHETICAL REFERENCE CIRCUIT

1. Introduction

The purpose of this Annex is to give some indication of the design objectives of hypothetical circuits that have more or fewer video-to-video sections than the three sections of the hypothetical reference circuit defined in § 1.2 of this Recommendation. The values calculable from Tables I and II provide only indications of the probable design objectives, which should be used with caution when considering specifications of actual circuits, because the law of addition is not precisely known for every type of impairment.

2. Laws of addition

If D_3 = design objective as expressed in this Recommendation, or the parameter derived therefrom and indicated in Table II, permitted in the hypothetical reference circuit,

and D_n = design objective, or the parameter mentioned above, permitted in n sections,

then $D_n = D_3 . (n/3)^{1/h}$,

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

Calculated values of $(n/3)^{1/h}$ are given in Table I.

TABLE I

n	$(n/3)^{1/h}$		
	$h = 1$	$h = 3/2$	$h = 2$
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
10	3·33	2·23	1·83
11	3·67	2·38	1·91
12	4·00	2·52	2·00
13	4·33	2·66	2·08
14	4·67	2·79	2·16
15	5·00	2·92	2·24

TABLE II

Relevant section of this Recommendation	Characteristic	D_3 expressed in	h	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 kHz to 1 MHz		2	3
	1 MHz to f_c		2	3
3.3.3	*Impulsive noise*	amplitude of noise		4
3.4	*Non-linearity distortion*			
3.4.2	Picture signal	$(1\text{-}m/M) \times 100\%$	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	6
3.5.3	Short-time			
	Overshoot and ringing	mask	2	6
	Rise-time	μs	no law	
3.6	*Steady-state characteristics*			
	Attenuation/frequency	dB	3/2	5
	Envelope-delay/frequency	μs	3/2	5

Note 1. — For circuits on coaxial cables, quadratic addition ($h = 2$) applies to random noise expressed in terms of r.m.s. voltage. For circuits on radio-relay links, see Recommendation 289.

Note 2. — Considering the probability of arithmetic addition of power-supply hum in circuits of few sections, it may be advisable to put $h = 1$ when $n \leqslant 3$.

Note 3. — Considering the probability of arithmetic addition when periodic noise consists of a few components that are very close in frequency, it may be advisable to put $h = 1$, when the number of such components is small.

Note 4. — When each of a number of sources of impulsive noise is operative for a small percentage of the time (e.g. $< 0{\cdot}1\%$), arithmetic addition of the percentage will apply.

Note 5. — In Canada and U.S.A., the practice is to use $h = 2$.

Note 6. — For systems *D* and *K*, the method outlined in Doc. CMTT/60, 1963-1966 could be used.

3. **Examples of the use of Tables I and II**

3.1 In the hypothetical reference circuit, if the tolerance on gain is $\pm$ 1 dB, the tolerance on gain for a video section will (with $h = 2$) 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 $h = 2$):

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:

$$\frac{S}{D_9} = \frac{S}{D_3} \times \frac{1}{1{\cdot}73}$$

or, in dB: $\left(\frac{S}{D_9}\right)$ dB $= 50 - 4{\cdot}8$, 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 $h = 3/2$):

$$D_1 = D_3\,(1/3)^{2/3} = D_3 \times 0{\cdot}48$$

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

RECOMMENDATION 451

REQUIREMENTS FOR THE TRANSMISSION OF TELEVISION SIGNALS OVER LONG DISTANCES (SYSTEM I ONLY)

The C.C.I.R., (1966)

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 television transmissions over long distances, common to the C.C.I.R. and C.C.I.T.T.,

UNANIMOUSLY RECOMMENDS

that, taking account of the definitions in Part 1, television transmissions over long distances for system I should satisfy the requirements laid down in Part 2 and its Annex.

The requirements for the transmission of other systems are contained in Recommendation 421-1 and Report 316-1. The existence of this new Recommendation does not necessarily imply that the requirements for other systems will later be included in this Recommendation or that their requirements will be changed in form.

PART 1 — DEFINITIONS

1. Definition of a long-distance international television connection (see Fig. 1 of Recommendation 421-1)

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.

1.2 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.

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

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.

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

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.*

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 of Recommendation 421-1) 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. — The Annex to Part 1 gives a provisional indication of the characteristics of circuits having more or fewer sections than the hypothetical reference circuit.

ANNEX TO PART 1

CIRCUITS HAVING MORE OR FEWER SECTIONS THAN THE HYPOTHETICAL REFERENCE CIRCUIT

1. Introduction

The purpose of this Annex is to give some indication of the design objectives of hypothetical circuits that have more or fewer video-to-video sections than the three of the hypothetical reference circuit defined in § 2 of Part 1 of this Recommendation. The values calculable from Tables I and II provide only indications of the probable design objectives, which should not be used directly when studying the design of equipment because the law of addition is not precisely known for every type of impairment.

2. Laws of addition

If D_3 = design objective as expressed in this Recommendation, or the parameter derived therefrom and indicated in Table II, permitted in the hypothetical reference circuit

and D_n = design objective, or the parameter mentioned above, permitted in n sections,

then $D_n = D_3 . (n/3)^{1/h}$,

where h has the value 1, 3/2 or 2 in accordance with Table II; $h = 1$ gives linear or arithmetic addition, $h = 3/2$ gives the " three-halves power " law of addition, and $h = 2$ gives quadratic (r.s.s.) addition.

Calculated values of $(n/3)^{1/h}$ are given in Table I.

TABLE I

n	$(n/3)^{1/h}$		
	$h = 1$	$h = 3/2$	$h = 2$
1	0·33	0·48	0·58
2	0·67	0·76	0·82
3	1·00	1·00	1·00
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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
10	3·33	2·23	1·83
11	3·67	2·38	1·91
12	4·00	2·52	2·00
13	4·33	2·66	2·08
14	4·67	2·79	2·16
15	5·00	2·92	2·24

TABLE II

Parameter	Section of Part 2	D_3 expressed in terms of	h	Notes
Insertion gain (error)	4.1	dB	2	
Insertion gain variations	4.2	dB	2	
Continuous random noise				
Luminance channel	4.3.1	—	—	1
Chrominance channel	4.3.2	—	—	1
Periodic noise				
Power-supply hum	4.4	noise voltage	2	2
Single-frequency	4.4	noise voltage	2	3
Impulsive noise	4.5	noise voltage	—	4
Non-linearity distortion, picture signal				
Luminance channel	4.6.1	%	3/2	
Chrominance channel				
Differential gain	4.6.2	%	3/2	
Differential phase	4.6.2	degrees	3/2	
Non-linearity distortion, synchronizing signal	4.7	%	3/2	
Linear waveform distortion				
Luminance channel	4.8.1	%	3/2	
Chrominance channel	4.8.2	%	3/2	
Luminance-chrominance inequalities				
Gain inequality	4.9.1	%	2	5
Delay inequality	4.9.2	ns	2	5
Frequency characteristics				
Attenuation	—			
Envelope delay	—			

Note 1. — For circuits on coaxial cables, quadratic addition ($h = 2$) applies to random noise expressed in terms of r.m.s. voltage. For circuits on radio-relay links, see Recommendation 289.

Note 2. — Considering the probability of arithmetic addition of power-supply hum in circuits of few sections, it may be advisable to put $h = 1$ when $n \leqslant 3$.

Note 3. — Considering the probability of arithmetic addition when periodic noise consists of a few components that are very close in frequency, it may be advisable to put $h = 1$ when the number of such components is small.

Note 4. — When each of a number of sources of impulsive noise is operative for a small percentage of the time (e.g. $< 0{\cdot}1\%$), arithmetic addition of the percentages will apply.

Note 5. — Quadratic addition ($h = 2$) for gain and delay inequalities is based on the assumption that positive and negative values are made equally likely by the use of correcting networks or equivalent means.

PART 2 — REQUIREMENTS FOR SYSTEM I

1. Introduction

In this Part are given the methods of testing and the limits and tolerances applicable to the hypothetical reference circuit for System *I*, i.e. the 625-line system having a nominal video bandwidth of 5·5 MHz.

2. Basic concepts

The requirements are based upon two concepts. The first follows from the fact that the composite colour signal may be regarded as the sum of a luminance signal (similar to a monochrome signal, including the line- and field-synchronizing pulses) and a chrominance signal (the modulated sub-carrier conveying the hue and saturation information, and the colour burst). A colour-television link may therefore be regarded as the combination of a " luminance channel " and a " chrominance channel " in overlapping frequency bands. For both specifying and testing purposes, it is convenient to deal with:

— the permissible distortion and noise impairments in these two channels taken separately;

— the permissible inequalities of gain and delay of the two channels taken in association.

The requirements for the luminance channel are assumed to be identical with those for monochrome transmission.

The second concept is based upon the consideration that it is sufficient in practice to specify and test the performance of the chrominance channel as though it were intended to carry a simple double-sideband amplitude-modulated signal. The test signals thus include sub-carrier elements modulated by waveforms chosen to suit the nominal bandwidth of the chrominance channel.

Applying these concepts to System *I* for the purpose of this Recommendation, the luminance-channel band is deemed to extend up to 5 MHz, and the chrominance-channel band from approximately 3·5 to 5·5 MHz, i.e. the baseband of the chrominance signal is deemed to extend up to 1 MHz. These assumptions do not imply restrictions upon the transmission of any luminance-signal components in the range 5·0 to 5·5 MHz, or chrominance-signal components below 3·5 MHz.

3. General requirements

3.1 *Impedance*

At points of video interconnection, the input and output impedance of each link should be unbalanced to earth with a nominal value of 75 Ω resistive and a return loss of at least 30 dB relative to 75 Ω.

The conventional frequency-domain interpretation of this requirement is that the return loss should be at least 30 dB at any frequency within the video band. A time-domain interpretation is, however, more convenient and useful because the technique of measurement is simpler and the results are more directly related to the picture impairments caused by mismatched impedances. The " waveform return loss ", as it may be termed, is measured with a television-type test signal and the result is taken as the ratio, expressed in decibels, of the peak-to-peak voltages of the " picture " portions of the incident and reflected waveforms. This result is numerically the same as the conventional one if the return loss is independent of frequency. Provisionally, it is required that the waveform return loss, relative to 75 Ω, shall be at least 30 dB when measured with each of the test signals shown in Figs. 1, 2 and 4.

3.2 *Polarity and d.c. component*

At points of video interconnection, 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 signal and need not be transmitted or delivered at the output.

Any non-useful d.c. component unrelated to the signal (e.g. the component due to d.c. supplies) should not cause more than 100 mW to be dissipated in a 75 Ω load impedance. If the load impedance is disconnected, the voltage of this component should not exceed 5 V.

3.3 *Signal amplitude*

At points of video interconnection, the nominal peak-to-peak amplitude of the picture luminance signal, between blanking level and white level, should be 0·7 V, and the nominal amplitude of the synchronizing pulses should be 0·3 V. The nominal peak-to-peak amplitude of the video signal is thus 1·0 V although it is recognized that this value may occasionally be exceeded during transmission of colour signals.

4. Transmission performance requirements

4.1 *Insertion gain*

Insertion gain should be measured under the following conditions. At the sending end, a 75 Ω generator of the $2T$ pulse-and-bar test signal shown in Fig. 1 should be adjusted so that, if connected directly to a 75 Ω load, the bar amplitude would be 0·7 V and the synchronizing pulse amplitude 0·3 V. The sine-squared pulse is ignored in this application. At the receiving end, the bar amplitude (between the points B and W shown in Fig. 10) should be measured with a 75 Ω oscilloscope. The ratio, expressed in dB, of this amplitude to 0·7 V is taken as the insertion gain.

After initial or routine adjustment, the insertion gain should be within the limits $0 \pm 0{\cdot}5$ dB.

4.2 *Variations in the insertion gain*

Any variations of insertion gain with time should not exceed the following limits:

- short-period variations (e.g. 1 s) $\pm$ 0·2 dB;
- medium-period variations (e.g. 1 h) $\pm$ 0·5 dB.

Long-period variations are not specified because they would generally be corrected by the normal routine adjustments.

The foregoing refers only to insertion gain as defined in § 4.1. When considering variations of gain with time, the permissible limits of luminance-chrominance gain inequality given in § 4.9.1 should not be overlooked.

4.3 *Continuous random noise*

The signal-to-weighted-noise ratio for continuous random noise is defined as the ratio, expressed in dB, of the nominal peak-to-peak amplitude of the picture luminance signal to the r.m.s. amplitude of the noise measured under the following conditions:

- the noise is passed through a specified bandpass filter to delimit the effective frequency range, and also through a specified weighting network, or equivalent;
- the measurement is made with an instrument having, in terms of power, an effective time constant or integrating time of 1 s.

4.3.1 *Luminance channel*

The nominal frequency range is 10 kHz to 5 MHz. The lower limit is determined by the high-pass member of the junction filter shown in Fig. 6; its purpose is to exclude power-supply hum and microphony noise. The upper limit is determined by the low-pass filter shown in Fig. 7. The weighting network is shown in Fig. 8; it has a time constant of 200 ns giving a weighting effect of 6·5 dB for flat random noise and 12·3 dB for triangular random noise.

The signal-to-weighted-noise ratio should not fall below 52 dB for more than 1% of any month nor below 44 dB for more than 0·1% of any month.

4.3.2 *Chrominance channel*

The nominal frequency range is 3·5 to 5·5 MHz, determined by the combined bandpass filter and weighting network shown in Fig. 9. For each sub-carrier sideband, the filter provides a weighting effect which is approximately equal to that of the luminance weighting network in the 0 to 1 MHz band.

The signal-to-weighted-noise ratio should not fall below 46 dB for more than 1% of any month nor below 38 dB for more than 0.1% of any month.

4.4 *Periodic noise*

The signal-to-noise ratio for periodic noise is defined as the ratio, expressed in decibels, of the nominal peak-to-peak amplitude of the picture luminance signal to the peak-to-peak amplitude of the noise.

For power-supply hum including lower-order harmonics, the signal-to-noise ratio should not be less than 35 dB. The measurement is made through the low-pass member of the junction filter shown in Fig. 6.

For single-frequency noise between 1 kHz and 5·5 MHz, the signal-to-noise ratio should not be less than 55 dB.

4.5 *Impulsive noise*

The signal-to-noise ratio for impulsive noise is defined as the ratio, expressed in decibels, of the nominal peak-to-peak amplitude of the picture luminance signal to the peak-to-peak amplitude of the noise.

For impulsive noise of a sporadic or infrequently-occurring nature, the signal-to-noise ratio should not be less than 25 dB.

4.6 *Non-linearity distortion, picture signal*

Line-time non-linearity distortions in the luminance and chrominance channels are measured with the test signal shown in Fig. 3, consisting of a 5-riser staircase, with superimposed sub-carrier, in every fourth line. Separate measurements are made with the three intermediate lines at black level and white level, and the higher value of distortion is taken as the result.

4.6.1 *Luminance channel*

At the receiving end, the test signal is passed through a differentiating and shaping network (see Doc. CMTT/3, Monte Carlo, 1958), whose effect is to eliminate the sub-carrier and transform the staircase into a train of 5 pulses of approximately sine-squared shape with 2 μs half-amplitude duration. Comparing the amplitudes of the pulses, the numerical value of the distortion is found by expressing the difference between the largest and smallest amplitude as a percentage of the largest.

The distortion should not exceed 12%. In addition, when the test signal is sent at 3 dB above normal amplitude (i.e. 1·4 V peak-to-peak), the distortion should not exceed 24%.

4.6.2 *Chrominance channel*

At the receiving end, the sub-carrier is filtered from the rest of the test signal and its six sections are compared in amplitude and phase. Taking the blanking-level section of sub-carrier as reference, the differential gain is defined as the largest departure from the reference amplitude, expressed as a percentage, and the differential phase is defined as the largest departure from the reference phase-angle, expressed in degrees. (It seems desirable to seek a method of deriving numerical values which are more closely related to picture impairment.)

Provisionally, the differential gain should not exceed ± 8%, and the differential phase should not exceed ± 4°. In addition, when the test signal is sent at 3 dB above normal amplitude, the distortions should not exceed ± 16% and ± 8° respectively.

4.7 *Non-linearity distortion, synchronizing signal*

The distortion is expressed in terms of percentage departure of the mid-point amplitude of the line-synchronizing pulse from its nominal amplitude, i.e. 0·3 V for a circuit having zero insertion gain as defined in § 4.1. Using the staircase test signal shown in Fig. 3, separate measurements are made with the three intermediate lines at black level and white level, and the higher value of distortion is taken as the result.

The distortion should not exceed ± 10%. In addition, when the test signal is sent at 3 dB above normal amplitude, the distortion should not exceed ± 20%.

4.8 *Linear waveform distortion*

4.8.1 *Luminance channel*

The short-time, line-time and field-time linear distortions in the luminance channel are found from the waveform responses to the pulse-and-bar and 50 Hz square-wave test signals shown in Figs. 1 and 2. The result is expressed as a rating factor *K* by the method described in the Annex to Part 2.

The rating factor should not exceed 3%.

4.8.2 *Chrominance channel*

The short-time and line-time linear distortions in the chrominance channel are found from the waveform responses to the pulse-and-bar modulated sub-carrier test signal shown in Fig. 4. The result may be expressed by a rating factor analogous to that of the luminance channel but a limit cannot be proposed until more experience has been gained.

4.9 *Luminance-chrominance inequalities*

Gain and delay inequalities between the luminance and chrominance channels are measured with the composite test signal shown in Fig. 5. It consists essentially of added luminance and chrominance signal elements which are equal in single-peak amplitude and coincident in time. At the receiving end, two calibrated variable networks are adjusted to annul any inequality of amplitude or delay.

4.9.1 *Gain inequality*

The gain inequality, expressed as the percentage departure of the amplitude of the chrominance element from the amplitude of the luminance element, both measured at the mid-point of the bar, should not exceed ± 10%.

4.9.2 *Delay inequality*

The delay inequality should not exceed ± 100 ns.

ANNEX TO PART 2

LINEAR WAVEFORM-DISTORTION, LUMINANCE CHANNEL

1. Introduction

This Annex describes two complementary methods of specifying the linear transmission performance of a luminance channel. The first, or " routine-test method ", is rapid but less precise because it relies on direct oscilloscopic observation of the responses to prescribed test signals, and because the spectrum of one of these signals unavoidably extends beyond the nominal 5 MHz limit of interest. The second, or " acceptance-test method ", is slow but more precise because a process of computation applied to a series of waveform ordinates enables irrelevant information to be eliminated and certain measuring equipment errors to be corrected.

The performance limits are given in terms of a rating factor, K, for which numerical values are assigned in the individual specifications of links and equipment. Rating factors may range from 0.5% ($K = 0.005$) for a short-distance link up to several percent for a chain of long-distance links.

2. Routine-test method

To meet a specified rating factor, K, the responses to the pulse-and-bar and 50 Hz square-wave test signals shown in Figs. 1 and 2 should fall within the following limits.

2.1 2T *bar response*

The limits are indicated by the oscilloscope mask shown in Fig. 10. In effect, 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 midpoints of the $H/2{\cdot}5$ " black " and " white " portions coincide with B and W respectively. The response should then fall within the $\pm$ K limits indicated by the full lines, which extend to $H/100$ from the half-amplitude point of each transition.

2.2 2T *pulse response*

The limits are indicated by the oscilloscope mask shown in Fig. 11. In effect, 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.

2.3 2T *pulse/bar ratio*

The ratio of the amplitude of the $2T$ pulse response to the amplitude of the $2T$ bar response should fall within the limits $1/(1 \pm 4\ K)$, where the pulse amplitude is the difference between the " black " level and the peak of the response, and the bar amplitude is the difference between the points B and W already defined. The limits are included in the mask shown in Fig. 10.

2.4 T *pulse response*

To meet the luminance-channel requirements, the T pulse response should not show appreciable ringing at a frequency below $5{\cdot}0$ MHz, irrespective of the assigned rating factor. This is only of academic interest for System I because the chrominance-channel requirements are such that the ring frequency should not be less than $5{\cdot}5$ MHz.

Other limits cannot be specified rigidly because the spectrum of the *T* pulse extends far beyond 5 MHz, and the response must therefore contain irrelevant information. A partial solution is found in the insertion of a " 5·3 MHz link filter " between the link and the oscilloscope. This is a member of a series of delay-equalized low-pass filters designed to have good waveform responses; its insertion loss is almost constant up to 5·0 MHz, thence increases by about 3 dB at 5·3 MHz (the ring frequency) and 20 dB at 5·7 MHz. Being dominant in determining the overall upper cut-off characteristic, it substantially attenuates the irrelevant components of the response. The *T* pulse/bar ratio of the overall response is then a useful feature for measurement; it is closely related to the ratio which forms the basis of restriction (3) in the acceptance-test method (§ 3.2).

It has been found empirically that, to meet a specified rating factor, *K*, the *T* pulse/bar ratio of the link plus filter should fall within the limits $0 \cdot 84/(1 \pm 6K)$. 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 amplitudes to be expected under normal conditions:

Lobe	Upper limit of lobe amplitude expressed as 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.

2.5 *50 Hz square-wave response*

The limits are indicated by the oscilloscope mask shown in Fig. 12. As for the *2T* bar response, the oscilloscope is to be adjusted so that the waveform passes through the four marked points, the line-synchronizing pulses being ingored.

3. Acceptance-test method

3.1 2T *bar response*

The limits are identical with those given in § 2.1 for the routine-test method.

3.2 T *pulse response*

From the measured *T* pulse response and the measured or assumed response of the measuring equipment itself, the " filtered impulse response " is derived and expressed in the form of a normalized time series (see Lewis, *Proc. I.E.E.*, Vol. 101, Part III, 258 (1954)). The " main " term of this series represents the ideal or non-distorting part, and 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 restrictions is met.

Let the time series representing the filtered impulse response be

$$B(rT) = \ldots B_{-r} \ldots\ldots\ldots B_{-1}, B_o, B_{+1} \ldots\ldots B_r$$

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

$$C(rT) = C_{-r} \ldots C_{-1}, C_0, C_{+1} \ldots\ldots\ldots C_{+r} \ldots\ldots\ldots$$

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

Restriction (1) is then given by

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

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

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

Restriction (2) is given by

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

Restriction (3) is given by

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

Restriction (4) is given by

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

The series $C(rT)$ represents fairly closely the response to a $2T$ pulse. Restriction (1) is thus approximately equivalent to the limits indicated in Fig. 11 for the $2T$ pulse response in the routine-test method. Restriction (2) is similar to the limits placed on the $2T$ pulse/bar ratio in the routine-test method. Restriction (3) is equivalent to limits placed on the pulse/bar ratio of the response to a hypothetical pulse-and-bar test signal in which the pulse is an ideal filtered impulse. Restriction (4) is an upper limit placed on the average amplitude, ignoring signs, of the 16 central echo terms.

3.3 *50 Hz square-wave response*

The limits are identical with those given in § 2.5 for the routine-test method.

4. Gain/frequency characteristic

As a precaution against possible overloading effects, the insertion gain at any frequency between 50 Hz and 5 MHz should not exceed the gain at the line-repetition frequency by more than an amount in dB numerically equal to the percentage rating factor, e.g. 1 dB for a rating factor of 1% ($K = 0{\cdot}01$).

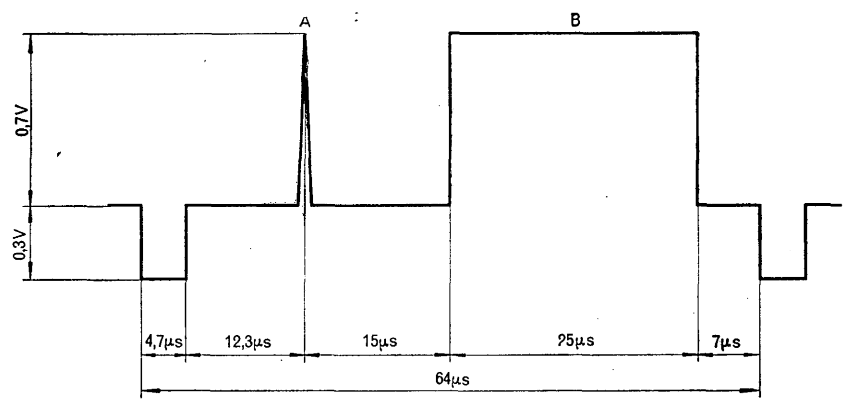


FIGURE 1

T and 2T pulse-and-bar test signals

(For insertion gain, and short-time and line-time linear distortions in the luminance channel)

A: T pulse or $2T$ pulse

B: T bar or $2T$ bar

$T = 100$ ns

Note. — For the design of the shaping-network, see MacDiarmid and Phillips, *Proc. I.E.E.*, Vol. 105B, 440 (1958).

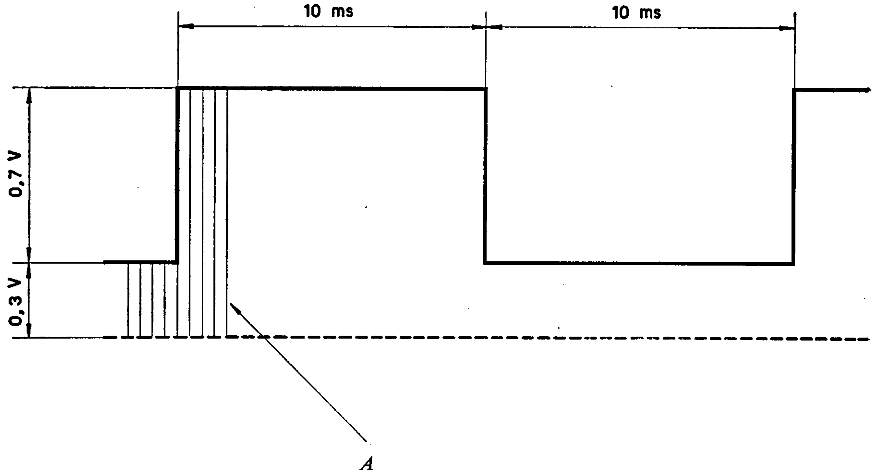


FIGURE 2

50Hz square-wave test signal

(For field-time linear distortion in the luminance channel)

A : Line-synchronizing pulses

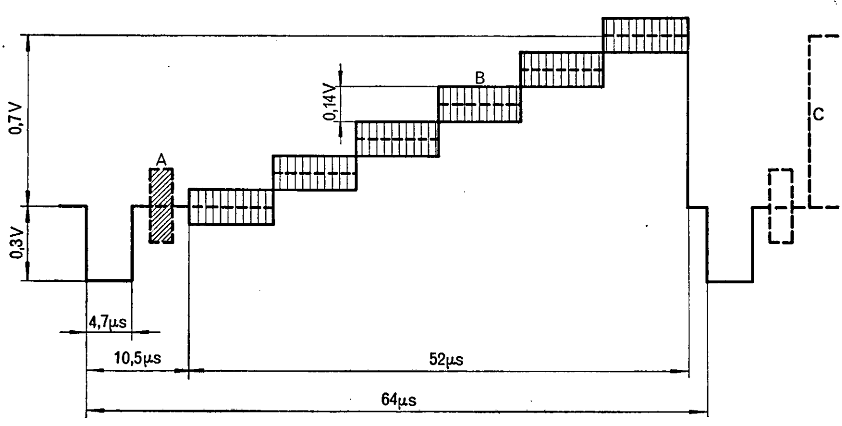


FIGURE 3

Staircase test signals

(For all non-linearity distortions)

A : Optional colour burst

B : Superimposed sub-carrier (4·43 MHz)

C : 3 lines at black level or 3 lines at white level

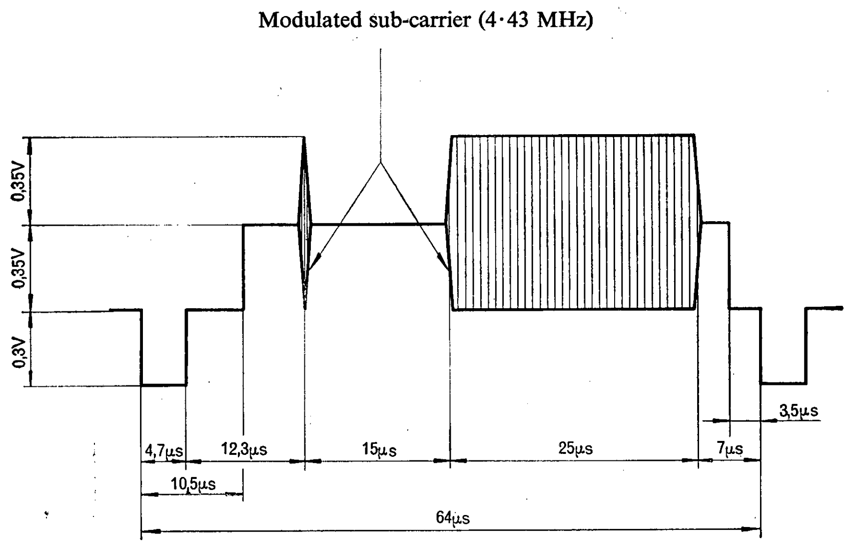


FIGURE 4

T_c and $2T_c$ pulse-and-bar test signals

(For short-time and line-time linear distortions in the chrominance channel)

$T_c = 500$ ns

Note. — For the design of the shaping-network, see MACDIARMID and PHILLIPS, *Proc. I.E.E.*, Vol. 105B, 440 (1958).

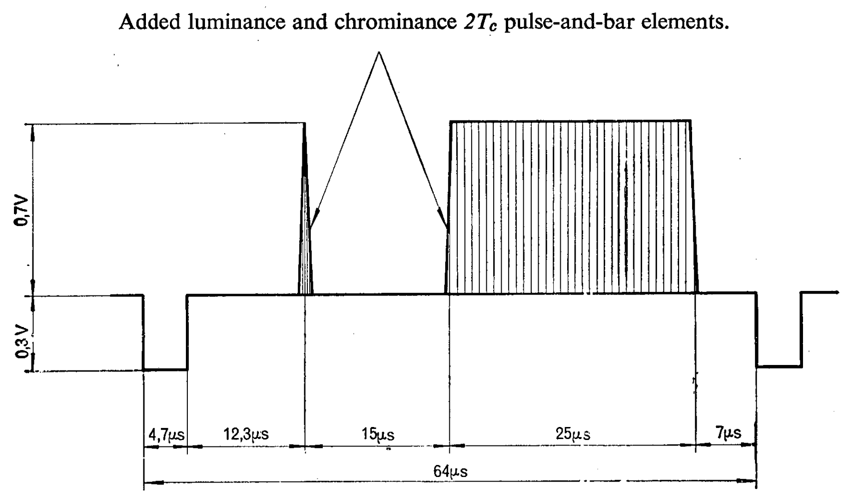
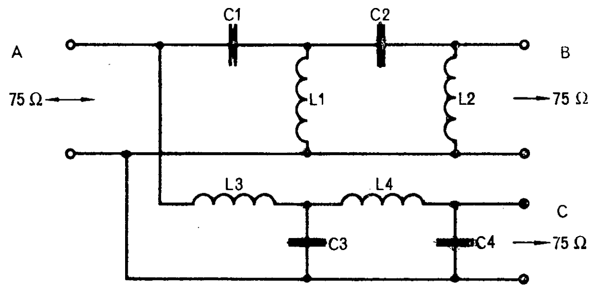


FIGURE 5

Composite test signal

(For luminance-chrominance gain and delay inequalities)

$T_c = 500$ ns



A : Input
B : High-pass output
C : Low-pass output

TABLE OF VALUES

Component	Value	Tolerance
C1	139000	±5%
C2	196000	
C3	335000	
C4	81200	
L1	0·757	±2%
L2	3·12	
L3	1·83	
L4	1·29	

Note 1. — Inductances are given in mH, capacitances in pF.

Note 2. — The Q-factor of each inductor should be equal to, or greater than, 100 at 10 kHz.

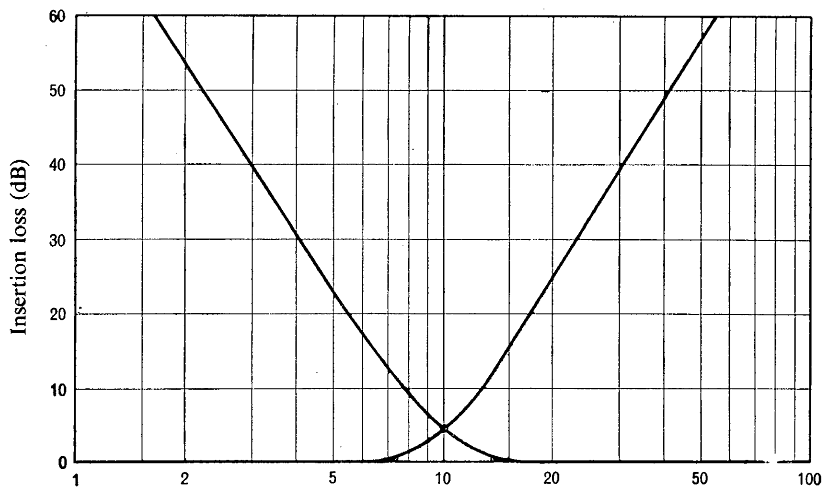


FIGURE 6

Junction filter

(For noise measurement)

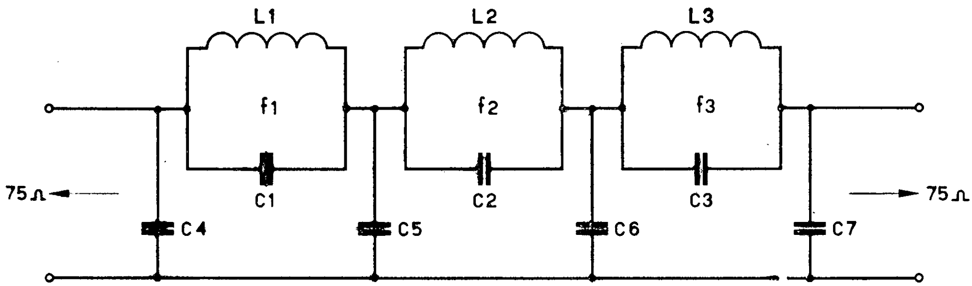


TABLE OF VALUES

Component	Value	Tolerance
C1	100	(Note 2)
C2	545	
C3	390	
C4	428	
C5	563	
C6	463	
C7	259	
L1	2·88	(Note 3)
L2	1·54	
L3	1·72	
f_1	9·408	
f_2	5·506	
f_3	6·145	

Note 1. — Inductances are given in μH, capacitances in pF, frequencies in MHz.

Note 2. — Each capacitance quoted is the total value, including all relevant stray capacitances, and should be correct to ± 2%.

Note 3. — Each inductor should be adjusted to make the insertion loss a maximum at the appropriate indicated frequency.

Note 4. — The Q-factor of each inductor measured at 5 MHz should be between 80 and 125.

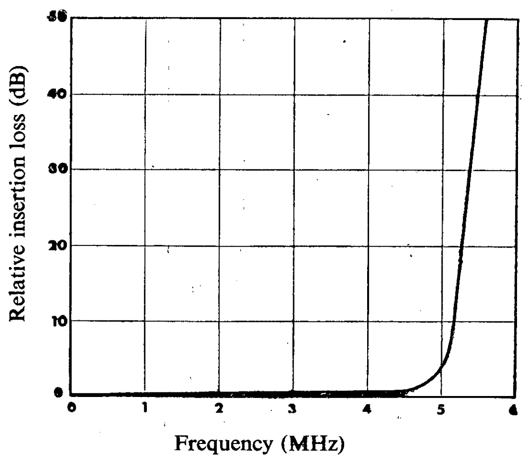


FIGURE 7

Low-pass filter
(For random noise in the luminance channel)

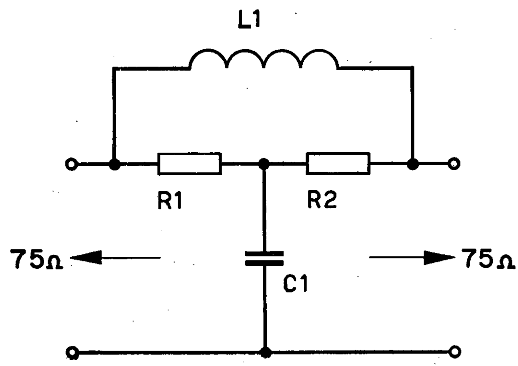


TABLE OF VALUES

Component	Value	Tolerance
C1	2660	±1%
L1	15	
R1	75	
R2	75	

Note 1. — Inductance is given in μH, capacitance in pF, resistance in ohms.

Note 2. — The Q-factor of inductor L1 should be equal to, or greater than, 25 at 8 MHz.

Note 3. — Insertion loss $= 10 \log_{10} [1 + (2\pi\tau f)^2]$ dB,

where $\tau = 200$ ns.

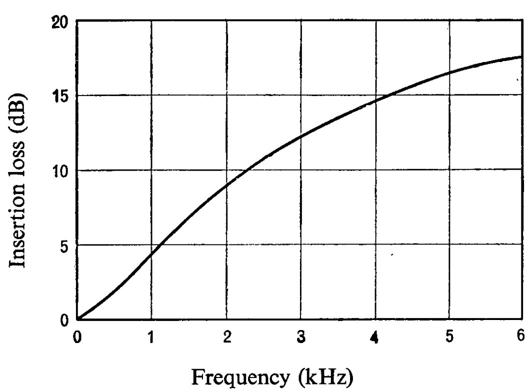


FIGURE 8

Weighting network

(For random noise in the luminance channel)

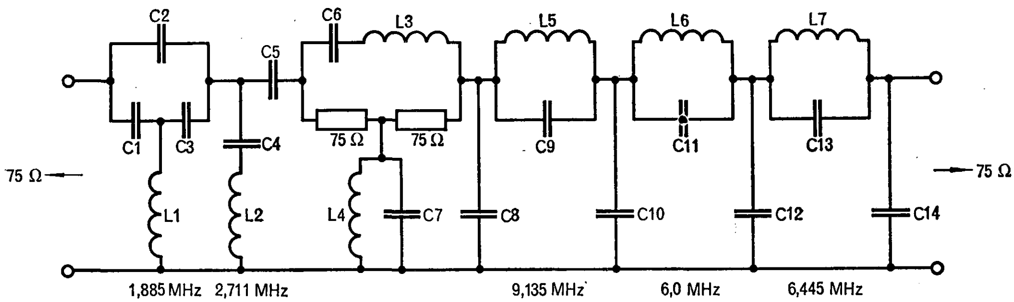


TABLE OF VALUES

Component	Value	Tolerance	Component	Value	Tolerance
C1	496·0		C12	311·4	
C2	89·47		C13	619·2	±1%
C3	292·1		C14	187·5	
C4	715·8		L1	2·960	
C5	1239·0		L2	4·814	
C6	194·3	±1%	L3	6·650	
C7	1182		L4	1·093	(Note 2)
C8	385·7		L5	2·149	
C9	141·3		L6	0·7476	
C10	418·6		L7	0·9846	
C11	941·2				

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

Note 2. — L3 is adjusted to resonate with C6, and L4 with C7, at 4·428 MHz. L1, L2, L5, L6 and L7 are adjusted to give maximum insertion loss at the appropriate indicated frequencies.

Note 3. — The Q-factor of each inductor should be equal to, or greater than, 100 between 3 MHz and 6 MHz.

Note 4. — The insertion loss is equal to, or greater than, 35 dB at frequencies above 6 MHz.

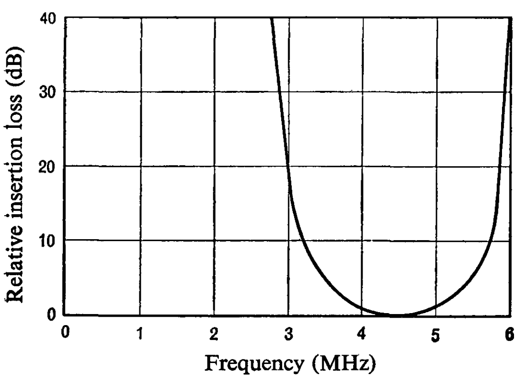


FIGURE 9

Band-pass filter and weighting network

(For random noise in the chrominance channel)

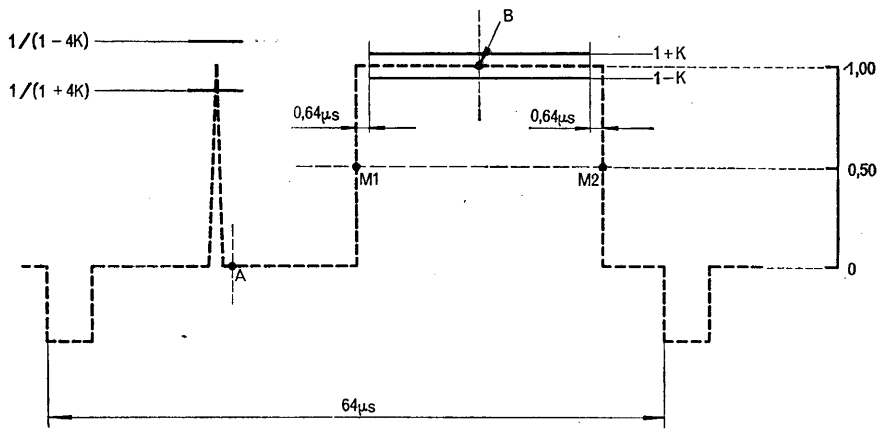


FIGURE 10
2T bar response and 2T pulse/bar ratio

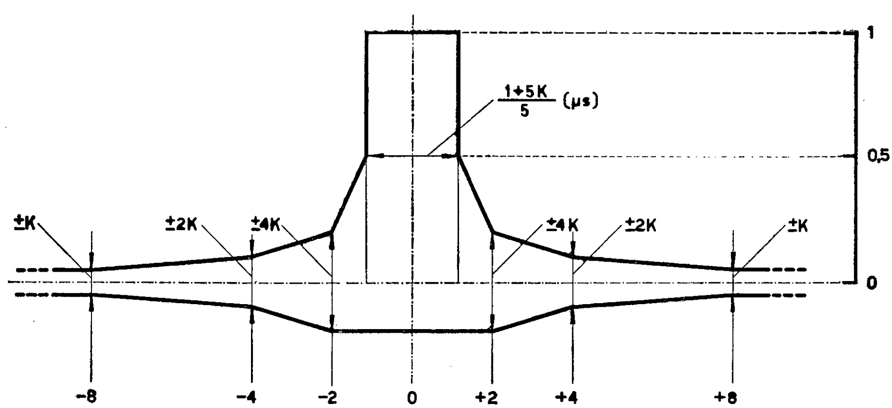


FIGURE 11
2T pulse response

Unit interval: 100 ns

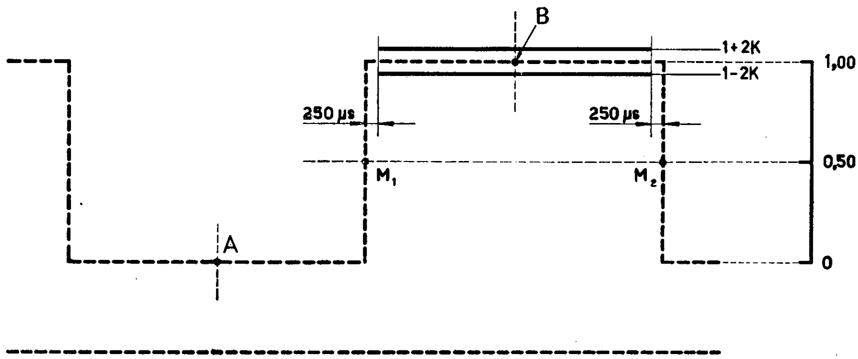


FIGURE 12

50 Hz square-wave response

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REPORTS OF SECTION E (SOUND BROADCASTING AND TELEVISION)

E. 1: Audio-frequency and recording

REPORT 79-1 *

MEASUREMENT OF CHARACTERISTICS OF SOUND SIGNALS RECORDED ON MAGNETIC TAPE

(Question 3/X)

(1956—1966)

1. This Report is based on the information given in Docs. X/122 (U.K.), X/131 (U.S.A.) and X/153 (Italy), 1963-1966, which provides a partial answer to Question 3/X. Account has also been taken of the work of I.E.C. in this field.

2. Whilst work is continuing on this subject, the following tentative answers to the various parts of Question 3/X are given below.

2.1 In view of the fact that the " ideal head " method of measurement is the only practical method which can be used over a wide range of wavelengths and furthermore, since characteristics of modern reproducing heads are approaching those of the " ideal head ", the concept of the " ideal head " should not be abandoned.

Note. — The long-gap method described in I.E.C. Publication 94 is considered to be a variant of the " ideal head " method.

2.2 There are no alternative measurement techniques that can be substituted, but as the " ideal head " method is unsuitable at very long wavelengths, the following supplementary methods may be used at these wavelengths:

— the single-conductor method, which can be used from very long to medium wavelengths;

— other methods which are still being studied, such as those making use of a magnetometer, the Hall effect, or the principle of constant-current recording.

3. Good correlation has been found between measurements made using the " ideal head " method and the single-conductor method in the wavelength range they have in common.

4. For measurement of a reference level at intermediate wavelengths the single conductor and magnetometer methods are suitable.

5. The " ideal head " method is the only one suitable for measurements over a wide range of wavelengths for determining the recorded frequency characteristic.

6. Recorded signal levels on magnetic tapes should be expressed either in terms of short circuit flux per half wavelength and per unit track width (picoweber per millimetre) or in terms of surface induction (millitesla) **. For practical use these are connected by the formula:

$$\Phi' = \lambda B_s / \pi$$

in which the flux per half wavelength and per millimetre of track width Φ' is expressed in picowebers per millimetre, the wavelength λ (μm) and the surface induction B_s (mT).

Note. — It has been suggested that the adoption of a standard reference level of 0 dB corresponding to 100 pWb/mm should be considered.

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* This Report was adopted unanimously.

** The I.E.C. is considering a proposal to express the frequency characteristic in terms of the surface induction.

REPORT 292-1 *

MEASUREMENT OF PROGRAMME LEVEL IN SOUND BROADCASTING

(Question 151, Study Programme 109)

(1963—1966)

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.

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 O.I.R.T. 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 O.I.R.T.

This Report is, as far as possible, a reply to Question 151.

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.—ON 301) 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: $n = 1$ (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 exponential 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 N 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 N to 82%.

* This Report 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	10 (1)	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 U21)	1	around 80	5 (approx.)	1 or 2 seconds from 100% to 10% of the reading in the steady state
(6) O.I.R.T. — Programme level meter		less than 300 ms for meters with pointer indication and less than 150 ms for meters with light indication	10 ± 5	1.5 to 2 seconds from " 0 dB " point at 30% of the length of the operational section of the scale

(1) The figure 4 ms that appeared in previous editions was actually the time taken to reach 80% of the final reading with a d.c. step applied to the rectifying/integrating circuit. In a new and somewhat different design of this programme meter, using transistors, the performance on programme remains substantially the same as that of the earlier versions and so does the response toan arbitrary, quasi-d.c. test signal but the integration time as here defined is about 20% greater at the higher meter readings.

REPORT 293-1 *

AUDIO-FREQUENCY PARAMETERS FOR THE STEREOPHONIC REPRODUCTION OF SOUND

(Study Programme 15A/X)

(1963—1966)

1. Introduction

Extensive studies have been carried out in several countries with regard to Study Programme 15A/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. and by the O.I.R.T.; 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.), Bad Kreuznach, 1962 and Doc. 206 (E.B.U.), 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:

— 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.

3. **Doc. X/35 (U.S.A.), 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 Hz;

* This Report was adopted unanimously.

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

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 Hz;

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 Hz.

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

TABLE I

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 $f < 100$ Hz and $f > 10$ kHz)
Crosstalk ratio (2)	A and B	−26 dB, or if necessary −20 dB from 100 Hz to 5 kHz −20 dB, or if necessary −14 dB at 10 kHz (6 dB/octave for $f > 5$ kHz)
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 ½ $(A + B)$ and S to ½ $(A - B)$.

(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.

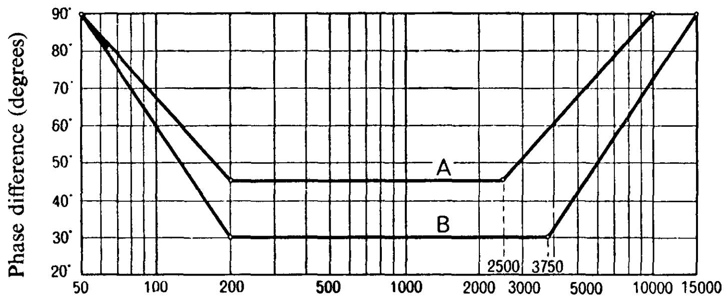
(6) This concerns the unintentional phase difference between the A and B signals. The values are defined in a graphical representation having a logarithmic frequency scale, by segments of straight lines joining the following points (see Fig. 1):

— *limit of perceptibility*

Frequency (Hz)	50	200	3750	15 000
Phase difference	90°	30°	30°	90°

— *acceptable limit, if necessary*

Frequency (Hz)	50	200	2500	10 000	15 000
Phase difference	90°	45°	45°	90°	90°



Frequency (kHz)

Curve *A*: Acceptable limit, if necessary
Curve *B*: Limit of perceptibility

FIGURE 1

Phase-difference as a function of frequency

4. **Doc. X/45 (U.S.S.R.), 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 analysed 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.

5. **Doc. X/52 (O.I.R.T.), 1963-1966,** gives some results reached with stereo studio-technique and stereo-broadcasting.

One of the most important bases for stereo work is the so-called " listening standard ". In fact, this " listening standard " is represented by a reference sound-field produced by a reference monitoring-equipment in a reference listening-room. Because present measuring methods are not sufficient to give exact values for the parameters of the reference sound-field, it is proposed to take as listening standard, a monitoring equipment, the parameters of which are found by subjective evaluation.

Some comments on control-equipment technique show that O.I.R.T. members prefer the so-called symmetrical *A/B* mixture technique in consoles rather than *M/S* technique.

6. **Doc. X/56 (O.I.R.T.), 1963-1966,** deals with the results of theoretical work on intensity stereophony and phase stereophony.

The theory of stereophonic reproduction given has shown where the differences between the various types of stereophonic pictures lie; among other things, this theory has also made possible a confrontation between all aspects of intensity stereophony and phase stereophony and an explanation of any advantages of both.

The fundamental requirement imposed upon stereophony, compatibility, is briefly considered in the paper as an expression of the Czechoslovak point of view. Problems of technical and artistic compatibility are discussed and, in spite of many factors, the results of theoretical and experimental work show that it will be possible to receive and to hear a stereophonic transmission also monaurally with an acceptable quality; one may therefore speak of " practical compatibility ". From this point of view no important difference (advantage or disadvantage) exists between the phase and intensity systems.

7. **Doc. X/59 (U.S.S.R.), 1963-1966,** gives standards, proposed for the quality indices of two-channel stereophonic systems, worked out in accordance with the principles mentioned in Doc. X/45 (U.S.S.R.), Bad Kreuznach, 1962, and taking account of technical and economic considerations. These standards are given for two grades of quality (highest class and class I).

TABLE II

Tolerances for stereophony

Limits of perceptibility for faults

Parameters	Signals (1)	Values
Bandwidth	*A, B, M, S*	30 to 15 000 Hz
Amplitude/frequency response — at 30 and 15 000 Hz — in the range 125–10 000 Hz	*A, B*	 ±2 to 3 dB ±1·0 dB
Crosstalk ratio (2)	*A, B*	−26 dB
Intermodulation (3)	*A, B*	not known
Harmonic distortion — below 100 Hz (63 Hz) — in the range 100–5000 Hz (1000 Hz) — over 5000 Hz (5000 Hz)	*A, B, M*	 −34 dB −46 dB −40 dB
Non-linear crosstalk (4)	*A, B*	not known
Signal-to-noise ratio	*A, B, M*	>60 dB
Difference in volume (5) — at 1 kHz — from 125–1000 Hz — at 30 Hz — at 15 000 Hz	*A, B*	 0·5 dB 0·5 to 1·5 dB 2·5 dB 1·5 dB
Phase difference (6) at 50 Hz 200 Hz 250 Hz 400 Hz 700 Hz 3750 Hz 4000 Hz 15 000 Hz	*A, B*	(degrees) >90 30 30 30 45 >90 >90 >90

(1) A is the " Left " signal and B the " Right " signal; M is equal to $\frac{1}{2}(A + B)$ and S to $\frac{1}{2}(A - B)$.

(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.

8. **Doc. X/147 (O.I.R.T.), 1963-1966,** summarizes the proposals and results which were obtained by the O.I.R.T., the E.B.U. and other organizations of the limits and tolerances of the most important AF parameters. The O.I.R.T. is of the opinion that the establishment of specifications for the most important stereophonic parameters is urgent to ensure reproduction and broadcasting under the best possible conditions of stereophonic recordings obtained through international exchange.

Table II shows the limits of perceptibility as they were determined for optimum studio conditions. In the opinion of the O.I.R.T., values to be specified should represent a good compromise between the subjective limit value and reasonable economic practice. Doc. X/147 gives additional notes on each parameter.

Doc. X/147 shows that the addition of all tolerances of the individual sections of the transmission chain in most cases leads to imperfections which widely exceed subjective values required for high quality. The O.I.R.T. believes that it is urgent to study further the conditions which have to be ensured in the different parts of the chain for the international exchange.

Bibliography

1. Report and Order, Docket No. 13506, Federal Communications Commission, Washington, 25, D.C.
2. Harvey, F. K. and Schroeder, M. R. Subjective evaluation of factors affecting two-channel stereophony, presented at the 12th Annual Meeting, Audio Engineering Society (October, 1960).
3. Beaubien, W. and Moore, H. Perception of the stereophonic effect as a function of frequency, presented at the 11th Annual Meeting, Audio Engineering Society (October, 1959).
4. Csicsatka, A. and Linz, R. The new stereo FM broadcasting system—How to understand the F.C.C. specifications and generate the composite signal, presented at the 13th Annual Meeting, Audio Engineering Society (October, 1961).
5. Matras, J. La radiodiffusion stéréophonique dans le cadre européen (Stereophonic broadcasting in the European setting). *L'Onde Electrique*, **42,** 420 (March, 1962).
6. Shorter, D. E. L. and Phillips, G. J., A summary of the present position of stereophonic broadcasting. *B.B.C. Engineering Monograph No. 29*—British Broadcasting Corporation, London (April, 1960).
7. Shorter, D. E. L. Operational research on microphone and studio techniques in stereophony. *B.B.C. Engineering Monograph No. 38*, British Broadcasting Corporation, London (September, 1961).
8. Figver, Y. I. Influence of simple artificial echoes on the stereophonic perception of speech. Work of the NIKFI Institute, *Akoustika, M*, **28,** 103-110 (1959).
9. Mankovski, V. S. Displacement of an apparent sound source in multi-channel stereophonic transmission. *Tekhnika kino i televidenia, IX*, **9,** 26-35 (1958).
10. Tager, P. G. Study of sound levels in stereophonic transmission by omnidirectional microphones. *Tekhnika kino i televidenia, II*, **2,** 54-59 (1959).
11. Galkin, D. I., Kononovitch,, L. M., Korolkov, V. G. *Stereophonic broadcasting and sound recording*. Gosenergoizdat (1962).
12. O.I.R.T.—Doc. TK-V-94 (September, 1964) and TK-II-214 (March, 1964).
13. Hoeg, W. and Arnold, P. On the question of the effect of level and phase differences between two stereo channels. *Tech. Mitteil. RFZ*, **4,** 171 (1963).
14. Steinke, G. Trick mixing in sound studio work. *Tech. Mitt. RFZ 9*, **1** (1965).
15. Keibs, L. Possibilities of stereo-ambiophonic sound transmission, *Akoustika 12*, Praha, **2,** 118-124 (1962).
16. Research Reports VURT, Praha, No. P 604 (1962), P 680, P 684 (1964).

REPORT 294-1 *

STANDARDS FOR THE INTERNATIONAL EXCHANGE OF MONOCHROME TELEVISION PROGRAMMES ON FILM

(Recommendation 265-1)

(1963—1966)

Recommendation 264-1 lists types of film to be used for the international exchange of television programmes. Recommendation 265-1 sets up standards for these film types so far as is possible at present.

Question 5/X poses the problem of optimum values of film density and optimum telecine transfer characteristics, together with methods of measuring and specifying the various parameters. General agreement on these matters in Europe appears in Doc. X/140 (E.B.U.), 1963-1966. Accordingly, it has been possible to reach agreement in Recommendation 265-1 concerning the optimum density values for film images. However, it is necessary to study further the questions concerning telecine transfer characteristics, methods of measurement specification of parameters.

It has been possible to agree to the inclusion of 35 COMMAG as a secondary standard type of film for international programme exchange (Doc. X/141 (E.B.U.), 1963-1966), and it is included in Recommendations 264-1 and 265-1.

Furthermore, consideration should be given to the status of SEPMAG for international programme exchange.

It was felt that the problem of a uniform starting and cueing leader for television films could not be solved due to the different practices in use by the various broadcasting organizations. Therefore, the existing definition of an identification leader, that ends with a dotted line at the beginning of the programme, has not been changed in the new Recommendation. Work should continue on this problem, and recent developments show that it may be possible to reach agreement in the future.

A recommendation for size and position of the scanned film area and action field is also desirable for television use. Recommendations in this connection have already been given by some international and national organizations (ISO TC36, Item 89; O.I.R.T. Recommendation 14; ARD Specification 12/8 (Doc. X/126, 1963-1966); ASA PH 22.95 and PH 22.96; S.M.P.T.E. RP-8 and RP-13).

Question 6/X has been drafted in order to promote further study of the problems of optical sound on film. It is hoped that better uniformity and more satisfactory sound quality will result, and that a recommendation will be possible in the future.

Recommendation 265-1 deals with specifications for films intended only for monochrome television. It is certain that, in the future, colour television will entail much international exchange of colour films. Documents concerned with standards for colour films for television programme exchange are necessary for further work. It seems, however, desirable to receive documentation proposing ways by which the number of recommended types of sound recording (COM and SEP types) may be reduced for film intended for colour television.

At the XIth Plenary Assembly, Oslo, 1966, time did not permit a complete examination of all these problems. It is expected that further information will be presented at the next Plenary Assembly of the C.C.I.R.

* This Report was adopted unanimously.

REPORT 295-1 *

RECORDING OF MONOCHROME TELEVISION SIGNALS ON MAGNETIC TAPE

(Question 7/X)

(1963—1966)

1. Introduction

1.1 At present, extensive 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 standardization of the systems used. However, since studies are still in progress and equipment and procedures are still being perfected, final standards for the principal characteristics of the systems used cannot yet be established.

1.3 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. For each of the two classes of television systems, known as 525-lines, 60-field and 625-lines, 50-field, a single recording standard, valid for both monochrome and colour television signals, is considered desirable.

2. Present situation

Current practices for international exchange of television programmes recorded on magnetic tape, using the 4-head transverse track system are described briefly below.

2.1 The 525-line, 60-field system of magnetic recording is defined by standards and recommended practices set out in Annex I.

2.1.1 Recorded frequencies, corresponding to specific video levels, have for several years been as stated in the first line of the Table below, but the use of higher recorded frequencies has recently been introduced, as stated in the second and third lines below:

	Frequency (MHz) corresponding to the level		
	Synchronization	Blanking	White
SMPTE LBM	4·3	5·0	6·8
SMPTE HB	7·06	7·9	10·0
NHK HB	7·0	7·9	10·0

2.2 Most countries, using the 625-line, 50-field television systems, carry out magnetic tape recording of television signals according to the following principal characteristics:

* This Report was adopted unanimously.

Characteristics related to movements of the tape and the heads	Tape speed Speed of rotation of the heads Number of tracks per field Number of tracks per second	39·7 cm/s (15·625 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	250 25 150%
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.)

625-line, 50-field equipment and tape are dimensionally identical with those used for 525-line, 60-field recording.

Operational practices for the recording of control track signal and frame pulses are set out in Annex II, based on Doc. 139/X (E.B.U.), 1963-1966.

Further operational practices can be found in Annex III, based on E.B.U. Recommendations.

Agreement has not been reached regarding preferred recorded frequencies corresponding to specific video levels. The E.B.U. has, since 1962, recommended the use of the frequencies listed in the first line of the Table below for international programme exchange. Various countries have adopted other characteristics for their national use in order to achieve a higher technical quality of the recordings.

The main tendency is towards the use of higher recorded frequencies, made possible by technological improvements.

Some years ago the A.R.D. and the O.R.T.F. adopted for operational use the higher recorded frequencies shown below and more recently the B.B.C. has adopted even higher recorded frequencies as shown.

An O.I.R.T. recommendation is also known to be in preparation.

	Frequency (MHz) corresponding to the levels		
	Synchronizing	Blanking	White
EBU	5·0	5·5	6·8
ARD	5·1	5·8	7·6
ORTF	5·7	6·3	7·7
BBC	7·16	7·8	9·3

3. Expected development

To improve the technical quality of exchanged programmes, it is considered desirable to obtain agreement on standard reproducing characteristics for both video and sound, which reflect the technical progress made on various parts of the system during recent years. At present sufficient documentation is not available to permit C.C.I.R. to establish such characteristics.

Bearing in mind the questions raised in Study Programme 7A/X, it is desirable that a draft Recommendation be presented to the XIIth Plenary Assembly of the C.C.I.R.

It is also desirable that such a Recommendation should include the requirements of recording for colour-television.

ANNEX I

VIDEO TAPE STANDARDS AND SMPTE RECOMMENDED PRACTICES FOR VIDEO TAPE-RECORDING (525-LINES, 60 FIELDS) IN THE UNITED STATES OF AMERICA

Number	*Title*
ASA C98.1-1963	Dimensions of 2-inch video magnetic tape
ASA C98.2-1963	Monochrome video magnetic tape leader
ASA C98.3-1963	Audio records for 2-inch video magnetic tape recordings
ASA C98.4-1963	Speed of 2-inch video magnetic tape
ASA C98.5-1965	Dimensions of 2-inch video magnetic tape reels
ASA C98.6-1965	Dimensions of video, audio and tracking control records on 2-inch video magnetic tape
SMPTE RP-5-1964	Dimensions of patch splices in 2-inch video magnetic tape
SMPTE RP-6-1960	Modulation levels for monochrome 2-inch video magnetic tape recording
SMPTE RP-10-1962	Signal specifications for a monochrome video alignment tape for 2-inch video magnetic tape recording
SMPTE RP-11-1962	Tape vacuum guide radius and position for recording standard video records on 2-inch magnetic tape
SMPTE RP-16-1964	Specifications of tracking control record for 2-inch video magnetic tape recordings.

ANNEX II

RECORDING OF CONTROL SIGNAL AND FRAME PULSES IN THE 625-LINE, 50-FIELD SYSTEM

A control signal and frame pulses are recorded on the control track. The relative position of these recordings in relation to those of the video signals is specified in Fig. 1. The characteristics of the recordings made on the control track are specified below:

1. Control signal

The frequency of the control signal shall be five times the field frequency of the television signal.

The amplitude of the control signal current in the recording head shall be such that the tape is driven to the verge of saturation. This amplitude can be established by the method described in § 3 below.

The control signal shall be positioned so that a point of maximum record current and the extended centre-line of the area between the fifth and the sixth video tracks before the track containing the field-synchronizing pulse shall coincide within $\pm 0 \cdot 025$ mm at the lower edge of the tape.

The point of maximum record current coinciding with the frame pulse shall be one that immediately follows an area on the control record to which a south-seeking pole of a compass needle will be attracted (see § 4 below).

The waveform of the control signal current in the record head should be sinusoidal.

2. Frame pulses

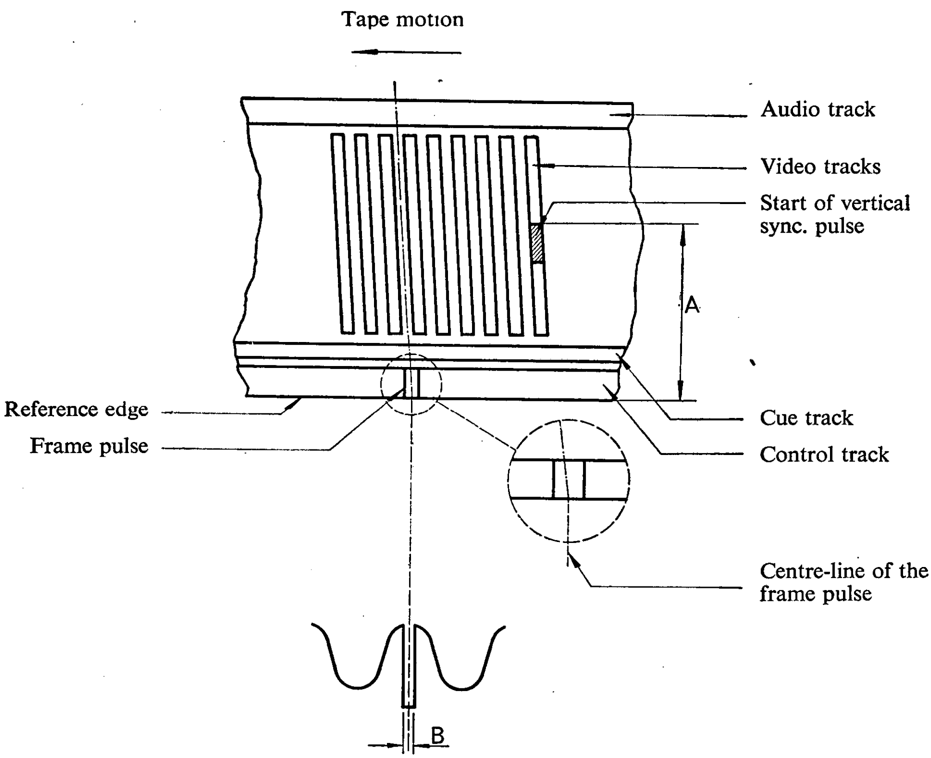
These pulses, which serve to identify the position of the field-synchronizing pulses, are superimposed on the control signal. One pulse is recorded per television frame to identify the field-blanking interval that follows an even field (Report 308-1).

The frame pulse shall be positioned so that the centre-line of the recorded pulse and the extended centre-line of the area between the fifth and sixth video tracks before the track containing the field-synchronizing pulse intersect within ± 0·05 mm at the lower edge of the tape (Fig. 1).

The amplitude of the frame-pulse current shall be between 150% and 180% of the peak-to-peak value of the control signal current in the record head.

The polarity of the pulse with respect to the control signal shall be as shown in Fig. 1.

The location of the field-synchronizing pulse and the frame pulse will apply only if the recorder video head and capstan servo-mechanism work in relation to the incoming video signal or to its synchronizing generator.



Dimens. A: Min.: 27·9 mm Max.: 30·5 mm	
Dimens. B: 60 μs ± 10 μs (half-amplitude duration)	

FIGURE 1

Relative position of the recorded control signal, frame pulse and video signals

3. Determination of the verge of saturation of the control track

The transfer characteristic of the magnetic tape is non-linear. The curve representing the induction of the tape as a function of the recording current has the shape indicated in Fig. 2*a*. When a sinusoidal current is applied to the recording head, the resulting recorded flux density is as shown in Fig. 2*b*. The playback voltage waveform (Fig. 2*d*) is the first derivative of the recorded flux. Thus, the zero axis crossing region of the playback signal corresponds to the maximum recorded flux region.

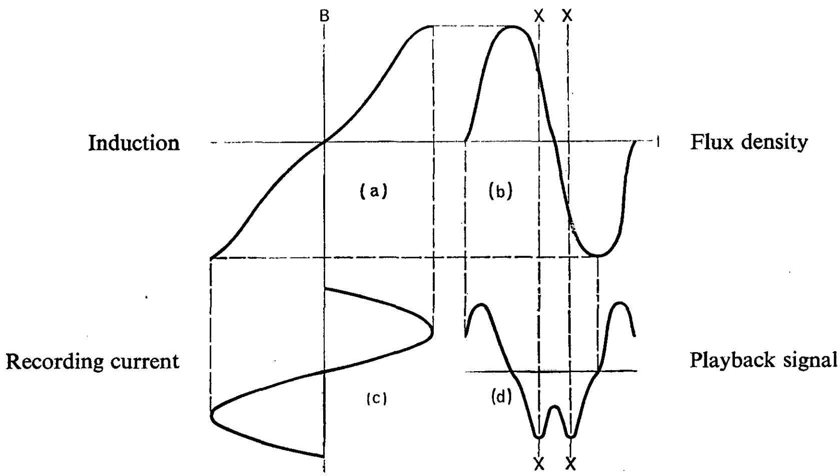


FIGURE 2

Relation between the recording current and the playback signal

The verge of saturation is considered to be the condition where the recorded flux waveform is just noticeably flattened on its peaks. This flattening of the flux peaks results in an inflection in the playback signal waveform in the zero axis crossing region. The verge of saturation can thus be determined by increasing the record current until a just perceptible inflection occurs in the zero axis crossing region of the playback signal.

4. Areas of attraction of a compass needle

The areas to which a compass needle is attracted do not coincide with point of maximum recording current. The compass will be attracted to two areas (*X*, as shown in Fig. 2) adjacent to the point where the recording current crosses the zero axis. The two areas will appear as bars when the track is made visible with carbonyl-iron or an equivalent material.

ANNEX III

OPERATIONAL PRACTICES FOR THE INTERNATIONAL EXCHANGES OF PROGRAMMES, IN THE 625-LINE, 50-FIELD SYSTEM

1. Splices

Splices should conform to the SMPTE Recommended Practice R.P. 5 and their number should be kept to the minimum compatible with programme requirements.

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. The tape should be on metal spools, conforming to the U.S.A. standard ASA C 98.5. Reel capacity and playing time, however, will be as follows:

Outside diameter of spool		Maximum capacity		Maximum playing time
Millimetres	Inches	Metres (approx.)	Feet	Minutes
203	8	500	1650	21
267	10½	1100	3600	46
318	12½	1700	5540	71
356	14	2200	7230	92

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

REPORT 398 *

MEASUREMENT OF AUDIO-FREQUENCY NOISE IN BROADCASTING AND IN SOUND-RECORDING SYSTEMS

(Study Programme 2A/X)

(1966)

The aim of Study Programme 2A/X is to determine whether mean, r.m.s. or peak value measurements should be used to evaluate audio noise in broadcasting and in sound-recording systems, and also to determine the appropriate measuring set characteristics.

In Doc. X/3 (Federal Republic of Germany), 1963-1966, it is suggested that the subjective assessment of noise is best approached by means of a weighted quasi-peak value. Recent developments have considerably reduced price, weight and volume and facilitated the operation of such peak-reading devices.

The discussion of this document showed that the majority of countries thought that measuring methods of this kind were appropriate but that a further study of the problem was necessary.

Another economical solution seems to be the use of the Peak Programme Meters described in Report 292-1, Table I, Type 4-6. Both solutions make use of a weighting network, according to the C.C.I.F., 1949.

In Doc. X/3 (Federal Republic of Germany) as well as in Doc. X/155 (O.I.R.T.), 1963-1966, it is shown that a better approach to the subjective impression is attainable by the use of another type of weighting curve [1]. Both proposals correspond very closely. The discussion on these documents led to the conclusion that curve *A* (I.E.C. Publication 179) for the evaluation of loudness figures, does not seem to be appropriate for taking into account annoyance effects. Further studies with respect to the weighting curve are necessary.

Concerning the integration time, O.I.R.T. suggests applying the principle of the pulse sound level-meter [2]. A similar method is proposed in the above-mentioned Doc. X/3. Tests should be carried out to examine the influence of the magnitude of the integration time.

The C.I.S.P.R. specifications for radio interference measuring sets (C.I.S.P.R. Publications 1 and 2), employing quasi-peak type voltmeters for the measurement of impulsive noise, should also be taken into account.

There are existing I.E.C. Recommendations (Publication 123) for measuring sound levels by determining the weighted values of sound pressures, but the relationship between the output voltage of a piece of audio-frequency equipment in the broadcasting chain and the resulting sound pressure is indeterminate, and the I.E.C. Recommendations cannot be applied.

It is understood that for the time being noise measurements on lines should be carried out in accordance with the existing C.C.I.T.T. Recommendation, but that in future a single standardized method of noise measurement for broadcasting and sound-recording systems as well as for lines should be approached. In due course a C.C.I.R. Recommendation on the measurement of audio noise should be referred to C.C.I.T.T.

Whilst it is a noise voltage that must be measured, the result should be stated as a signal-to-noise ratio where the magnitude of the signal is known, or as a noise factor, whichever is the more appropriate.

Bibliography

1. Belger, E. On the measurement and evaluation of noise. *NWDR-Hausmitt.*, 51 (1953).
2. Niese, H. Proposal for a new sound-level meter. *Hochfrequenztechnik und Elektroakustik*, 66/4, 125 (January, 1958).

* This Report was adopted unanimously.

E. 2: Radio-frequency

REPORT 32-1 *

HF BROADCASTING

Directional antenna systems

(Question 14/X)

(1953—1966)

1. Reduction of subsidiary lobes

Question 14/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 eliminated 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

* This Report, which replaces Reports 32 and 296, was adopted unanimously.

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 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.

Tests have been carried out in Italy (Doc. X/49, 1963-1966), with an array of HR5/4/1·5 dipoles with reflectors in which each stack of dipoles is fed separately. The five feeders are so adjusted as to reduce the amplitude of the subsidiary lobes. Measurements showed that the reduction was substantial (about 8 dB). This property is maintained when the main lobe is slewed; the largest subsidiary lobe is then very greatly reduced (15 dB for a 18° slew of the main lobe). The whole array remains simple and the increase in the cost price is slight.

Type HR4/4 antennae have recently been manufactured in France. Their special feature is that the reflector is fed, an arrangement which makes it possible to adjust accurately the voltage amplitudes and phases in the arrays, back and front. Measurements of the pattern from a helicopter showed that it resembled the theoretical patterns very closely (nulls about 40 dB). Compared with systems with passive reflectors, the new arrays have a larger bandwidth and are more easily adjusted.

2. Actual protection obtained with directional antennae

The United Kingdom and the Republic of South Africa have carried out an experimental study of the real protection at a great distance by the use of directional antennae in the HF band (Doc. X/15 (United Kingdom), Bad Kreuznach, 1962 and Doc. X/221 (United Kingdom), Geneva, 1963). 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 MHz 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 were 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 antenna characteristics was about 38 dB.

Using transmitting antennae at different sites, which were separated by 250 km, the real protection as measured was 21·0 dB (average value), as compared with a protection of 16 dB calculated on the basis of Recommendation 80. The protection deduced from theoretical antenna 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.

Doc. X/124 (United Kingdom), 1963-1966, describes a further experiment carried out between the United Kingdom and the Federal Republic of Germany over medium distances of about 1000 km.

The field strength measured at the receiving station indicated that in only one of five cases was the real protection greater than the theoretical protection. In all other cases the real protection was 1 to 7 dB less than the theoretical value.

On the other hand, the real protection was greater than that determined on the basis of Recommendation 80 by 3 dB, 6 dB and 9 dB in three cases, whilst it was 2 dB and 3 dB less in the remaining two cases.

The protection measured on these particular tests was considered sufficiently close to that obtained by the application of Recommendation 80 to confirm the validity of the Recommendation for medium distances.

Bibliography

1. Foster, D. Radiation from rhombic antennae. *Proc. IRE*, **25**, 1327 (October, 1937).
2. Laport, E. A. Design data for horizontal rhombic antennae. *R.C.A. Review*, Vol. 13, **1**, 71 (March, 1952) (see especially Fig. 4 of this Report).
3. Christiansen, W. N. Directional patterns for rhombic antennae. *A.W.A. Tech. Rev.*, **7**, 33 (September, 1946).
4. Christiansen, W. N., Jenvey, W. W. and Carmen, R. D. Radio-frequency measurements on rhombic antennae. *A.W.A. Tech. Rev.*, **7**, 131 (December, 1946).
5. Christiansen, W. N. Rhombic antenna arrays. *A.W.A., Tech. Rev.*, **7**, 361 (October, 1947).
6. Kraus, J. D. Antennas. First Ed., 93, McGraw-Hill (1950).
7. Dolph, C. L. A current distribution for broadside arrays which optimizes the relationship between beam width and side lobe level. *Proc. IRE*, **24**, 335 (June, 1946).
8. Hayes, L. W. and Maclarty, B. N. The Empire Service broadcasting station at Daventry. *Journal I.E.E.*, **85**, 573 (September, 1939).
9. Page, H. The measured performance of horizontal dipole transmitting arrays. *Journal I.E.E.*, **92**, 18 (June, 1945).
10. Parmeggiani, C. Progetto e realizzazione delle nuove cortine a larga banda del Centro onde corte di Prato Smeraldo (Plans and implementation of new wide-band arrays at the Prato Smeraldo short-wave Centre). *Elettronica*, **3** (1963).
11. Parmeggiani, C. Antenne à più dipoli con particolari leggi di distribuzione delle correnti di alimentazione (Multi-dipole antennae with feeder currents following different distribution laws). *Elettronica*, **1** and **2** (1964).
12. Lacharnay, S. Nouvelles antennes rideaux en ondes décamétriques au centre d'Issoudun (France) (New HF curtain antennae at Issoudun (France)). E.B.U. Review, **98-A** (August, 1966).

REPORT 297-1 *

HF BROADCASTING

Bandwidth of emissions

(1948—1956—1959—1963—1966)

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 Hz, 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 Hz, 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 Hz.

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 kHz, 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 kHz from the carrier-frequency. It does not appear that a reduction in the radio-frequency signal-to-interference ratio will change this conclusion, as far as present types of receiver 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 Hz and 6400 Hz respectively, to assume a new importance.

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* This Report was adopted unanimously.

REPORT 298-1 *

PROTECTION RATIOS FOR AMPLITUDE-MODULATION SOUND BROADCASTING

(Question 8/X)

(1963—1966)

1. Introduction

This Report is a summary of the information available on the subject of protection ratios for amplitude-modulation sound-broadcasting services.

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.

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 12/X and Study Programme 12A/X;

— reduction of radiated bandwidth, Question 8/X;

— use of the sky-wave to increase the service area, Question 10/X;

— use of filter devices at the receiver;

— general studies on broadcasting coverage, Question 9/X.

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 1/XII and Study Programme 1C/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.), Bad Kreuznach, 1962, in Doc. 218 (France), Geneva, 1963 and also in Doc. X/36 (France), 1963-1966.

2.1 *Techniques for measuring the protection ratio*

The lack of standardized measuring techniques has led to wide differences in the published results. For example, some of the figures and published curves presented relate to measurements made with limited types of wanted and unwanted programme material, whilst others cover a much wider range.

To overcome the difficulties resulting from the large number of parameters associated with subjective methods of measurement, an objective method has been developed for determining radio-frequency wanted-to-interfering signal ratios (see Report 399).

When the audio-frequency protection ratio has been determined by subjective methods, it is then possible to obtain the corresponding radio-frequency protection ratios by purely objective means.

* This Report was adopted unanimously.

2.2 *Radio-frequency protection ratios for ground-wave services*

2.2.1 *Stable wanted and interfering signals (ground wave signal interfered with by another ground wave signal)*

In Recommendation 448, a value of 40 dB is given for use on hectometric and kilometric waves for co-channel transmissions.

The Preparatory Meeting of Experts, set up to prepare the technical data for use by the African Broadcasting Conference, Geneva, 1964, recommended a figure of 40 dB for the radio-frequency protection ratio in this case.

Curves showing the relative value of radio-frequency protection ratio as a function of frequency separation have been derived from information at present available (see Recommendation 449).

2.2.2 *Stable wanted and fluctuating interfering signal*

2.2.2.1 *Short-term fading*

Short-term fading of the interfering signal modifies the character of the disturbance felt by the listener: if, for a given audio-frequency signal-to-interference ratio, the interfering signal is made to fluctuate, the disturbance is subjectively felt to be more severe. Docs. X/5 (E.B.U.), X/31 (F.R. of Germany) and X/36 (France) indicate that, to obtain the same degree of satisfaction of the listener, the protection must be increased by about 5 dB in the latter case.

In Recommendation 448, this value has been incorporated in the radio-frequency protection ratio.

2.2.2.2 *Long-term field-strength variations*

Report 264-1, § 2.5, gives a formula permitting the determination of the ratio between two fluctuating field strengths transmitted by the ionosphere.

In the case under consideration, this formula becomes, with some simplifications of form:

$$R(T) = F_{ou} - F_{on}(50) - \delta(100 - T) - \Delta_H(50) \tag{1}$$

where

$R(T)$ is the ratio (in dB) of the two field-strengths exceeded during $T\%$ of the nights in a year;

F_{ou} is the field-strength of the ground-wave of the wanted signal;

$F_{on}(50)$ is the field-strength of the ionospheric wave of the signal at local midnight at the mid-point of the propagation path, which is exceeded during 50% of the nights in a year;

$\Delta_H(50)$ is the correction factor to be applied to field-strength F_{on} to take into account the time at the mid-point of the path;

$\delta_H(T)$ is the correction factor to be applied to field-strength F_{on} to take into account the percentage T of the nights in a year, at H hours (local time) at the mid-point of the path.

The values of $\Delta_H(50)$ and δ_H are given respectively in Figs. 4 and 5 of Report 264-1 as far as the European Broadcasting Area is concerned.

To ensure protection corresponding to a protection ratio of A(dB), the condition

$$A \leqslant R(T) \tag{2}$$

must be satisfied.

2.3 *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 a primary one, as in HF broadcasting, or a secondary one, as in LF/MF broadcasting where the primary service is normally provided by the ground wave.

However, there is at present insufficient information available on this aspect of broadcasting and Administrations are strongly urged to initiate appropriate studies (see Question 8/X, §§ 3.1 and 4.2 and Question 10/X).

2.4 *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, Third Edition, 1965.

3. Subjective assessment of the quality of reception

Doc. X/53 (U.S.S.R.), 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 which are established on the basis of the degree of perceptibility of distortion and interference (see Doc. X/53 (U.S.S.R.), Bad Kreuznach, 1962).

Bibliography

1. Belger, E. and von Rautenfeld, F. Der erforderliche Gleichkanal und Nachbarkanal Störabstand bei amplitudenmodulierten Tonrundfunk. (The protection ratios required for common channels and adjacent channels in amplitude-modulated sound broadcasting). *Rundfunktechn. Mitteilungen*, **2**, 172-177 (1958).

REPORT 299-1 *

COMPATIBLE SINGLE-SIDEBAND TRANSMISSION (CSSB) FOR AMPLITUDE-MODULATION SOUND-BROADCASTING SERVICES

(Question 12/X)

(1963—1966)

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):

$$E = \zeta \sin 2\pi ft + a \sin 2\pi(f + F)t + \frac{a^2}{4\zeta} \sin 2\pi(f + 2F)t \tag{1}$$

of which the envelope amplitude is given by

$$A = \zeta + \frac{a^2}{4\zeta} + a \cos 2\pi Ft \tag{2}$$

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 required amplitude-modulation, the required compatible single-sideband signal. The required phase-modulation is given by

$$\varphi = \arcsin \left(\frac{a \sin 2\pi Ft + \dfrac{a^2}{4\zeta} \sin 4\pi Ft}{\zeta + \dfrac{a^2}{4\zeta} + a \cos 2\pi Ft} \right) \tag{3}$$

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.

* This Report was adopted unanimously.

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 328-1 (out-of-band radiation for AM emissions) and 329-1 (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 Hz should not be required.

2.5 In connection with § 2.4 there is a possible advantage in permitting double-sideband or reduced sideband transmission up to 750 Hz. However, this 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), 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 kHz 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.

Bibliography

1. Dixon, J. M. Envelope modulation. *Proc. IRE Australia*, 401-406 (August, 1961).

2. Kahn, L. R. Compatible single-sideband. *Proc. IRE*, **49**, 1503-1527 (1961).

3. Van Kessel, Th. J., Stumpers, F. L. H. M., and Uyen, J. M. A. A method for obtaining compatible single-sideband modulation. *E.B.U. Review*, 71-A, 12-19 (1962).

4. Vackar, J. *(a)* Czechoslovak Patent No. 91.295, *(b)* A further work to be published later.

5. Tetel'baum, S. I. On a method of increasing the efficiency of radio communications (Od odnom metode povyshenia effektivnosti radiosvyazi). *Zhurnal techn. fiziki* IX, Vyp. 17 (1939).

6. Tetel'baum, S. I. and Grinevich, J. G. Experimental investigation of the method of optimum amplitude-phase modulation (Eksperimentalnoye issledovaniye metoda optimalnoy amplitudno-fazovoy modulyatsii). *Radiotekhnika, U.S.S.R.*, **5** (1957).

7. Korenblyum, B. I., Kreyn, M. G. and Tetel'baum, S. I., On the mathematical theory of a method of optimum amplitude-phase modulation (K matematicheskoy teorii metoda OAF modulyatsii). *Sbornik trudov instituta elektrotekhniki AN Ukrai. SSR*, Vyp. 7, Kiev (1951).

8. Kettel, E. Einseitenbandsignale und das Problem einer Einseitenbandmodulation, bei der die Nachricht in der Envelope liegt. (Signals and problems of compatible single-sideband modulation, when the audio-frequency is contained in the envelope). *Telef. Ztng.* **37**, 247-259 (1964).

9. Besslich, P. and Burkhardsmaier, W. Eigenschaften Aufbereitungsverfahren und Demodulationsverzerrungen des kompatiblen Einseitenbandsignals. (Characteristics, methods of preparation and demodulation distortion of the compatible single-sideband signal). *Telef. Ztng.* **37**, 260-275 (1964).

10. Netzband, R. and Suverkrubbe, R. Untersuchungen einer kompatiblen Einseitenband—Übertragungskette. (Investigations carried out by means of a compatible single-sideband transmission chain). *Rundfunk Mitt.* **9**, 75-90 (1965).

REPORT 300-1 *

STEREOPHONIC BROADCASTING

(Question 15/X and Study Programme 15A/X)

(1963—1966)

1. Introduction

Since the XIth Plenary Assembly of the C.C.I.R., certain Administrations and Broadcasting Organizations have conducted theoretical and experimental work relating to stereophonic broadcasting. As a result of this work, stereophonic transmissions intended for the public, using single frequency-modulation transmitters, were introduced in a number of countries.

The present Report summarizes the situation concerning stereophonic broadcasting systems on the basis of the documents listed in the Annex.

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 293-1);

* This Report was adopted unanimously.

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 according to some Administrations, 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. However, other 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. The system ensures a high quality of sound reproduction and good compatibility with monophonic broadcasting.

For the period 1959 to 1964, additional studies and experiments have been carried out and new decoding circuits have been developed, as a result of which there has been further improvement of the system. Moreover, this system has been tested within the framework of the O.I.R.T. and found to provide high-quality monophonic and stereophonic reception. The Technical Commission of the O.I.R.T., in its Recommendation No. 45, suggested the use of the polar-modulation system in the O.I.R.T. member countries.

The polar-modulation system can be used with maximum frequency deviations of $\pm$ 50 kHz and $\pm$ 75 kHz. It is defined by the specifications in Recommendation 450.

3.1.1 *Compatible monophonic reception*

As a result of tests, compatible monophonic reception by the polar-modulation system may be characterized by the test results given below as observed at the output of a typical domestic receiver.

3.1.1.1 Audio-frequency response: the same as for monophonic service.

3.1.1.2 Intermodulation S to M: $-$ 44 dB.

3.1.1.3 Total harmonic distortion: equal to or slightly greater than the value for monophonic transmission.

3.1.1.4 Non-linear crosstalk S to M: better than $-$ 39 dB.

3.1.1.5 Signal-to-noise (weighted) ratio: 1 to 2 dB worse than for monophonic transmission.

3.1.1.6 Radio-frequency protection-ratio: almost equal to that for reception of a monophonic transmission, whether the interfering transmission is monophonic or stereophonic.

3.1.2 *Stereophonic reception*

Stereophonic reception by the polar-modulation system may be characterized by the following results observed at the output of a typical domestic receiver.

3.1.2.1 Audio-frequency response: the same as for monophonic service.

3.1.2.2 Linear crosstalk between A and B:

between 300 Hz and 5 kHz:	better than – 30 dB
between 60 Hz and 300 Hz and 5 kHz and 10 kHz:	better than – 20 dB
between 30 Hz and 60 Hz and between 10 kHz and 15 kHz:	better than – 12 dB

3.1.2.3 Total harmonic distortion: not greater than 1%.

3.1.2.4 Non-linear crosstalk between A and B: better than – 39 dB.

3.1.2.5 Signal-to-noise (weighted) ratio: 9 to 19 dB worse than for monophonic service.

3.1.2.6 Radio-frequency protection ratios relative to the values used for monophonic transmission: for a deviation of $\pm$ 50 kHz as a function of the separation Δf of the carrier frequencies.

$\Delta f = 0$: increase of about 10 dB;

$\Delta f =$ 30 to 60 Hz: increase of about 18 dB;

$\Delta f =$ 135 kHz: no change.

3.2 *Pilot-tone system*

During the period 1959 to 1962, detailed studies of a system of stereophonic broadcasting, the service performance characteristics of which are given in §§ 3.2.1 to 3.2.5, were carried out independently in many countries. These studies have comprised theoretical analyses, 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 the documents listed in the Annex.

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 have been continued to date. Tests have also been made on this system within the framework of the O.I.R.T., the Technical Commission of which, in its Recommendation No. 45 suggested the use of this system in the O.I.R.T. member countries.

Nine countries have commenced a regular stereophonic service using the pilot-tone system because they considered that this system best complied, on the whole, with the conditions set out in § 2 of this Report.

The pilot-tone system has been tested with maximum frequency deviations of $\pm$ 75 kHz and $\pm$ 50 kHz. It is defined by the specifications in Recommendation 450.

3.2.1 *Compatible monophonic reception*

As a result of tests, compatible monophonic reception, by the pilot-tone system may be characterized by the test results given below as observed at the output of a typical domestic receiver.

3.2.1.1 Audio-frequency response: same as for monophonic service.

3.2.1.2 Linear crosstalk: S to M: – 60 dB below 1 kHz
– 44 dB from 1 to 15 kHz.

3.2.1.3 Intermodulation: S to M: equal to or better than – 40 dB.

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: better than − 40 dB.

3.2.1.6 Signal-to-noise (weighted) ratio: 66 to 76 dB for an input level of − 54 dBm.

3.2.1.7 Beat-frequency interference: better than − 50 dB.

3.2.1.8 Radio-frequency protection ratio: 0 to 3 dB higher than for monophonic reception for a carrier frequency separation between 0 and 300 kHz.

3.2.1.9 Multipath propagation effects: almost equivalent to a monophonic transmission.

3.2.1.10 Sensitivity to impulse noise: almost equivalent to that for monophonic transmission.

3.2.2 *Stereophonic reception*

Stereophonic reception by the pilot-tone system may be characterized by the following results observed at the output of a typical domestic receiver.

It is possible, however, to improve most of the following results by using better receiving installations, notably by using a decoder containing:

— a low-pass filter inserted in the multiplex channel, having a relatively sharp cut-off above 53 kHz;
— a filter to attenuate unwanted frequencies close to 19 kHz;
— an amplitude-modulation limiter for the pilot signal in the sub-carrier reconstitution circuits.

The figures in parenthesis refer to these improved receivers.

3.2.2.1 Audio-frequency response: the same as for monophonic service.

3.2.2.2 Linear crosstalk between A and B: better than − 20 dB at frequencies up to 15 kHz and better than − 35 dB between 100 Hz and 3 kHz independent of the receiver input level.

3.2.2.3 Intermodulation between A and B: − 45 dB at 1 kHz; − 30 dB at 10 kHz (− 45 dB from 50 Hz to 15 kHz).

3.2.2.4 Total harmonic distortion: equal to or slightly greater than the value for monophonic transmission.

3.2.2.5 Non-linear crosstalk between A and B: better than − 40 dB.

3.2.2.6 Signal-to-noise (weighted) ratio: 58 to 64 dB for an input level to the receiver of 54 dBm.

3.2.2.7 Beat-frequency interference: better than − 50 dB.

3.2.2.8 Radio-frequency 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 transmission;

$\Delta f =$ 50 kHz: between 50 and 55 dB (42 dB); it is clearly desirable to avoid the use of frequency separation of 50 kHz for stereophonic services;

$\Delta f =$ 100 kHz: between 25 and 30 dB (17 dB), the value for monophonic transmission being 12 dB;

$\Delta f =$ 200 kHz: equal to or less than the value of 6 dB adopted for monophonic transmission.

3.2.2.9 Multipath propagation effects: satisfactory if the signal-to-echo ratio, at the receiver input, is equal to or greater than 16 dB. (It is possible to have an improvement of 20 dB relating to the distortion due to unwanted components appearing outside the band occupied by modulation signals, these components being responsible for an appreciable part of the disturbance observed in the presence of multipath propagation).

3.2.2.10 Sensitivity to impulse noise: satisfactory reception, if the field strength is greater than a value between 250 μV/m and 1 mV/m, depending on the regulations in different countries applying to the suppression of interference.

3.2.3 *Transmission and reception of independent monophonic programmes in the M and S channels having an audio-frequency bandwidth of 15 kHz and equal maximum modulation depth*

3.2.3.1 Overall crosstalk (linear and non-linear) S to M: $-$ 45 dB.

3.2.3.2 Overall crosstalk (linear and non-linear) M to S: $-$ 55 dB.

The presence of multipath propagation can degrade these figures by 10 dB or more.

3.2.4 *Direct re-broadcasting of stereophonic programmes*

No difficulties were encountered in transmitting over three links in tandem.

It was also found possible, with the pilot-tone system, to provide for the international exchange of high-quality stereophonic programmes using a communications space satellite system.

3.2.5 *Variants of the pilot-tone system*

A variant of the pilot-tone system has been investigated in the Netherlands using a single-sideband modulation of the sub-carrier, having a vector amplitude twice that of the sidebands generated in the case of normal sub-carrier modulation, making it compatible for stereophonic receivers having a synchronous type of decoder. The variant could offer interesting applications in certain circumstances, while maintaining the normal receiving and decoding principles.

3.3 *The FM-FM system using a compressor/expandor in the S-channel*

In the documents listed in § 3 of the Annex, results are given of tests on a number of systems using a compressor for the S-channel in the transmitter and a corresponding expandor in the receiver. These tests were carried out with an FM-AM system, a pilot-tone system and an FM-FM system. The results obtained have shown that noise in the S-channel is considerably suppressed by the compressor/expandor. Recent tests have furthermore shown that, when transmitting two independent monophonic programmes, only the FM-FM system can give sufficiently low crosstalk from the S-channel, into the M-channel. The FM-FM system is defined by the following specification:

3.3.0.1 a compatible signal M produces a deviation of the main carrier of not more than 80% of the maximum frequency deviation for monophonic transmissions; in the case of two-programme transmission, the deviation is equal to that of the first programme signal and in the case of stereophonic transmissions, equal to one half the sum of the left-hand signal A and the right-hand signal B;

3.3.0.2 a signal S produces frequency-modulation of a sub-carrier in case of two-programme transmissions equal to the second programme signal and in case of stereophonic transmissions, equal to one half the difference between the left-hand signal A and the right-hand signal B;

3.3.0.3 the frequency of the sub-carrier is $33 \cdot 3$ kHz $\pm$ 100 Hz;

3.3.0.4 the maximum frequency deviation of the sub-carrier is $\pm$ 10 kHz;

3.3.0.5 the sub-carrier produces a deviation of the main-carrier between 18 and 20% of the maximum frequency deviation for monophonic transmissions;

3.3.0.6 the pre-emphasis of the S-signal is identical to that of the compatible M-signal;

3.3.0.7 a compressor with transfer ratio 2/1 (in dB) is inserted in the *S*-channel of the transmitter before the pre-emphasis network, this compressor has time-constants respectively equal to 2 ms for the rise-time and 20 ms for the decay-time;

3.3.0.8 an expandor with characteristics reciprocal to those of the compressor, is inserted in the *S*-channel of the receiver after the de-emphasis network;

As a result of tests carried out by the Swedish Telecommunications Administration, the performance of the system may be characterized by the typical results given below as obtained at the output of a typical domestic receiver.*

3.3.1 *Compatible monophonic reception*

3.3.1.1 Audio-frequency response: same as for monophonic service.

3.3.1.2 Linear crosstalk *S* to *M*: better than − 60 dB up to 10 kHz.

3.3.1.3 Intermodulation *S* to *M*: better than − 60 dB up to 10 kHz.

3.3.1.4 Total harmonic distortion: equivalent to that for monophonic transmission.

3.3.1.5 Non-linear crosstalk *S* to *M*: better than − 60 dB up to 10 kHz when transmitting two different programmes and better than −50 dB up to 10 kHz when transmitting stereophonic programmes.

3.3.1.6 Signal-to-noise (weighted) ratio: 2 dB less than for monophonic transmission.

3.3.1.7 Radio-frequency protection ratio as a function of the separation Δf between the carrier frequencies:

— for Δf = 0 kHz: almost equivalent to that for monophonic transmission;

— for Δf = 50 kHz: higher than that for monophonic transmission, but less than 24 dB;

— for Δf = 100 kHz: equivalent to that for monophonic transmission;

— for Δf = 200 kHz: equivalent to that for monophonic transmission.

3.3.1.8 Multipath propagation effects: equivalent to that for monophonic transmission.

3.3.1.9 Sensitivity to impulsive noise: almost equivalent to that for monophonic transmission.

3.3.2 *Monophonic reception of the* S-*channel*

3.3.2.1 Audio-frequency response: same as for monophonic service.

3.3.2.2 Linear crosstalk *M* to *S*: better than − 60 dB up to 10 kHz.

3.3.2.3 Intermodulation *M* to *S*: better than − 50 dB up to 10 kHz.

3.3.2.4 Total harmonic distortion: equivalent to that for monophonic transmission.

3.3.2.5 Non-linear crosstalk *M* to *S*: better than − 60 dB up to 10 kHz.

3.3.2.6 Signal-to-noise (weighted) ratio: at 1% of the maximum audio input level equivalent to that for monophonic transmission, then changing gradually to 20 dB below the value for monophonic transmission at 100% audio-frequency input level.

3.3.2.7 Radio-frequency protection ratio as a function of the separation Δf between the carrier frequencies:

for Δf = 0 kHz: less than that for monophonic transmission;

for Δf = 50 kHz: equivalent to that for monophonic transmission with Δf = 0;

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* Other Administrations have not been able to confirm all these results.

— for $\Delta f = 100$ kHz: slightly higher than that for monophonic transmission but less than 15 dB; (a lower figure than 15 dB can be obtained by using an additional filter circuit in the decoder, which filter circuit is suppressing the interfering components around 100 kHz);

— for $\Delta f = 200$ kHz: equivalent to that for monophonic transmission.

3.3.2.8 Multipath propagation effects: slightly worse than for monophonic transmission (mainly non-linear crosstalk from M).

3.3.2.9 Sensitivity to impulsive noise: almost equivalent to that for monophonic transmission.

3.3.3 *Stereophonic reception*

3.3.3.1 Linear crosstalk between A and B: better than − 30 dB up to 5 kHz and better than − 25 dB up to 10 kHz *.

3.3.3.2 Intermodulation between A and B: better than − 40 dB at 1 kHz and 10 kHz.

3.3.3.3 Non-linear crosstalk between A and B: better than − 40 dB.

4. Conclusions

Bearing in mind the desirable characteristics for a system of stereophonic broadcasting set out in § 2 of this Report, and taking into account the results contained in documents listed in the Annex, it would appear that the polar-modulation system and the pilot-tone system meet in service the requirements of § 2.1 (compatibility), § 2.2 (quality), § 2.4 (monophonic coverage), § 2.5 (stereophonic coverage), § 2.6 (protection against interference) and § 2.7 (frequency assignment plans).

On the other hand, experience of industrial manufacturing in countries where these systems are operating has shown that the corresponding stereophonic receivers meet the requirement of § 2.3 (reasonable cost). Finally, the FM/FM system with amplitude compression/expansion has not yet been sufficiently tested in one country and further studies seem to be necessary.

For these reasons, although some difficulties remain concerning the condition of § 2.8 (transmission of independent programmes), Study Group X is of the opinion that either the polar-modulation system or the pilot-tone system, as indicated in Recommendation 450, can be proposed for a stereophonic broadcasting service.

ANNEX

DOCUMENTS CONCERNING STEREOPHONIC BROADCASTING SYSTEMS

Note. — The list given below indicates, for each system described in the present Report, the various documents submitted to the Interim Meetings of Study Group X in 1962 and 1965 and to the Xth and XIth Plenary Assemblies of the C.C.I.R. (1963 and 1966). Documents dealing with more than one system are listed under each corresponding heading.

1. Polar-modulation system

Doc. 238 (U.S.S.R.), Geneva, 1963	VHF/FM stereophonic broadcasting.
Doc. X/54 (O.I.R.T.), 1963-1966	Stereo broadcasting. Reduction of the zone of coverage due to random and pulse interference.

* To obtain these figures it may be necessary in some cases to have automatic or manual control of the relative amplitudes of the M and S signals.

Doc. X/63 (O.I.R.T.), 1963-1966	Opinion of the O.I.R.T. on the choice of a system for stereophonic broadcasting.
Doc. X/70 (O.I.R.T.), 1963-1966	Radio transmission of two signals by means of a VHF transmitter using an AM sub-carrier.
Doc. X/162 (U.S.S.R.), 1963-1966	Basic results of tests with polar-modulation stereophonic broadcasting systems.
Doc. X/163 (U.S.S.R.), 1963-1966	Some stereophonic detector circuits for polar-modulation stereophonic broadcasting systems.

2. Pilot-tone system

Doc. X/28 (E.B.U.), Bad Kreuznach, 1962	Choice of a standardized system of stereophonic broadcasting on metric waves.
Doc. X/35 (U.S.A.), Bad Kreuznach, 1962	Stereophonic broadcasting standards for compatible systems in sound and television broadcasting.
Doc. 205 (E.B.U.), Geneva, 1963	Technical results of the tests on the service area of the suppressed sub-carrier stereophonic system.
Doc. 223 (Japan), Geneva, 1963	Stereophonic broadcasting standards for compatible systems.
Doc. 309 (E.B.U.), Geneva, 1963	Choice of a standardized system of stereophonic broadcasting on metric waves.
Doc. X/13 (Canada), 1963-1966	Stereophonic broadcasting for frequency-modulation sound systems using a maximum frequency deviation of 75 kHz.
Doc. X/16 (Netherlands), 1963-1966	Stereophonic broadcasting. A single-sideband variant of the pilot-tone system of stereophonic broadcasting.
Doc. X/20 (United Kingdom), 1963-1966	Stereophonic broadcasting. The effect on population coverage of introducing the pilot-tone system of stereophonic broadcasting into the United Kingdom VHF/FM service.
Doc. X/22 (U.S.A.), 1963-1966	Two separate programmes with the pilot-tone system.
Doc. X/23 (U.S.A.), 1963-1966	Protection ratios for stereophonic broadcasting.
Doc. X/42 (E.B.U.), 1963-1966	Stereophonic broadcasting. Results of further technical tests.
Doc. X/45 (F. R. of Germany), 1963-1966	Standards for stereophonic broadcasting.
Doc. X/53 (O.I.R.T.), 1963-1966	Reduction of the service area of a VHF transmitter on transition from monophonic to stereophonic transmissions or in the case of two-programme transmissions using an AM sub-carrier procedure.
Doc. X/55 (O.I.R.T.), 1963-1966	On the usability of monophonic receivers for compatible reception of stereophonic broadcasts and of the main channel in the case of two-programme transmissions.
Doc. X/62 (U.S.A.), 1963-1966	The pilot-tone system for countries using $\pm$ 50 kHz deviation.

Doc. X/63 (O.I.R.T.), 1963-1966	Opinion of the O.I.R.T. on the choice of a system for stereophonic broadcasting.
Doc. X/69 (U.S.A.), 1963-1966	The relay of stereophonic programmes by a satellite using the pilot-tone system.
Doc. X/70 (O.I.R.T.), 1963-1966	Radio transmission of two signals by means of a VHF transmitter using an AM sub-carrier.

3. **Systems using an amplitude compandor in the S channel**

Doc. X/24 (Sweden), Bad Kreuznach, 1962	Stereophonic broadcasting.
Doc. 166 (Sweden), Geneva, 1963	Stereophonic broadcasting.
Doc. X/14 (Sweden), 1963-1966	Stereophonic broadcasting. Simultaneous transmission of two-sound channels in television.
Doc. X/42 (E.B.U.), 1963-1966	Stereophonic broadcasting. Results of further technical tests.
Doc. X/129 (Sweden), 1963-1966	Comments on the texts relating to the work of Study Group X.

REPORT 399 *

AMPLITUDE-MODULATION SOUND BROADCASTING

Objective two-signal methods of measurement of radio-frequency wanted-to-interfering signal ratios

(1966)

1. Introduction

Numerical values of radio-frequency protection ratios for amplitude-modulated sound broadcasting have been suggested from time to time by various authorities and agreed values of protection ratios are needed both for the use of future broadcasting conferences and for the solution of frequency assignment problems in the LF, MF and HF broadcasting bands.

It appears to be essential, therefore, that future work connected with protection ratios should be carried out under strictly defined test conditions to produce exact numerical values against which the results obtained by different authorities may be compared.

The terms defined in Recommendation 447, namely:

— the audio-frequency signal-to-interference ratio,

— the audio-frequency protection ratio,

— the radio-frequency wanted-to-interfering signal ratio, and

— the radio-frequency protection ratio,

are all interdependent, the audio-frequency signal-to-interference ratio at the receiver output being directly related to the radio-frequency wanted-to-interfering signal ratio at the receiver input. This relationship depends on a number of technical factors including carrier-frequency spacing, type and depth of modulation, transmission bandwidth, amplitude of receiver input voltage and the characteristics of the receiver itself.

* This Report was adopted unanimously.

The need to establish a minimum quality of reception leads to a minimum audio-frequency signal-to-interference ratio to be protected, that is to say, to the audio-frequency protection ratio. The relationship between the audio-frequency and radio-frequency protection ratios is determined by the transmission parameters and the receiver characteristics.

2. Possibilities and limitations of objective methods of measurement

The required audio-frequency protection ratio is generally determined by subjective listening tests with several observers, who are presented with various types of broadcast programmes with different forms of interference. If, as is usual, the radio-frequency wanted-to-interfering signal ratio is plotted for different values of the carrier-frequency spacing, there is obtained, taking into account the various technical parameters, a great number of curves. In addition to the technical parameters, different types of unwanted and wanted programmes have a considerable effect on the results. Moreover, for statistical reasons, it is necessary to use a fairly large number of observers and consequently the numerous possible combinations of the test conditions lead to experiments on a scale which, in practice, demands a drastic reduction of the number of variables.

It is desirable, therefore, to replace, wherever possible, subjective tests by objective measurements where a standard noise signal may be used to simulate the wanted and unwanted programmes and where the observers can be replaced by a measuring instrument.

It is impossible, in theory, to obtain numerical values for radio-frequency *protection* ratios by means of objective measurements *alone*. The measuring method proposed merely produces quantitative information concerning the relationship between different audio-frequency signal-to-interference ratios and the corresponding radio-frequency wanted-to-interfering signal ratios. To determine the radio-frequency protection ratio, it is necessary to decide first of all upon a basic audio-frequency protection ratio corresponding to the desired reception quality.

3. Principle of the method of measurement

The objective method developed by the European Broadcasting Union and used by broadcasting organizations and Administrations in the Federal Republic of Germany, France and the Netherlands, is essentially a psophometric two-signal method which consists in modulating successively, with a given modulation depth, the wanted and the interfering transmitter by a standard coloured noise signal. This noise signal shows a spectral composition corresponding to that of a typical broadcasting programme (for example, modern dance music or a mixture of several different broadcast programmes *).

The transmitters are followed by a receiver at the audio-frequency output of which the noise levels resulting from the two transmissions are measured one after the other by means of an internationally standardized psophometer [1]. This instrument replaces the observers necessary in subjective measurements. The ratio of the two psophometer readings gives the audio-frequency signal-to-interference ratio, whereas the corresponding radio-frequency wanted-to-interfering signal ratio is equal to the difference in level of the wanted and the unwanted signal at the receiver input. It should be noted that this psophometric method differs from the one-signal and two-signal measuring methods proposed by the I.E.C. [2], which are used for determining linear and non-linear receiver characteristics and are not suitable for the measurement of radio-frequency wanted-to-interfering signal ratios.

The psophometric method is described in detail in [3, 4 and 5]. A filter circuit to obtain the " coloured " noise, which can be used for this method, from white noise is given in the Annex.

4. Receivers

In principle, the method of measurement described may be employed with any given receiver providing the characteristics of the receiver used are clearly stated, together with the

* In France, a mixture of 16 types of programme has been used.

measurement results. As it is not possible to define an average receiver representing all types of receiver now in use or likely to become available in the future, it is appropriate to use reference receivers with well-defined characteristics [3, 4, 5 and 6].

In the case of domestic broadcast receivers, measurements taken at the audio-frequency output of these receivers neglect loudspeaker characteristics and, since the characteristics of audio-frequency amplifier and loudspeaker are matched to each other, it is advisable to take the measurements at the detector output.

5. Conclusions

The results obtained with the objective method have been compared with the results of corresponding subjective tests in the Federal Republic of Germany [7] and in France [8] and from these tests it has been found that objective measurements give a first approximation to those obtained with the subjective method.

Whilst the subjective method definitely measures the phenomena under study, it is in general less accurate and much more difficult to arrange whereas the objective method is easy to implement and leads to a higher statistical accuracy of results.

However, it should be borne in mind that objective methods only provide information on the relationship between audio-frequency signal-to-interference ratios and radio-frequency wanted-to-interfering signal ratios. The audio-frequency protection ratio can only be determined on the basis of subjective tests.

On the other hand, the objective method is particularly suitable for the study of the influence of various technical factors, such as the transmitted bandwidth, effect of compressors, limiters and similar devices, receiver selectivity, and of new techniques such as compatible single-sideband modulation. In the latter case, it is necessary to use appropriate modulation characteristics during measurements.

Bibliography

1. Psophometers (apparatus for the objective measurement of circuit noise). C.C.I.T.T. Recommendation P.53; C.C.I.T.T. Red Book, Vol. V (1962), pages 123-133. Especially Chapter A, No. 5 (Dynamic characteristic) and Chapter B, Table 2 or Fig. 30 (Characteristic curve of the filter network).

2. IEC, Publication 69. Recommended methods of measurement on receivers for amplitude-modulation broadcast transmissions. Especially Chapter III, 25-27. Geneva (1954).

3. Belger, E. and Rautenfeld, F. V. The objective measurement of the audio-frequency wanted-to-interfering signal ratio in amplitude-modulated sound broadcasting. *E.B.U. Review*, 90A, 57-64 (April, 1965).

4. Belger, E. and Rautenfeld, F. V. Objektive Messung der hochfrequenten Störabstände beim amplitudemodulierten Tonrundfunk. (The objective measurement of the radio-frequency protection ratio in amplitude-modulation sound broadcasting). *Rundfunktechn. Mitt.* 9, **2**, 65-74 (1965).

5. C.C.I.R. Doc. X/2 (E.B.U.), 1963-1966. An objective two-signal measuring method for determining the radio-frequency protection ratios for amplitude-modulated sound broadcasting.

6. I.T.U. African LF/MF Broadcasting Conference. Report by the Preparatory Meeting of Experts, I.T.U., Geneva (February, 1964), § 3.1, page 11, and Appendix 2, pages 85-95.

7. C.C.I.R. Doc. X/5 (Federal Republic of Germany), 1963-1966. Amplitude-modulation sound broadcasting, radio-frequency protection ratios — Objective two-signal method of measurement.

8. C.C.I.R. Doc. X/35 (France), 1963-1966. Amplitude-modulation, LF and MF broadcasting. Contribution to the assessment of protection ratios.

ANNEX

FILTER CIRCUIT FOR OBTAINING THE SIGNAL CORRESPONDING TO THE STANDARDIZED " COLOURED " NOISE

The double-signal objective method of measuring radio-frequency protection ratios [3, 4, 5] makes use of a standardized noise signal whose spectral composition is well defined by Fig. 1 (Curve A). It seems to be worth-while to specify a passive circuit capable of producing the signal in question from a " white-noise " generator.

The characteristics of this filter are shown in Fig. 2. Also reproduced here, as Fig. 1 (Curve **B**), is the frequency-response characteristic used for verifying the circuit by means of sinusoidal signals. It should be noted that the difference between curves (A) and (B) of Fig. 1 is due to the fact that curve (A) is based on measurements with " one-third octave " filters which pass greater amounts of energy as the bandwidth of the filter increases with frequency.

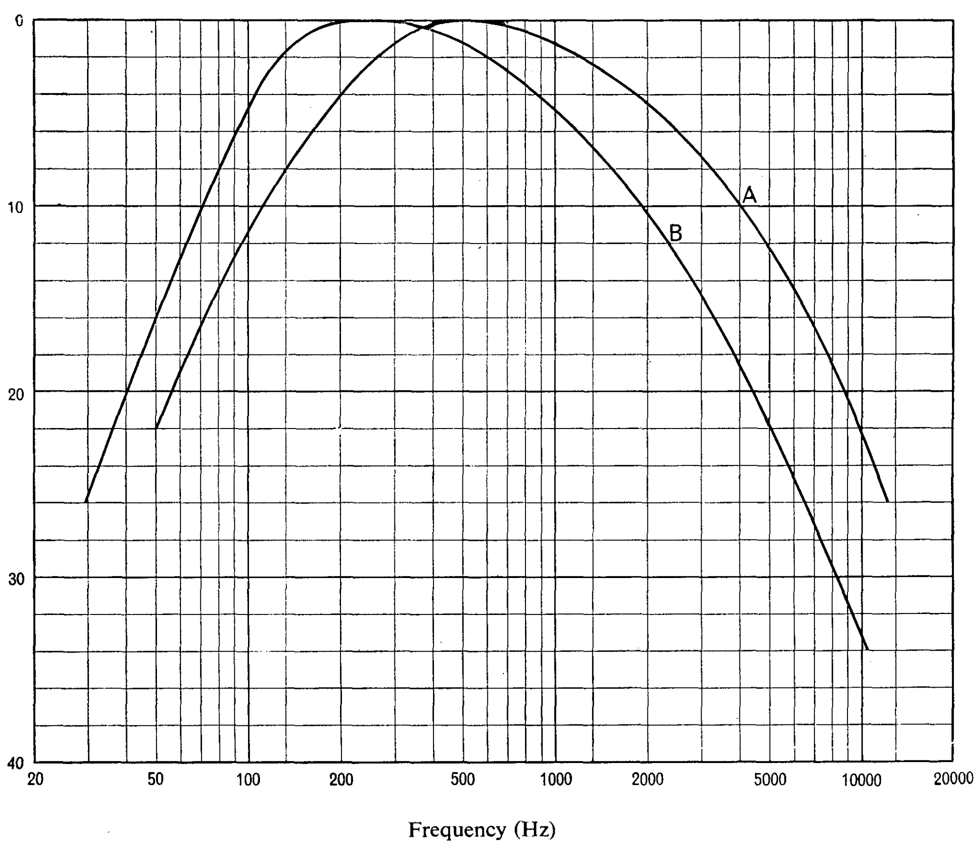

FIGURE 1

Curve A: Frequency spectrum of standardized noise (measured with one-third octave filters)

Curve B: Frequency response characteristic of filter-circuit

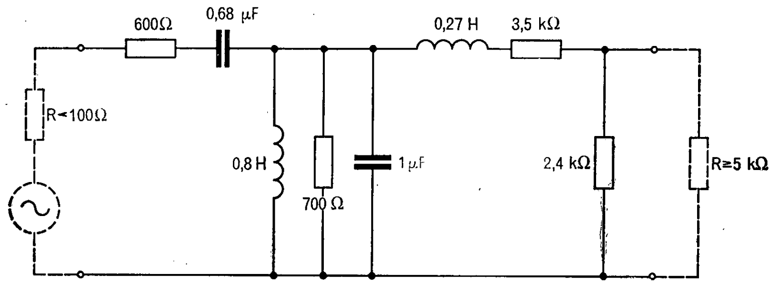

FIGURE 2

Filter-circuit

REPORT 400 *

AMPLITUDE-MODULATION SOUND BROADCASTING

MF broadcasting coverage

(Question 9/X)

(1966)

1. Introduction

Broadcasting transmitter networks must be so organized as to provide coverage of the greatest area with the fewest frequencies.

From the purely technical standpoint, the service area of each transmitter depends on a number of factors such as transmitter power, minimum useful field, wanted-to-unwanted transmitter radio-frequency protection ratio, distance between transmitters using the same frequency, ground conductivity, frequency, etc.

The aim of this paper, which sums up studies made by the French Radio and Television Authority (O.R.T.F.) in the framework of the European Broadcasting Union's activities [1, 2], is to examine a specific aspect of this problem, namely, the influence on the service area of the distance between transmitters working on the same frequency and the radio-frequency protection ratio.

2. Coverage factor as a function of distance and protection ratio

Let us consider two transmitters operating on the same frequency with an *equal power*, separated by a distance D (km) and with a service range R (km) defined *exclusively* by a protection ratio A. Using this assumption, the service area is independent of the transmitter power.

Study was then made of the variation with distance D and protection ratio A of the quantity R^2/D^2, which will be referred to as the " coverage factor " since it is proportional to the " coverage ".

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* This Report was adopted unanimously.

Note. — The conventional definition of " coverage " is: " for a given very extensive area S comprising a large number of transmitters (at the same frequency) each with a service area s_n, the " coverage " is $\Sigma s_n/S$."

A network of curves giving $10^3\ R^2/D^2$ was then drawn as a function of D, with A as a parameter.

The curves were established for the following conditions:

- transmitters with equal powers;
- the wanted transmitter's service range limited to the primary area (coverage by direct waves);
- direct propagation curves of Recommendation 368;
- interference due exclusively to the sky-wave;
- sky-wave field: annual median value of the hourly median values at midnight;
- sky-wave propagation curves deduced from Report 264-1 (Fig. 1), extrapolated beyond 3500 km.

The extrapolation was made in three different ways:

- by extending the curves using formula (1*a*) of § 2.2 of Report 264-1 (propagation type No. 1);
- by halving the mean slope of the existing curves every 500 km from 3500 km onwards (propagation type No. 2);
- by taking an intermediate curve between the first two curves (propagation type No. 3).

The curves $10^3R^2/D^2 = f(D)$ were plotted for three conductivity values of the wanted transmitter's area, i.e. 10^{-2}, 3×10^{-3}, 10^{-3} mho/m (with $\varepsilon = 4$) and the following frequencies: 500 kHz, 700 kHz, 1 MHz and 1·5 MHz.

3. Results

The curves in Fig. 2 are given as an example.

Also shown in decibels above 1 μV/m, is the field F_l of the wanted transmitter at the limit of the service area, for a transmission power of 1 kW on a short theoretical antenna. For instance, a point of intersection of a curve shown by long dashes, for $F_l = 40$ dB, and a curve $R^2/D^2 = f(D)$, for $A = 25$ dB, means that if the transmitters are separated by a distance D km (abscissa of the point of intersection) and for a protection ratio $A = 25$ dB, the field at the limit of the area, where the protection ratio is $\geqslant 25$ dB, is 0·1 mV/m.

Within the framework of these assumptions it was found that:

- the coverage factor decreases at first as D increases and is smallest at approximately 1500 km;
- from this distance onwards *up to at least 4000 km*, the coverage factor increases;
- beyond 4000 km, the variation of the coverage factor depends on propagation hypotheses. With propagation type No. 3, the variation is slight, at least for high protection ratios;
- the general shape of the curves, though varying with the propagation type for distances beyond 3500 km, is practically independent of the conductivity of the soil and the frequency;
- the optimum separation depends considerably on the propagation type but less on the protection ratio.

The fact that little is known of propagation beyond 3500 km is the major unknown factor in the problem.

4. Tentative conclusion

From the standpoint of coverage, the transmitters should be *at least* 4000 km apart and the transmitter power determined in such a way as to obtain the minimum usable field while maintaining a " reasonable " power value.

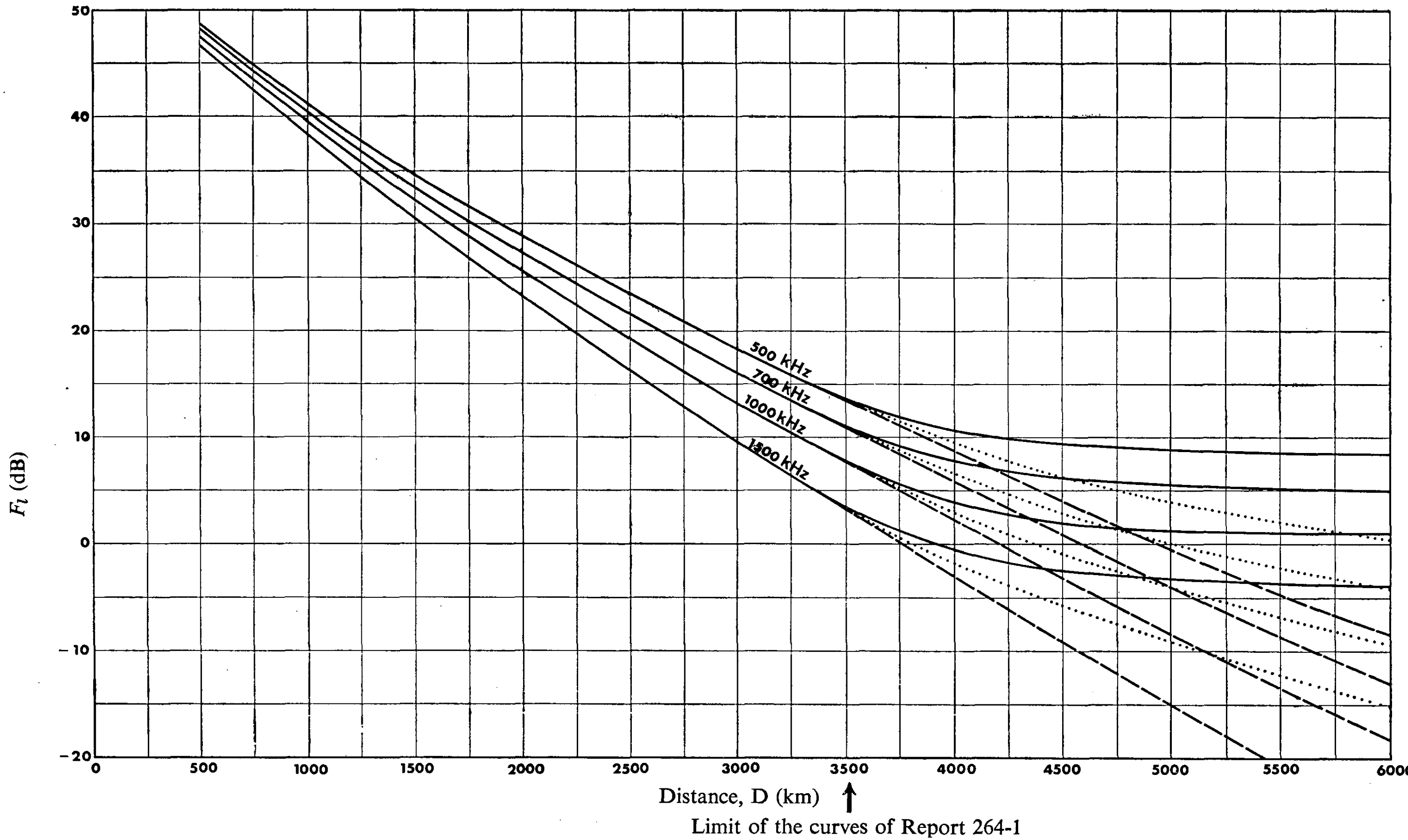


FIGURE 1

Ionospheric propagation curves (Report 264-1)

- - - - - - - - Propagation type No. 1 ———— Propagation type No. 2 ··················· Propagation type No. 3

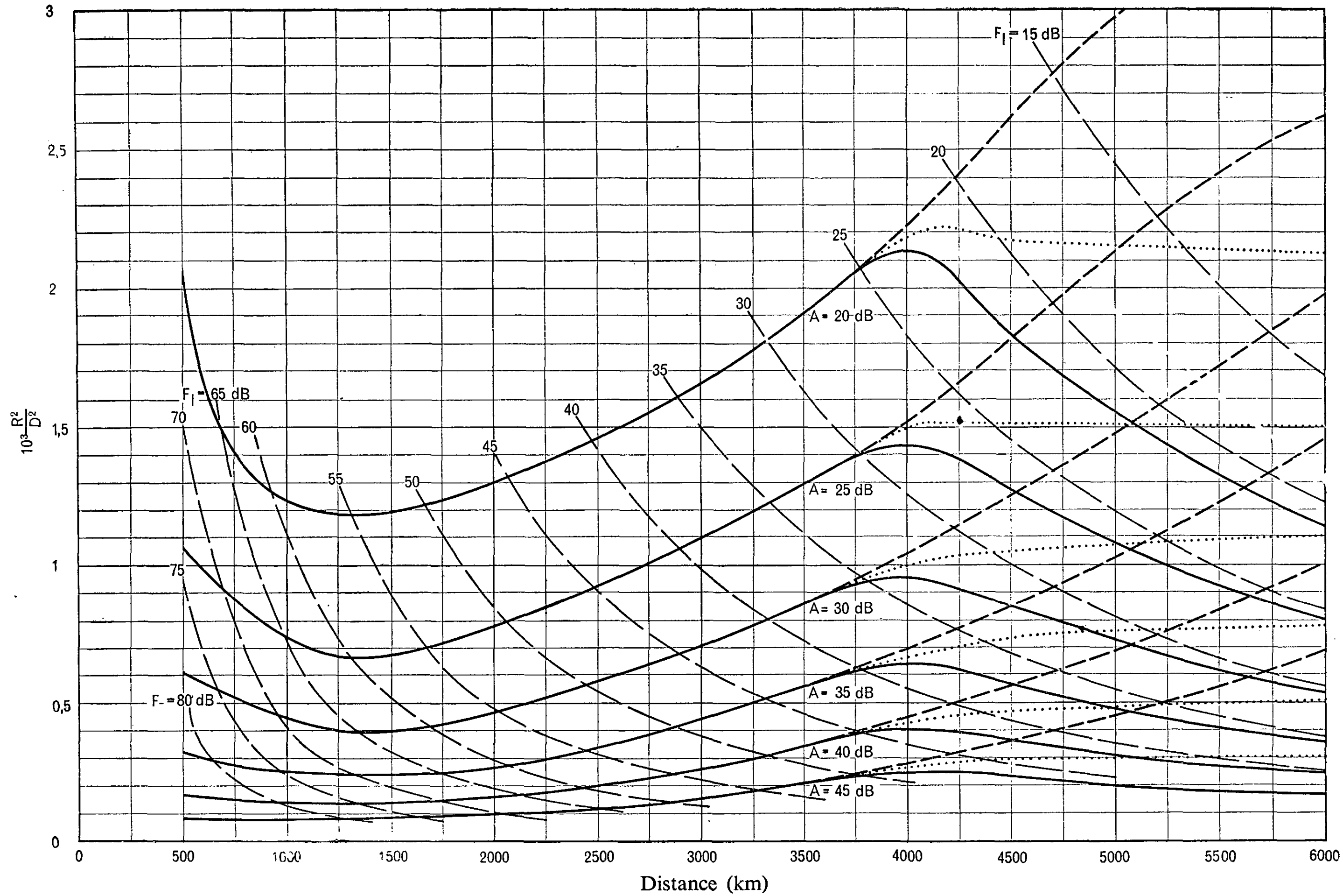


FIGURE 2

Coverage factor

$\sigma = 3 \times 10^{-3}$ mho/m : $f = 1000$ kHz

These considerations lead to the following Table (within the limits of the assumptions), based on propagation curves of type No. 3:

Frequency (kHz)	Power of transmitter (3 dB antenna gain) (kW)	Separation (km)
1500	100 250	4500 5000
1000	100 250	4800 5500
700	100 250	5000 5500
500	100 250	5250 6000

These figures correspond to a radio-frequency protection ratio A of about 40 dB when the interference is due to a single transmitter and about 35 dB when there are 5 or 6 interfering transmitters. The radio-frequency protection ratio relates to 50% of the nights of a year at midnight, local time (at the mid-point of the path).

However, these results are merely the beginning of a wider study of the problem. Any such study must also cover the possibilities of multiple interference and adjacent-channel interference.

4.1 Furthermore, various types of interference may occur depending on the choice of the intermediate frequency in the receiver. Some examples are given in [3].

It should, however, be possible to find values for the intermediate frequency, which can be used in large areas to avoid or reduce these types of interference.

Bibliography

1. C.C.I.R. Doc. X/134 (E.B.U.), 1963-1966.
2. C.C.I.R. Doc. X/148 (France), 1963-1966.
3. C.C.I.R. Doc. X/161 (France), 1963-1966.

REPORT 401 *

LF AND MF BROADCASTING

High-efficiency transmitting antennae

(Question 13/X)

(1966)

1. Antenna with reduced vertical radiation

Doc. X/21 (U.S.A.), 1963-1966, describes a high-efficiency anti-fading antenna consisting of a sectionalized tower of two 120° sections (used at the WOAI station at San Antonio, Texas). The " fading zone " area relative to the ground-wave service area is reduced from approximately 50% (for a 0·311 λ antenna) to about 30% for a ground conductivity of

10×10^{-3} mhos/m.

The document emphasizes that in this type of antenna the current distribution must be kept as sinusoidal as possible by using a thin structure of uniform cross-section.

Observations. — From experience in other countries it is evident that a high-efficiency anti-fading antenna should be of sectionalized construction and have a total electrical height of 2/3 to 1 λ, to produce the necessary rapid rise of sky-wave field strength near to the point where it equals that of the ground-wave. The effect of the resistive component of the antenna current on the vertical radiation pattern of a sectionalized tower can be reduced or compensated by multiple feeding. It should be noted that the location and extent of the " fading zone " varies due to changes in the properties of the reflecting ionospheric layers.

In practice, the fading zone is somewhat larger than that calculated. This might be due on the one hand to variations of the E-layer reflection and on the other hand to F-layer reflections. The design of antennae should take care of these effects.

2. Influence of ground conductivity on the vertical radiation pattern

Doc. X/121 (United Kingdom), 1963-1966, gives the results of a study into the influence of ground conductivity on the vertical radiation patterns of typical medium frequency antennae. The shape of these patterns has an important influence on sky-wave reception at great distances.

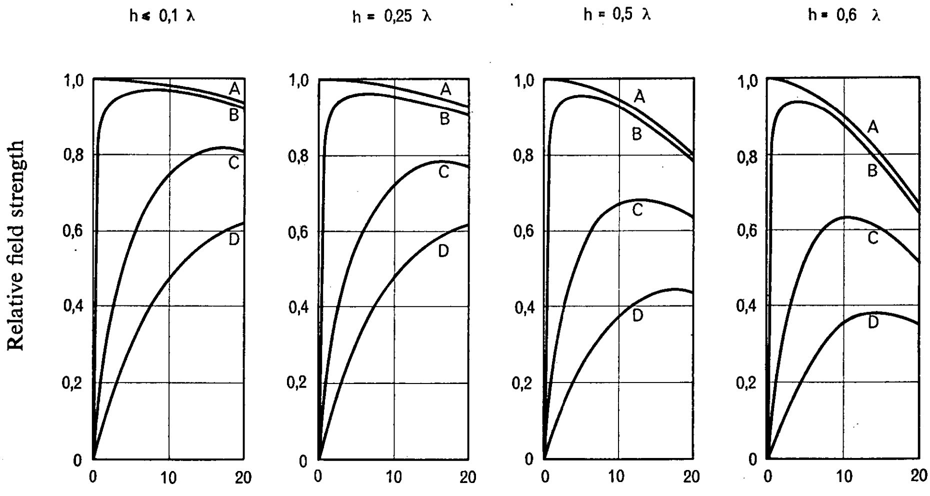
Fig. 1 shows radiation patterns for perfectly conducting ground, sea water, good ground and poor ground using antennae of different heights at a frequency of 750 kHz.

These patterns show clearly that at low vertical angles the radiation decreases rapidly as the ground conductivity worsens. Consequently the transmitting antenna should be erected on ground of good conductivity. On poor ground the higher angle modes will predominate. It should be noted that the same ground conductivity effects also apply to the receiving antenna.

The curves of Fig. 2 show the increase in receiver input voltage if ground of medium-conductivity ($\sigma = 10^{-2.5}$ mhos/m) is replaced by sea water. The influence of the antenna height is relatively small and has been neglected. The dashed curves correspond to the 1-, 2- and 3-hop modes and the full curve to the total effective increase when all three modes are considered.

It is also estimated that these results are only valid if the zone of good ground conductivity in the vicinity of the transmitting antenna extends over a section of radius at least 50 λ and subtends an angle at least 60° greater than that subtended by the service area.

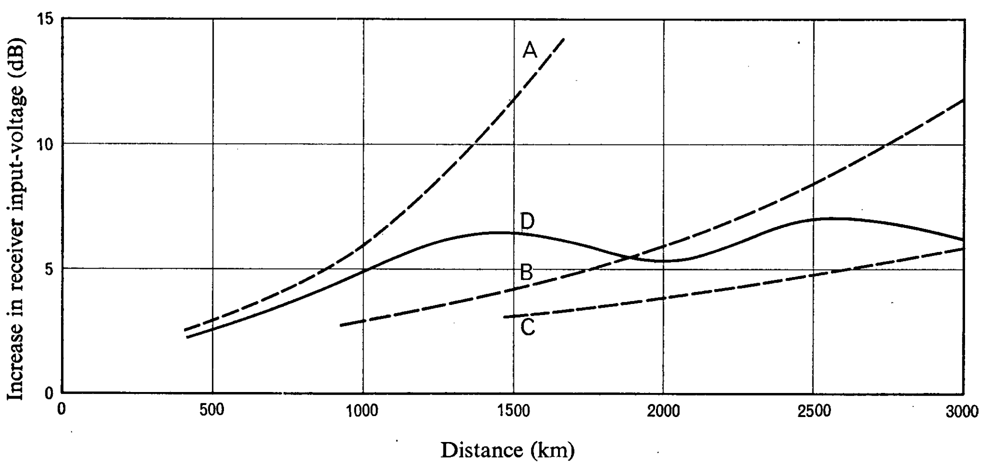
* This Report was adopted unanimously.



Curve A: perfect conductor
Curve B: sea water ($\sigma = 4 \cdot 6$ mho/m)
Curve C: good ground ($\sigma = 10^{-2}$ mho/m)
Curve D: poor ground ($\sigma = 10^{-3}$ mho/m)

FIGURE 1

Theoretical vertical radiation patterns of vertical antennae above ground of different conductivities



Curve A: 1-hop mode
Curve B: 2-hop mode
Curve C: 3-hop mode
Curve D: total increase

FIGURE 2

Theoretical increase in receiver input-voltage

BIBLIOGRAPHY

1. JEFFERS, C. L. and KERSHNER, S. W. Design and performance measurements on a new anti-fade radio station WOAI.

2. WILLIAMS, H. P. The broadcast antenna, presented in the 1947 Radio Convention of the British Institute of Radio Engineers (May, 1947).

3. JEFFERS, C. L. An antenna for controlling the non-fading range of a broadcasting station. *Proc. IRE,* Vol. 36, 1426-1431 (November, 1948).

4. KERSHNER, S. W. and JEFFERS, C. L. Design and performance measurements on a new anti-fade antenna for radio station WOAI. *IRE Transaction on Broadcasting*, Vol. B.C.6, **1** (March, 1960).

5. PAGE, H. and MONTEATH, G. D. The vertical radiation patterns of medium-wave broadcasting aerials. *Proc. I.E.E.*, Vol. 102, Part B, **3**, 279 (May, 1955).

6. MONTEATH, G. D. The effect of the ground constants, and of an earth system, on the performance of a vertical medium-wave aerial. *Proc. I.E.E.*, Vol. 105, Part C, **7**, 292 (March, 1958).

REPORT 402 *

FREQUENCY-MODULATION STEREOPHONIC BROADCASTING

Techniques for checking the essential modulation characteristics

(Question 16/X)

(1966)

Question 16/X has so far elicited only the following two contributions:

Doc. X/146 (U.S.A.), 1963-1966, which describes an experimental assembly of a phase monitor for the pilot-tone system of stereophonic broadcasting.

Doc. X/149 (Sweden), 1963-1966, which points out that this question is of interest not only to the C.C.I.R. but also to others concerned with the transmission of sound programmes from a studio to a broadcast transmitter, particularly C.C.I.T.T. Study Group IV.

The bibliography also gives some results of recent work.

However, as mentioned in Study Programme 16A/X, the importance of the problems raised by Question 16/X justifies a more thorough study and the results available at present do not permit more detailed conclusions.

Bibliography

1. Phillips, G. J. Measurement of phase errors in the pilot-tone system for stereophonic broadcasting. *Radio and Electr. Eng.*, Vol. 31, 3, 157-159 (March, 1966).
2. Funk, S. Der Einfluss der linearen Verzerrungen des komplexen Stereosignals auf die Übersprechdämpfung und ihre Bestimmung aus Oszillogrammen (The influence of linear distortion of the multiplex stereo signals on the crosstalk attenuation and their determination with oscilloscopes). *Technische Mitteilungen RFZ*, 10, **1**, 6-15 (1966).
3. Havas, G. Die stereofone Rundfunkübertragung und ihre Realisierbarkeit in Ungarn (Stereophonic broadcasting and its realization in Hungary). *Hiradastechnika*, **5**, 129-137 (1964).
4. Dias and Rykema. Journal of the Audio Engineering Society, Annual Convention (October 1963).
5. Report and Order, Docket 15.404. Federal Communications Commission, Washington, D.C.

* This Report was adopted unanimously.

REPORT 403 *

SIMULTANEOUS TRANSMISSION OF TWO SOUND CHANNELS IN TELEVISION

(Question 18/X)

(1966)

1. Existing systems

For the transmission of two sound channels in television, the systems so far proposed all make use of a sub-carrier in the sound channel. This sub-carrier can be modulated in frequency or in amplitude. When the modulated sub-carrier and the original audio-frequency signal together frequency-modulate the sound carrier we have respectively FM-FM or FM-AM systems.

Amplitude-modulated sub-carriers are synchronized to the line-frequency or to a frequency that is simply related to it (3/2, 2, 5/2 times the line-frequency). For frequency-modulated sub-carriers the centre-frequency is close to one of these multiples of the line-frequency.

To improve the signal-to-noise ratio in the second sound channel, compression and expansion can be used.

In the FM-AM system the sub-carrier can be suppressed. In this case the line-frequency is usually used as a pilot-tone, but a separate pilot-tone has also been provided. Instead of double-sideband amplitude-modulation of the sub-carrier, single-sideband modulation with a suppressed sub-carrier is also used.

In the systems so far discussed, the first programme is transmitted in the normal way. In the system that was used in Algeria by France, both sound programmes were transmitted in time-division multiplex by pulse-amplitude modulation, the pulses being synchronized with a line-frequency of 20 475 kHz.

1.1 *Choice of sub-carrier frequency*

The reason why some countries favour the use of an odd multiple of half the line-frequency for the sub-carrier frequency is to avoid interference from the picture signal into the second sound channel, when a simple multiple of the line-frequency is used for this purpose (especially when inter-carrier sound reception is used).

An advantage of the use of 3/2 the line-frequency for the sub-carrier in combination with single-sideband is the relatively narrow frequency spectrum, which facilitates the use of ordinary television sound receivers and avoids certain forms of interference. A disadvantage of the choice of an odd multiple of half the line-frequency for the sub-carrier frequency is that only modulation frequencies up to 7000 Hz can be admitted, if the quality of the first channel is to be maintained. The choice of a multiple of the line-frequency for the sub-carrier frequency offers the possibility of wideband modulation, but systems that make this choice are more sensitive to interference from the line-frequency harmonic. Frequency-modulation in the picture channel may be a source of interference but this is avoided in modern transmitters. In receiving a television signal of the vestigial-sideband type on inter-carrier sets, phase variation of the video sideband signal is mainly caused by the Nyquist slope in the receiver. Several possibilities for reducing the undesirable effects of this interference are being studied (e.g. compensation by means of a connection from the video detector output to the FM detector output via an insulating stage). In an FM-AM system studied in Poland and Japan to avoid interference in inter-carrier system receivers caused by the second harmonic of the line-frequency, modulated by the field-frequency, a shift of 90° between the switching voltage of the decoder and the second harmonic of the line-frequency is used.

* This Report was adopted unanimously.

1.2 *Frequency-deviation and other system characteristics*

In the FM-AM system studied in Poland and in the FM-AM and FM-FM systems studied in Japan, both channels deviate the carrier by $\pm$ 25 kHz at most. In the Swedish FM-FM system the second channel has a deviation of only $\pm$ 10 kHz (main channel $\pm$ 40 kHz), but its dynamics is compressed 2/1 in dB, with time constants of 2 ms for the rise time and 20 ms for the decay time. For the system used in the U.S.S.R. (SSB modulation of the sub-carrier) the first channel is allowed a frequency deviation of $\pm$ 40 kHz and the second channel a frequency deviation of $\pm$ 15 kHz.

In the French system, the width of the pulses is 8 to 10 μs, the rise-time 4 μs (approximately) and the delay with respect to the line synchronization pulse is respectively 5 μs (in channel 1) and 24 μs (in channel 2). Time-division multiplex may be possible with FM sound too, but this needs further study. This system requires only very small changes in existing receivers. It has the advantage of treating both sound channels in an identical manner, but it does not permit the reception of one sound channel without any modification of the receiver (Question 18/X), § 1. This requirement is met by the other systems discussed.

2. Required modifications to receivers

The modification to existing receivers necessary to allow the choice of either sound channel is the inclusion of a relatively small adaptor. This adaptor may contain only 1 switch, 2 diodes, 1 resistor and 1 coil, as in the French system, or it may use 3 coils, 9 transistors and 4 diodes, as in the Swedish system. The other systems are in between these two with regard to this requirement.

When adapting existing receivers to a second sound channel one has to see that the first detector is sufficiently wideband. Interference to the adjacent channel, crosstalk, distortion and deterioration of signal-to-noise ratio should also be carefully watched.

3. Stereophony

These systems can be used for stereophonic broadcasting. Compatibility to existing receivers would then require modulation of the main sound channel by the $A + B$ signal. High-quality requirements may put systems with a reduced bandwidth in the second channel at a disadvantage.

4. Service area

In the compression-expansion FM-FM system studied in Sweden, the second sound channel was found to have about the same service area as the first sound channel, almost equivalent to the service-area of monophonic one-channel transmission. In most other systems, one would expect a smaller service area for the second sound channel compared with the first and also for the first channel compared with ordinary monophonic transmission (because of reduced frequency deviation and because of the triangular FM noise characteristics before de-emphasis). The French system gives both sound channels the same quality, but it is not easy to see whether their service-areas are also the same as those of conventional amplitude-modulation systems.

5. Crosstalk

The crosstalk between the two sound channels can be better than -40 dB. For the Swedish system values of better than $-$ 60 dB are quoted. For some of the other systems no precise data are as yet available.

6. References

The systems discussed in this Report were described more fully in the Doc. X/34 (France), Bad Kreuznach, 1962, and in Docs. X/14 (Sweden), X/46 (Japan), X/144 (Japan), X/57 (People's Republic of Poland) and X/61 (U.S.S.R.), 1963-1966.

E. 3: Tropical broadcasting

REPORT 301-1 *

DESIGN OF TRANSMITTING ANTENNAE FOR TROPICAL BROADCASTING

(Question 3/XII)

(1953—1956—1963—1966)

This Report summarizes the information submitted to the C.C.I.R. in answer to the studies under Questions 70 and 3/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 Annexes, 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 2/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

* This Report 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), Warsaw, 1956,** describes briefly the measurements carried out in Barbados of short-wave (decametric) broadcast transmissions from Trinidad (350 km) at 3 and 6 MHz 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

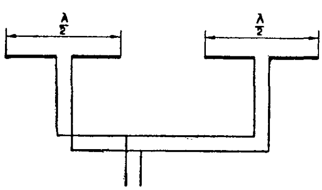
For the vertical radiated field to be a maximum, the optimum height of the dipoles above ground is $\lambda/4$ but the height is not critical. Figs. 1, 2 and 3 correspond to a height of $0{\cdot}2\ \lambda$ above ground, but each of the curves shown may be converted to apply to any height of h wavelengths above ground, by multiplying by:

$$\frac{\sin\,(2\,\pi h \cos\,\theta)}{\sin\,(0{\cdot}4\,\pi \cos\,\theta)}$$

4. Slewing

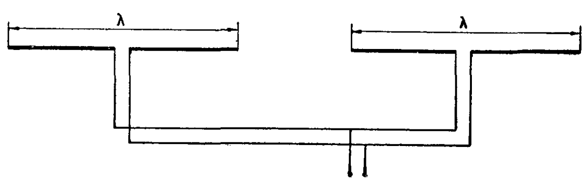
The diagrams shown in Figs. 1, 2 and 3 assume equal co-phasal currents in all the half-wave dipoles, and as may be seen, this results in a diagram suitable for a station situated in the centre of the service area.

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:

$$\frac{\cos\left(\pi \sin \theta + \dfrac{\varphi}{2}\right)}{\cos\left(\pi \sin \theta\right)}$$

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:

$$\arc\sin \frac{\varphi}{\pi}, \text{ for the array two dipoles wide,}$$

$$\arc\sin \frac{\varphi}{2\pi}, \text{ for the array four dipoles wide.}$$

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.

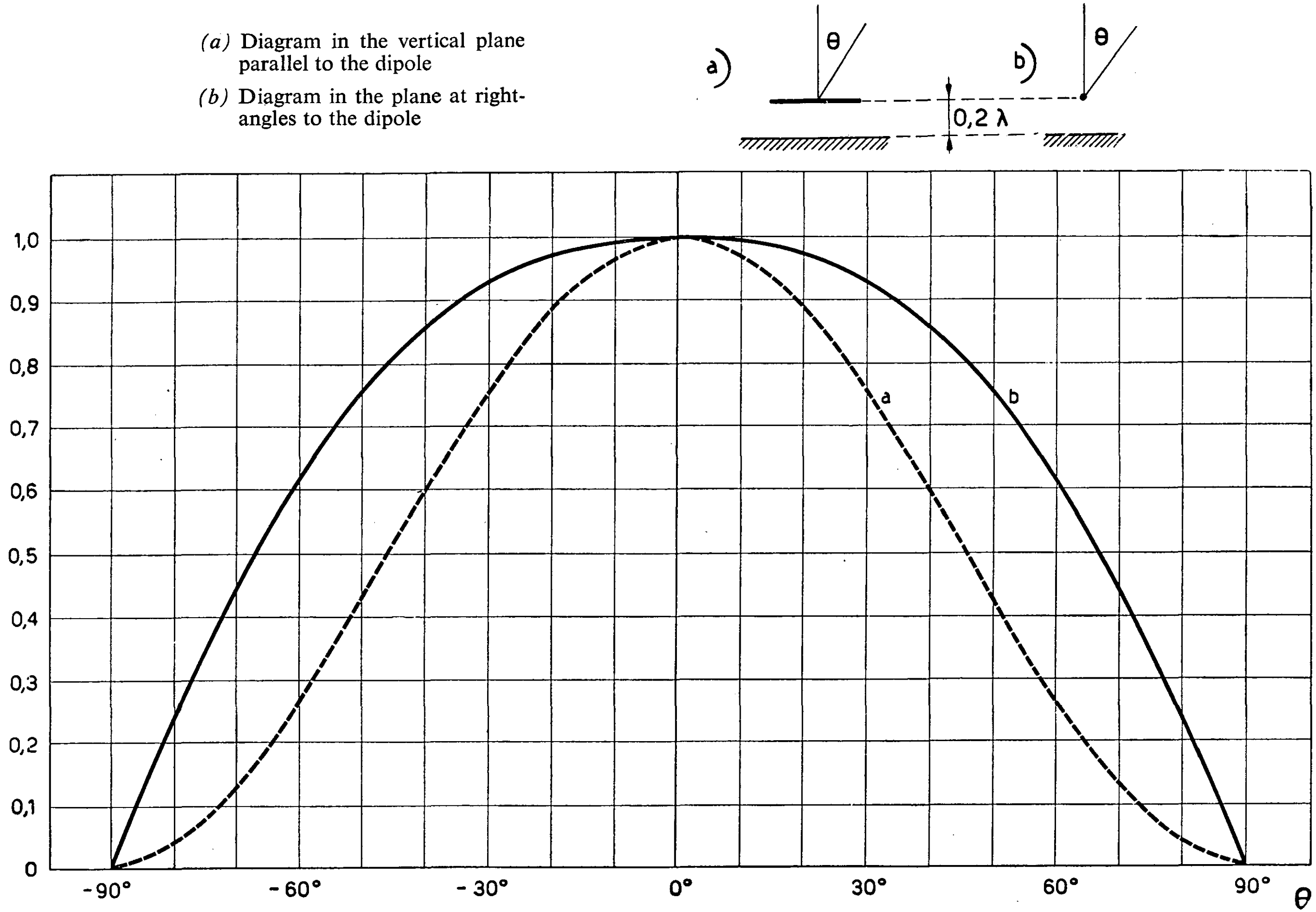
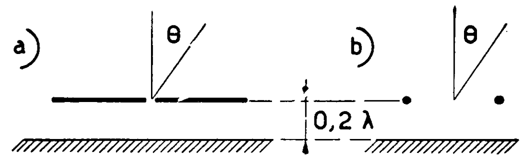


FIGURE 1

Diagram of a single λ/2 horizontal dipole *(a)* Diagram in the vertical plane parallel to the dipoles

(b) Diagram in the planes at right-angles to the dipoles



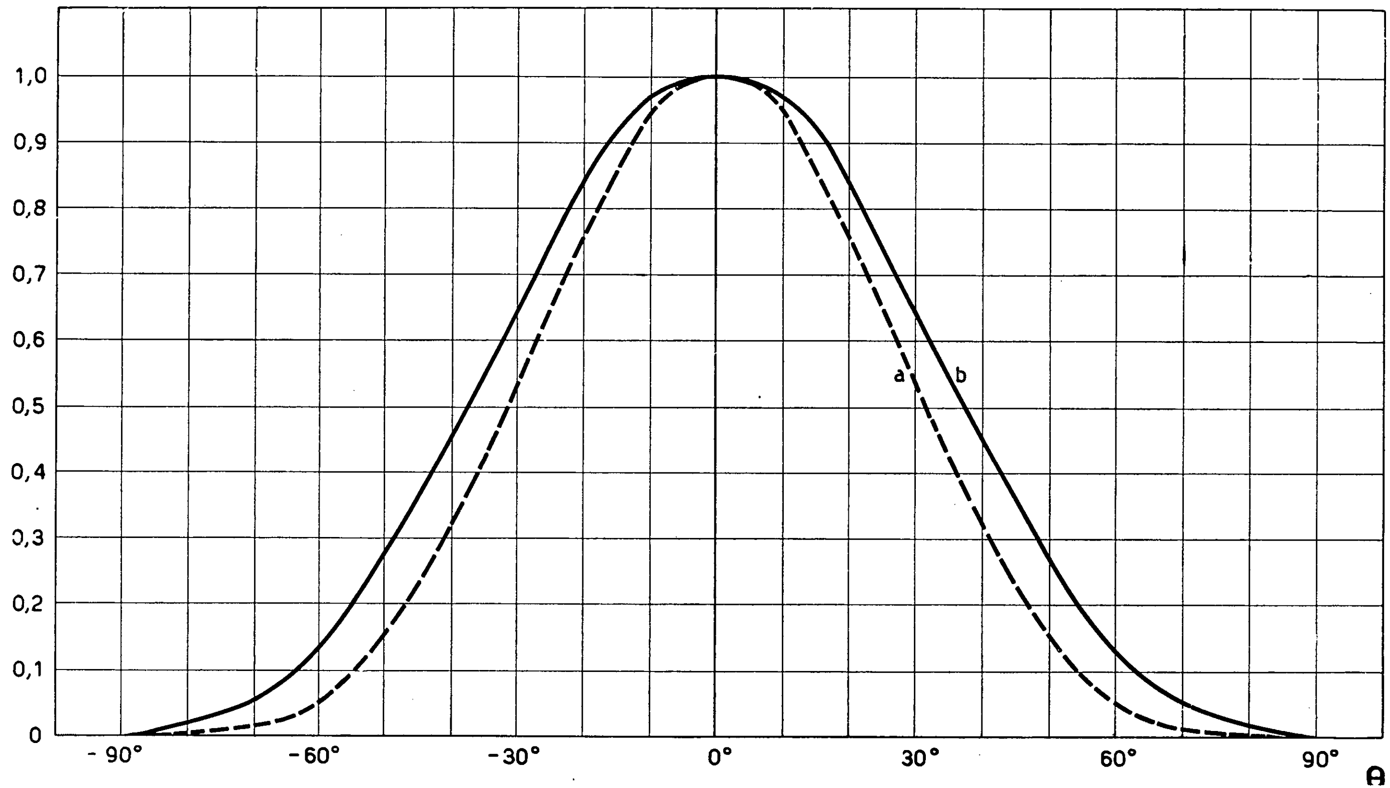
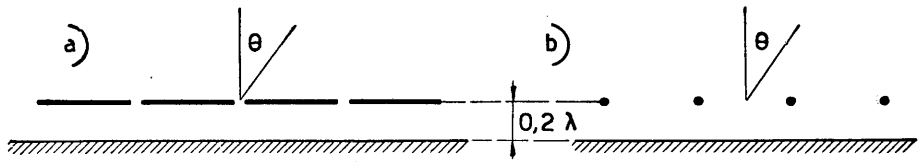


FIGURE 2

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



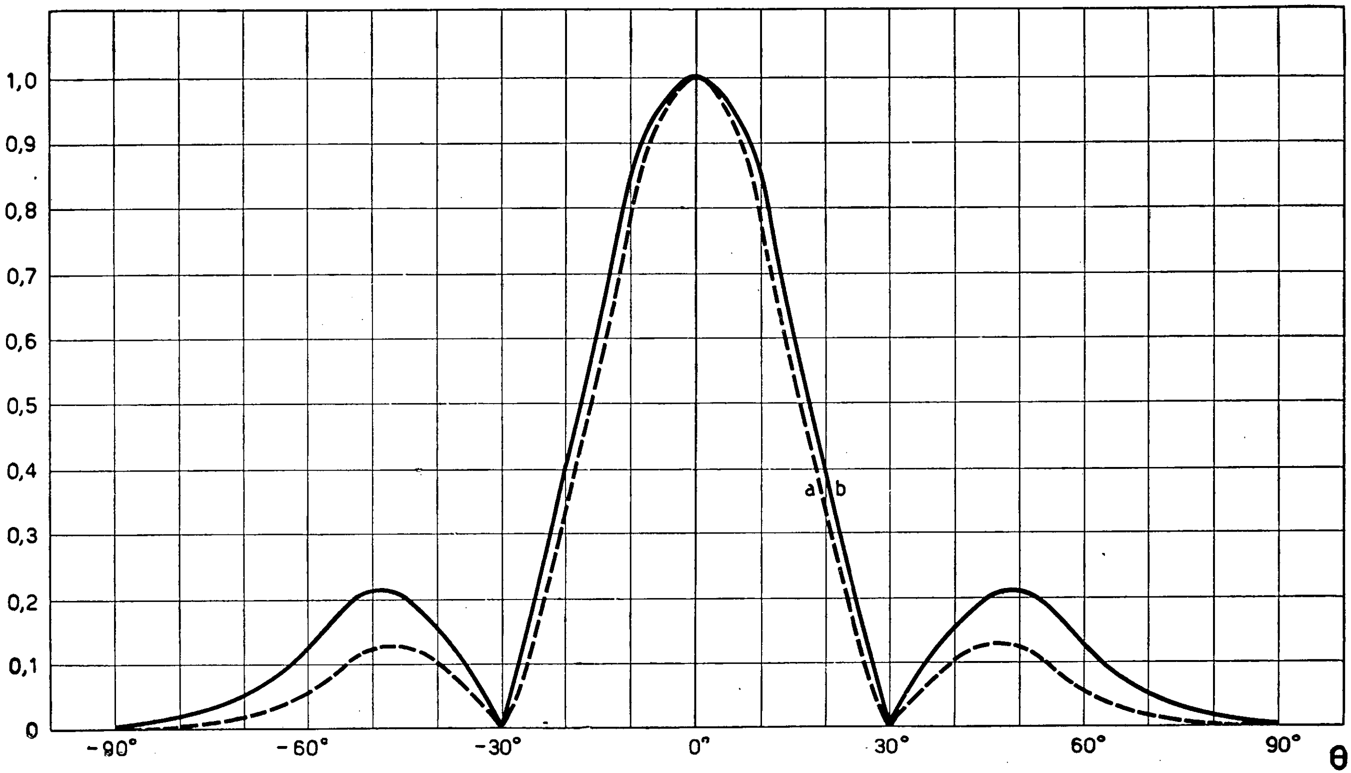


FIGURE 3

Diagram of an H4/4 array on its back

ANNEX II

HIGH-INCIDENCE ARRAY

1. **Doc. XII/1 (Republic of South Africa), 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

$$\int \int E^2 \, \mathrm{d}\theta \, \mathrm{d}\, \varphi = \eta P$$

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 angles of elevation 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.

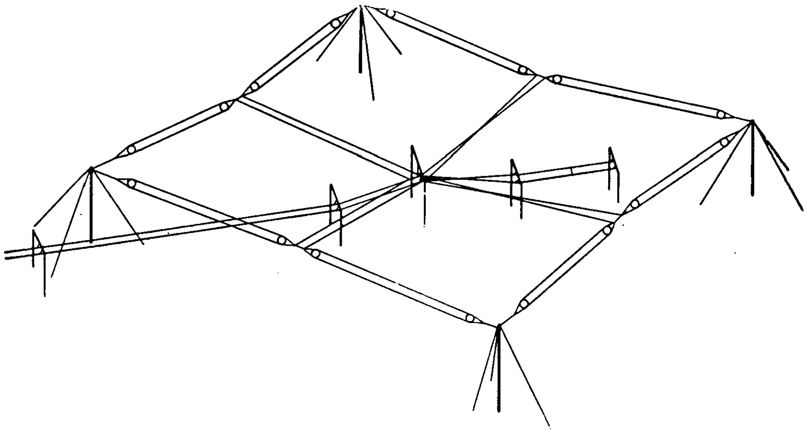


FIGURE 4

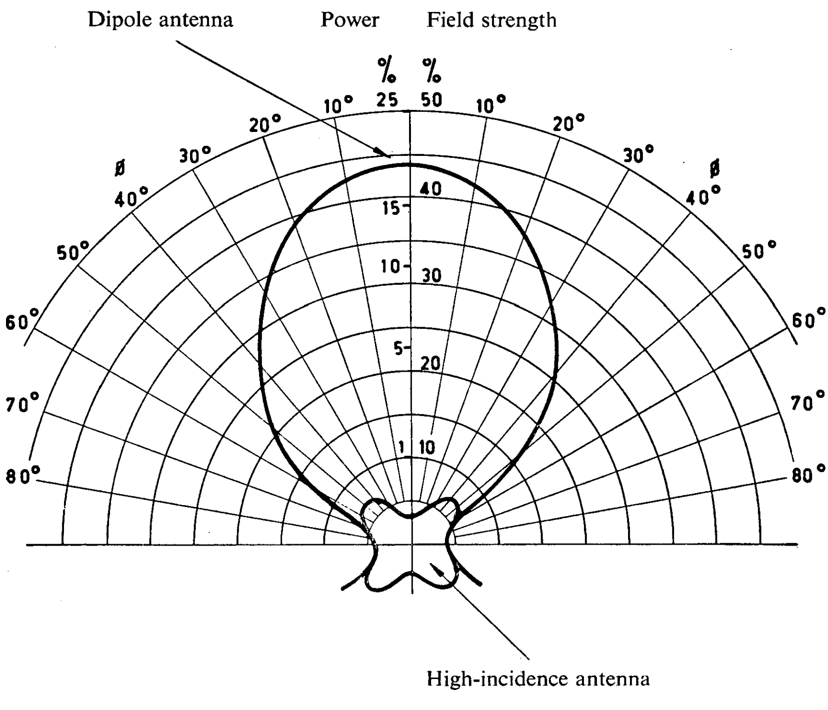


FIGURE 5

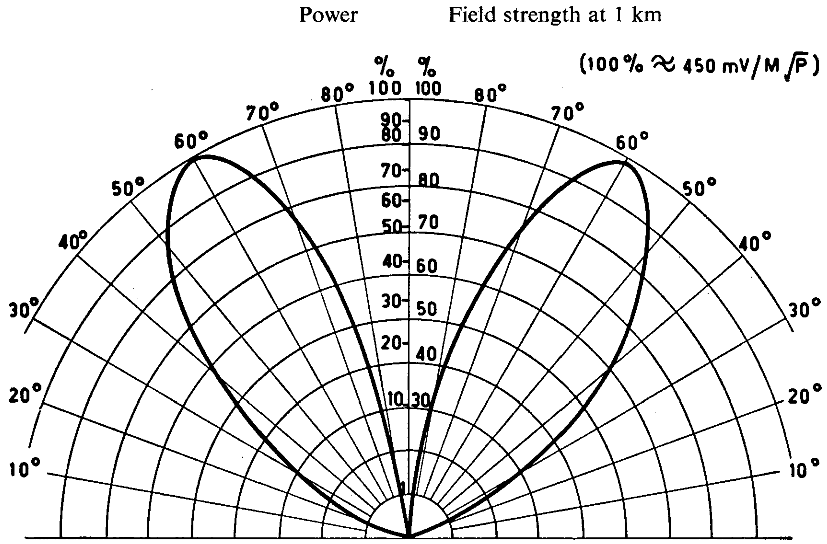


FIGURE 6 *(a) (diagonal to the square)*

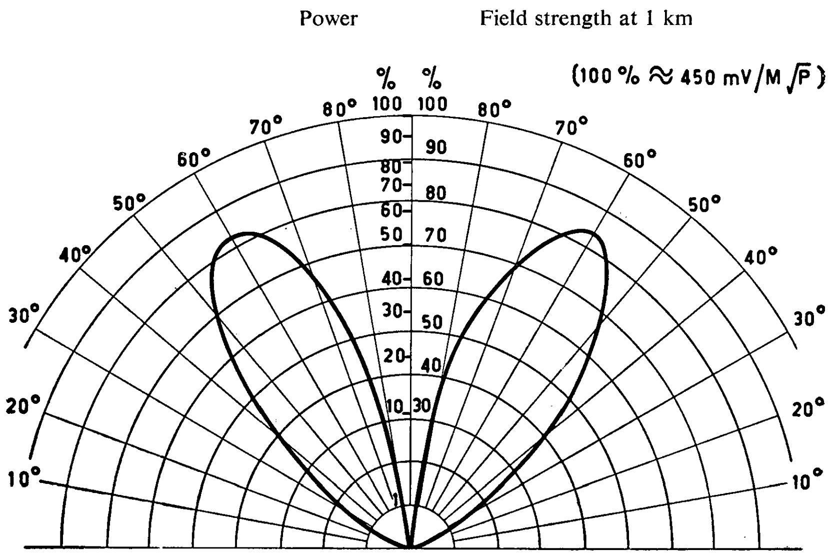


FIGURE 6 *(b) (parallel to one side)*

FIGURE 6

Measured polar diagrams for a high-incidence antenna

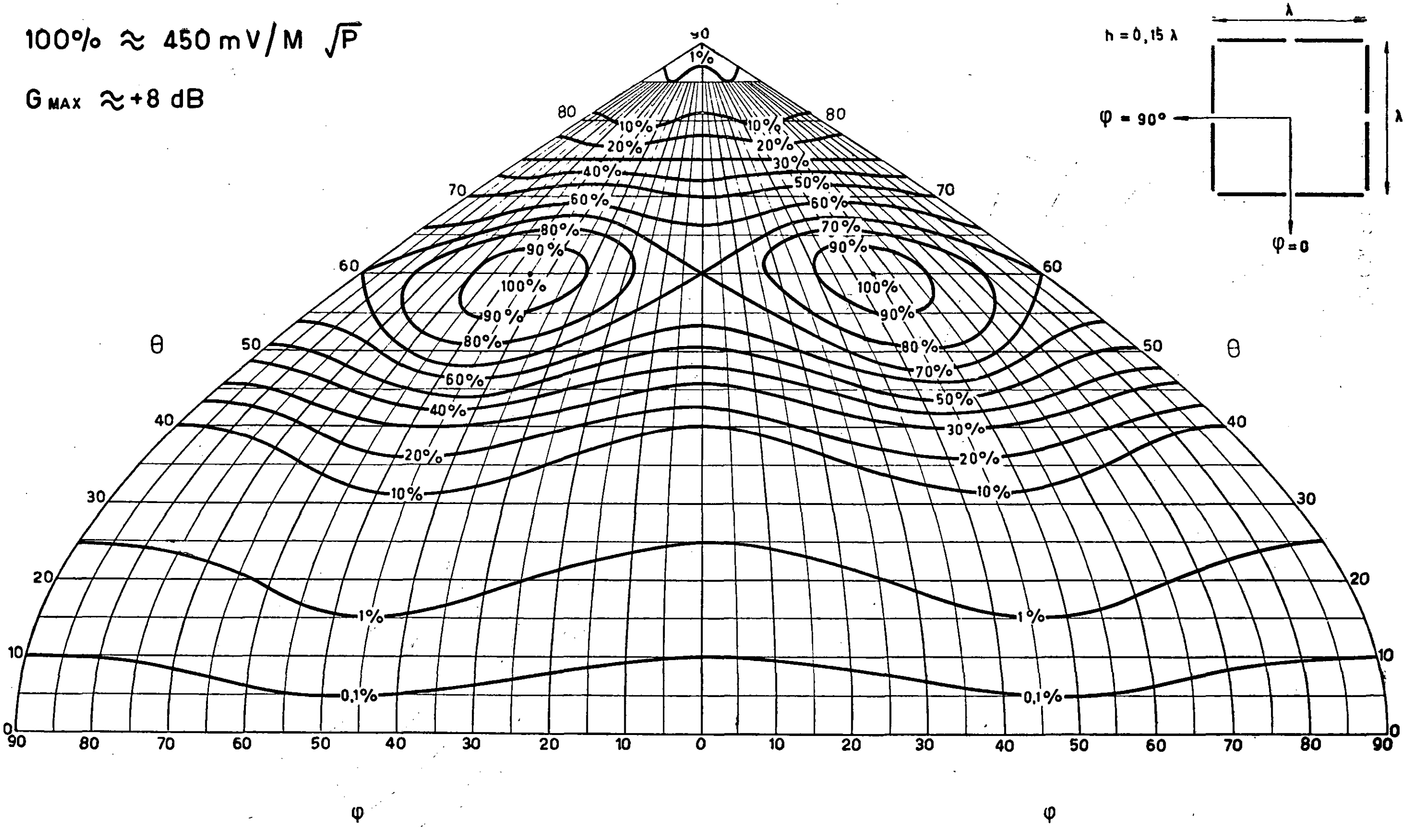


FIGURE 7

Power distribution diagram for the high-incidence array

ANNEX III

AN EXPERIMENTAL ANTENNA FOR TROPICAL BROADCASTING

(Doc. XII/4 (India), 1963-1966)

1. Introduction

Several types of antenna have been proposed from time to time for tropical broadcasting in various countries.

These are:

— a simple dipole,

— horizontal array of dipoles using 4 elements,

— horizontal array of dipoles using 16 elements,

— horizontal array of dipoles using 3 elements,

— omnidirectional system using four dipoles in a quadrant.

These antennae are erected at a low height ($0 \cdot 2\ \lambda$) above ground. All India Radio has been using a simple dipole erected at a height of $7/16\ \lambda$ above ground.

These antennae suffer from one or more disadvantages. Simple dipoles give a service range beyond 1000 km. Horizontal arrays of dipoles with 4 or 16 elements give a range of about 300 km only, while a three-element horizontal array can provide a range of about 400 km but this requires special feed arrangements. The omnidirectional system requires considerable space and a large earth mat though it gives better signals in the range of 100 km to 400 km in the broadside-on direction, and 100 km to 1000 km in the end-on direction. These antennae have been specially designed to meet the requirements of the internal services of the country of origin.

2. A H-1/2-array fed out-of-phase

A simple two-tier dipole array with standard $0 \cdot 5\ \lambda$ spacing was considered with a view to developing an antenna for tropical broadcasting. A H-1/2/0·5 antenna fed in-phase gives an angle of fire of 17½° with the horizontal while out-of-phase feeding raises this angle to 41°. Out-of-phase feeding can easily be arranged in such arrays, because of the standard $0 \cdot 5\ \lambda$ spacing between the elements. Such an antenna erected at a suitable height above ground would give the desired pattern.

3. Theoretical investigations

Theoretical investigations were first carried out to arrive at the best configuration which satisfied the general requirements of the antenna. The classical curtain theory was utilized for these computations. The computation showed that a H-1/2-array fed out-of-phase with the lower element at a height of $0 \cdot 2\ \lambda$ above ground satisfied the requirements. A typical vertical radiation pattern for a H-1/2/0·2 antenna fed out-of-phase is shown in Fig. 8.

4. Small-scale measurements

It was considered desirable to take measurements of the vertical radiation pattern before finally fixing the height above ground. This is because mutual effects at close spacings above ground would influence the current distribution in the elements and hence the vertical radiation pattern.

Full-scale measurements were excluded at the outset as the vertical radiation pattern would have to be measured with balloons or flying aircraft. The technique of small-scale measurements was therefore adopted. Scaling down to UHF was adopted in the context of available equipment and reasonable sizes for the swivelling structures for mounting the measuring antennae.

5. Results of small-scale measurements and correlation

Small-scale measurements showed that a height of $0 \cdot 4\ \lambda$ was more suitable than the theoretically computed height of $0 \cdot 2\ \lambda$. This was attributable to the mutual effects due to the close spacings from the ground. The assumption of an image multiplying-factor based on the conventional array theory did not represent the case precisely. A method involving direct vectorial summation of group patterns of each dipole and its electrical image, taking into account the relative phase of the feed as well as the spatial phase difference of the two group patterns, gave a good degree of correlation (Fig. 9).

6. Full-scale measurements

Field trials were carried out on the full-scale antenna system with the parameters as determined in the small-scale model tests. Daytime measurements were decided upon as it would facilitate measurements in the open. Transitional periods during the late evening and early morning could thus be avoided and the effect of the ionosphere on the vertical radiation pattern minimized as far as possible. Daytime schedules to fit in the propagation conditions prevailing during the periods of survey were worked out. 49 m transmissions for the morning, early noon and late evening periods and 31 m for the afternoon periods were found feasible. The 49 m and 31 m H-1/2/0·5 in-phase fed arrays at our Regional Transmitter site were modified for out-of-phase feed, with a facility for feeding the lower element only for comparison purposes. (In the modified form these arrays have their lower elements at a height of $0 \cdot 4\ \lambda$ above ground and simulate very nearly a single dipole erected at that height above ground). A 5 kW short-wave transmitter was used for energizing these antennae.

The test transmissions were monitored and their field strengths recorded at various All India Radio stations approximately in the broadside-on direction. During each test transmission the single dipole (i.e. the lower element only) was energized and subsequently, after a brief break for change-over, the double dipole fed out-of-phase was energized. Comparative figures could thus be readily obtained.

Median values of measured field strengths were assessed from the records and curves of field strength as a function of distance were drawn for the 49 m and 31 m test transmissions. A typical curve representative of 49 m transmissions is shown in Fig. 10. The curve for 31 m transmission is similar. The values between 840 km and 1250 km were interpolated as measurements could not be taken at distances in between; from the nature of the curves obtained this was found possible.

7. Results

The results show that at distances up to about 600 km the fields put out by the experimental antenna are higher by a factor of $1 \cdot 5$ to 2 than from the single dipole. At larger distances the differences become smaller and at about 700 km, the field strength put out by the experimental antenna starts falling off. At about 850 km, it is about 2½ times down as compared with the single dipole.

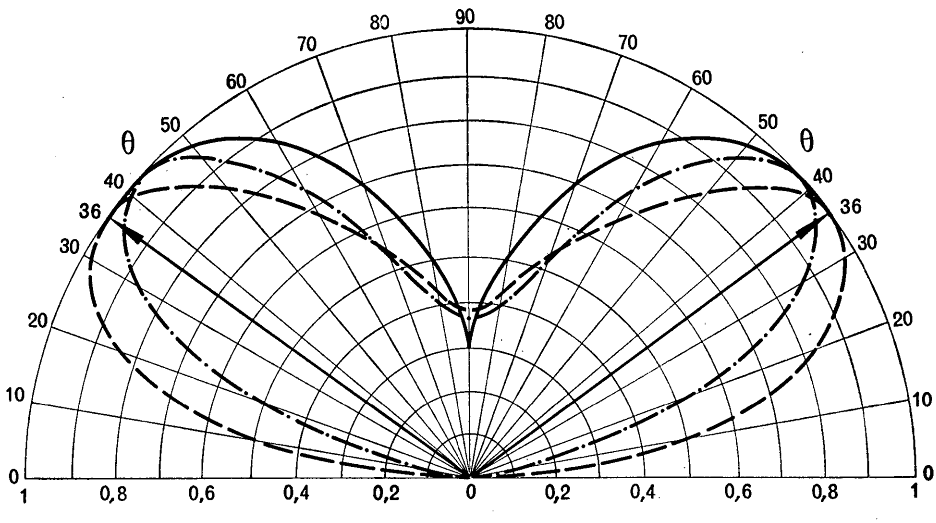


FIGURE 8

Vertical radiation patterns — idealized for 800 km distance and those obtainable by simple dipole and dipole array

———	Ideal
— — —	Dipole 7/16 λ above ground
—·—·	H-1/2/0·2 for out-of-phase feed

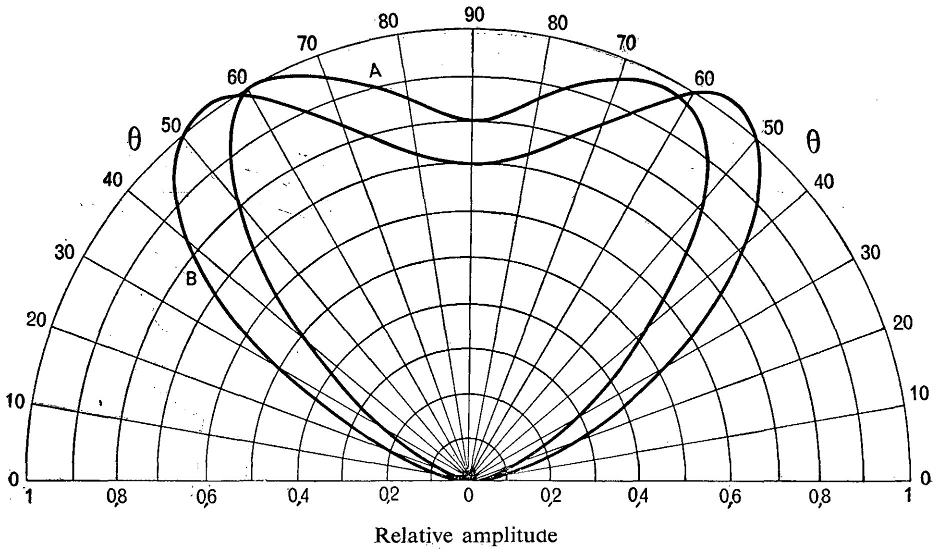


FIGURE 9

Vertical radiation patterns of H-1/2/0·4 array, out-of-phase feed

A: Curve computed by vector summation

B: Typical measured curve

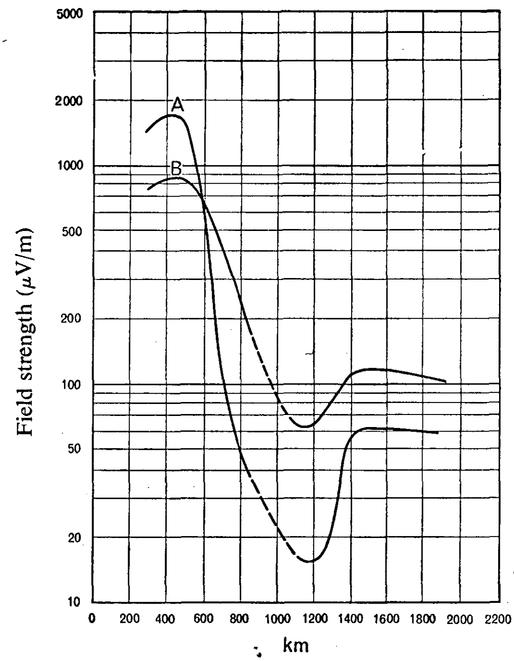


FIGURE 10

Experimental antenna for tropical broadcasting : field strength as a function of distance

Transmitter power = 5 kW
λ = 49 m

Curve *A*: H-1/2/0·4 array, fed out of phase

Curve *B*: H-1/1/0·4 comparison dipole

— — — : interpolated regions

REPORT 302 *

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

(Question 1/XII and Study Programme 1C/XII)

(1956—1959—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), 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 kHz, but with a filter giving an attenuation of about 8 dB at 5 kHz 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 Figs. 1-3 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 kHz.

   Table I gives the same information for:

   — frequency separations of 0 kHz and 5 kHz exactly;

   — nominal frequency separations of 0 kHz and 5 kHz under the most unfavourable conditions that could arise within the maximum permissible frequency tolerances of both wanted and unwanted signals, as specified in the Radio Regulations, Atlantic City, 1947.

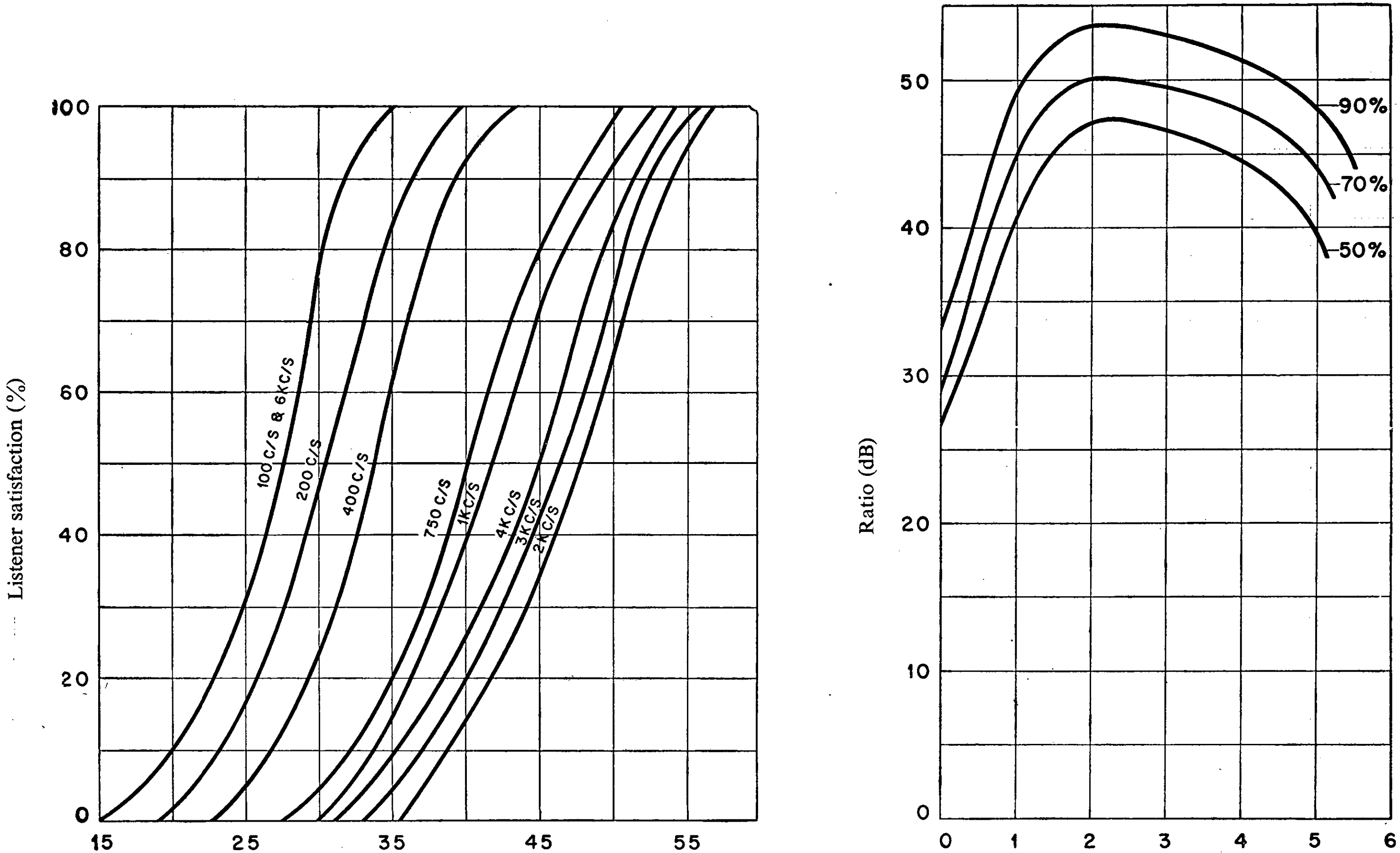
2. **Doc. 231 (United Kingdom), Warsaw, 1956,** gives details of the results of subjective tests made to determine the ratio of wanted-to-unwanted signal as a function of the frequency separation of the carriers of the two signals. Two typical broadcast receivers were used, having a fairly uniform response up to about 4 kHz falling to about − 8 dB to − 10 dB at 5 kHz. The unwanted signal was modulated by speech with a frequency range limited to 3 kHz. The ratio necessary to satisfy nearly all listeners varied from about 54 dB at 1 kHz separation, to a maximum of 56 dB between 2 and 3 kHz separation, falling to 52 dB at 5 kHz 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), Warsaw, 1956,** gives the results of similar tests made with two types of receiver, one a narrow-band receiver with considerable attenuation above 3 kHz, and the other a wider-band receiver with an attenuation of about 8 dB at 5 kHz. 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 kHz, is 43 dB for 90% listener satisfaction.

* This Report, which replaces Reports 89 and 127, was adopted unanimously.

TABLE I

Interfering emission	Maximum frequency tolerance (Rad. Regs. 1947) (Hz)	Frequency separation (kHz)	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 Hz tone)	150	0	35	31	28	42	38	34
A2 — mobile (525 Hz tone)	1000	0	35	31	28	49	45	42
A3 — fixed (3 kHz maximum modulation)	150	0	33	30	28	40	36	33
A3 — mobile (3 kHz maximum modulation)	1000	0	33	30	28	50	47	44
A3 — broadcasting	150	0	33	30	28	44	40	36
A2 — fixed (525 Hz tone)	150	5	39	37	36	43	40	38
A2 — mobile (525 Hz tone)	1000	5	39	37	36	49	46	43
A3 — fixed (3 kHz maximum modulation)	150	5	48	44	40	50	46	42
A3 — mobile (3 kHz maximum modulation)	1000	5	48	44	40	52	48	45
A3 — broadcasting	150	5	48	46	44	49	46	44

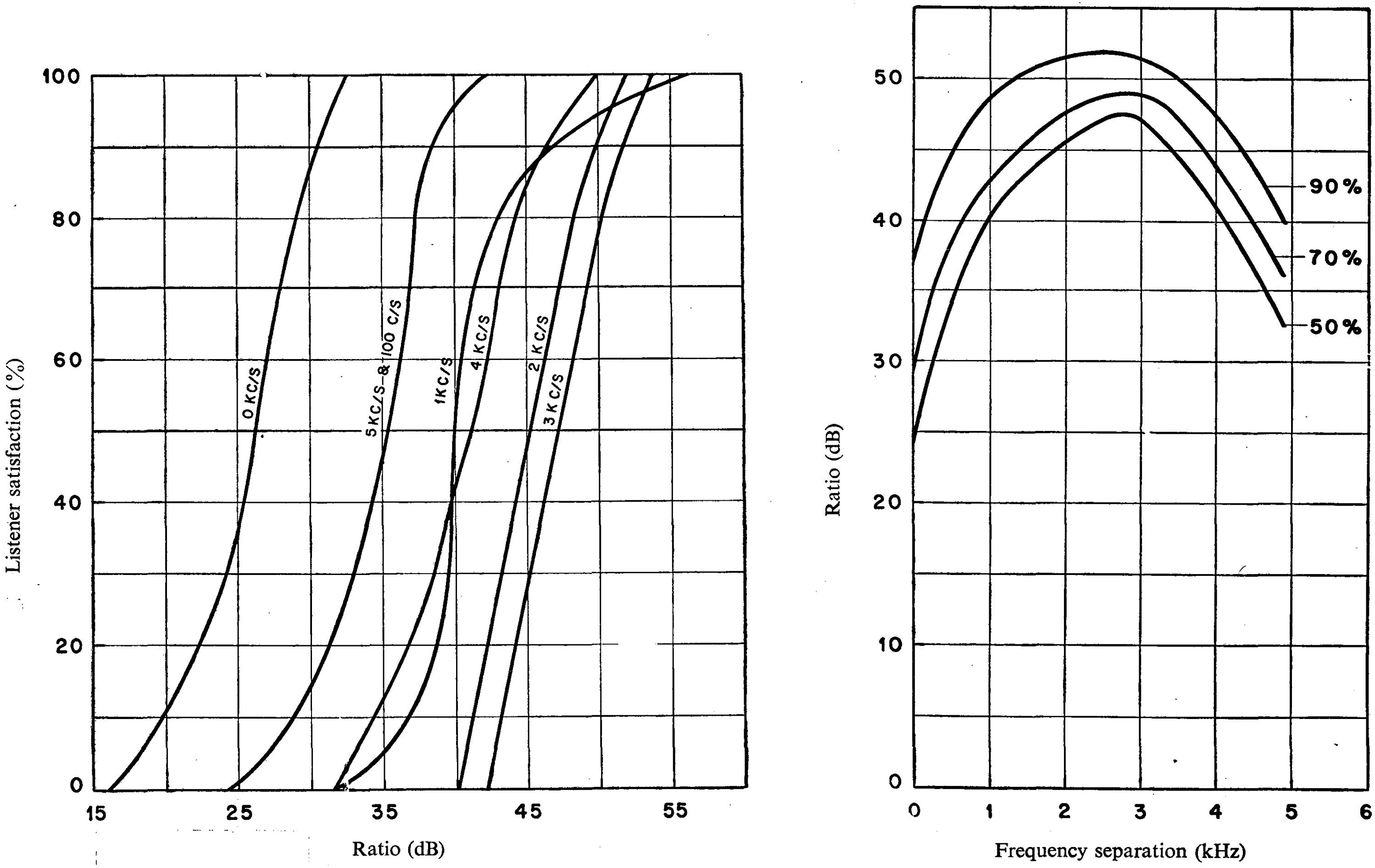


(a) Main programme: speech
Interference: A2 telegraphy

(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

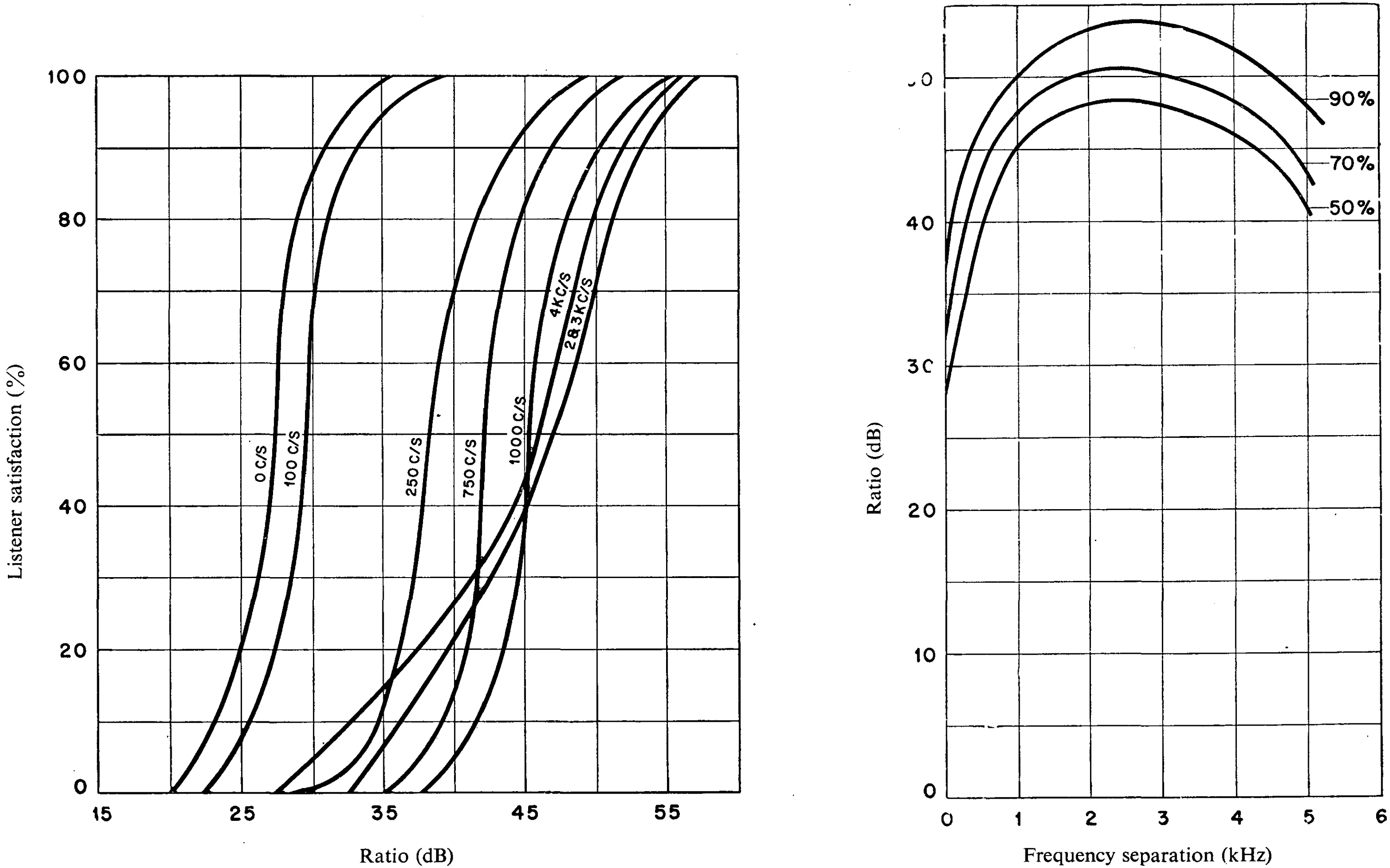


(a) Main programme: speech
Interference: A3 telephony

(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

4. Comparison of the results arrived at in the three documents shows 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 ratio which provides the various degrees of listener satisfaction given in Table I and Figs. 1-3 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 signals was always predominant. This was the case for a frequency separation of 5 kHz 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 kHz 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 Overseas Territories are of the opinion that a listener satisfaction higher than 50% should be provided. The Republic of South Africa and Australia consider that it would be impracticable to achieve 90% listener satisfaction from the aspect of signal-to-noise ratio, particularly under heavy static conditions, and therefore that, to aim at achieving 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), 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. 4. 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), Los Angeles, 1959,** describes work carried out in connection with Question 1/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 in § 4 of the Annex.

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 kHz 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 kHz. Any modifications to the design of broadcast receivers tending to attenuate frequencies at 5 kHz and lower will, therefore, result in serious deterioration in the quality of reception.

7. **Doc. XII/7 (India), Bad Kreuznach, 1962,** and **Doc. 94 (India), Geneva, 1963,** give results of further listening tests, in this case for frequency separations of 5-10 kHz. The experimental set-up was the same as before, except that, as recommended in Study Programme 1C/XI, filters with cut-off frequencies at 5, 6, 7, 8 and 9 kHz 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 Hz tone modulation). The document shows that on the basis of these experiments, which relate to values

TABLE II

Wanted signal	Interfering signal	Frequency separation (kHz)	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 kHz 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.

Note.—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.

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, Bad Kreuznach, 1962 (Table II and Figs. 1 to 5) and Doc. 94, 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 MHz, 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 kHz frequency separation and 1 dB for 10 kHz frequency separation. For frequencies of operation higher than 5 MHz, such protection ratios would be still higher. In the other limiting cases of interference from mobile stations, the increase in protection ratio at 5 MHz would be of the order of 4 dB for 5 kHz frequency separation and 3 dB for 10 kHz 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), 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 I 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 Hz) is 40 dB, and with 5 kHz 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.

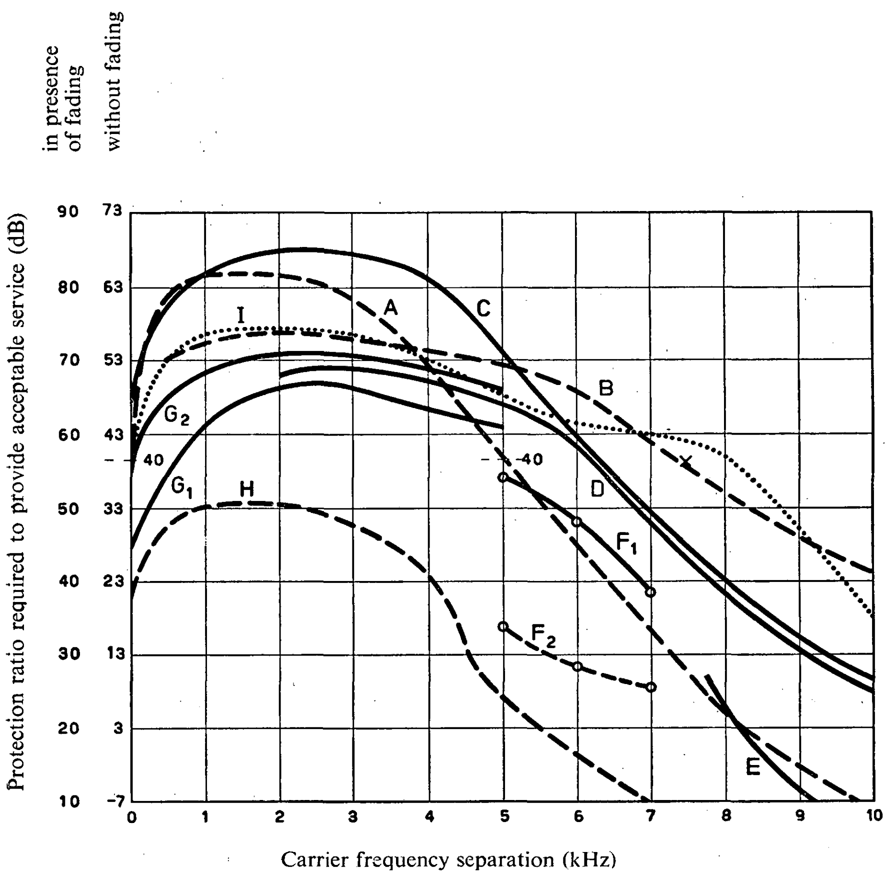


FIGURE 4

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.
I*** 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-Hz 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, 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 interferen ce 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 kHz)	30% average, peaking to 100% occasionally	Speech (0–8 kHz)	30% average, peaking to 100% occasionally
D	1950	Broadcast speech	Idem	Telephony (0–3 kHz)	70%
E	1951	Broadcast speech	Idem	Speech (0–6 kHz)	30% average, peaking to 100% occasionally
F	1956	Broadcast speech	Idem	Music (6 dB down at 4·6 kHz)	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 (kHz)	Protection ignoring frequency tolerance (dB)	Maximum frequency tolerance in the shared bands (Atlantic City) (Hz)	Protection taking into account the tolerance in column 5 (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 Hz)	0	35	150	42
	A2-mobile (mod. at 525 Hz)	0	35	1000	49
	A3-fixed (mod. at 3 kHz max.)	0	33	150	40
	A3-mobile (mod. at 3 kHz 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 Hz)	5	39	150	43
	A2-mobile (mod. at 525 Hz)	5	39	1000	49
	A3-fixed (mod. at 3 kHz max.)	5	48	150	50
	A3-mobile (mod. at 3 kHz 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 Hz)	0	24	150	28·5
	A2-mobile (mod. at 525 Hz)	0	24	1000	36
Music (vocal)	A3-fixed (mod. at 3 kHz max.)	0	26	150	34
	A3-mobile (mod. at 3 kHz 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 Hz)	5	39	150	40
	A2-mobile (mod. at 525 Hz)	5	39	1000	43
Music (vocal)	A3-fixed (mod. at 3 kHz max.)	5	42·5	150	44
	A3-mobile (mod. at 3 kHz 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 kHz, could be assessed.

4. Conditions of test for curve G_2 (India 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 (for stable transmitters $\pm$ 20 Hz). Any 5 kHz 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 I

See § 8 of the Report (page 179).

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 spacing of the order of 5 to 7 kHz, by as much as 12 to 20 dB.

REPORT 303-1 *

DETERMINATION OF NOISE LEVEL FOR TROPICAL BROADCASTING

(Question 5/XII)

(1956—1959—1963—1966)

Question 5/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), 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 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)*

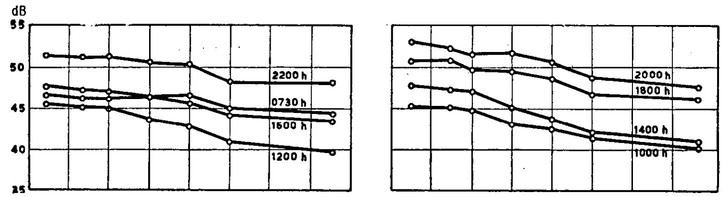


FIGURE 2 *(Equinox)*

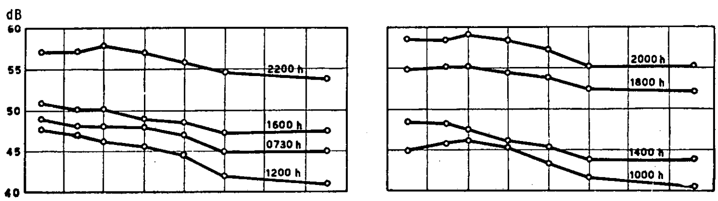
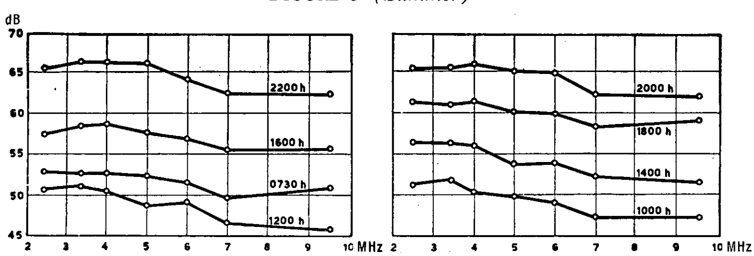


FIGURE 3 *(Summer)*



Minimum signal required for satisfactory listening (dB rel. 1 μV/m)

2. **Doc. XII/10 (India), Bad Kreuznach, 1962,** " Determination of atmospheric noise-level at Gauhati (26° 10′ N, 91° 40′ E) " and **Doc. XII/11 (India), 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), 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 kHz 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.), 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.

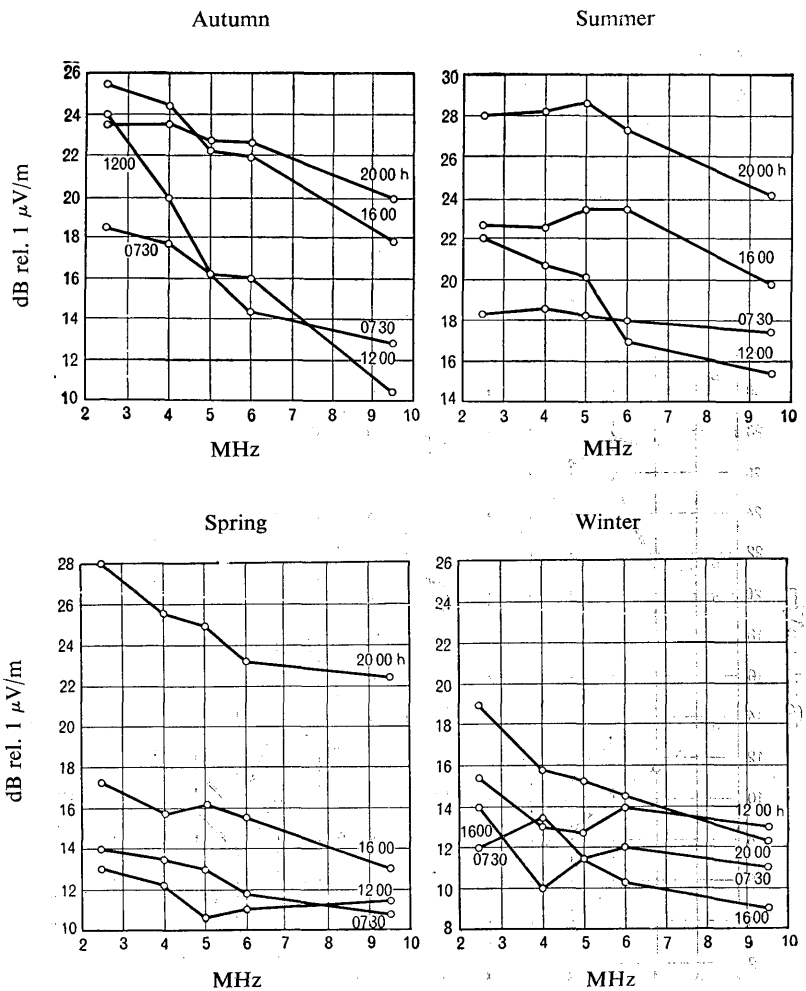


FIGURE 4

Atmospheric radio-noise at Gauhati

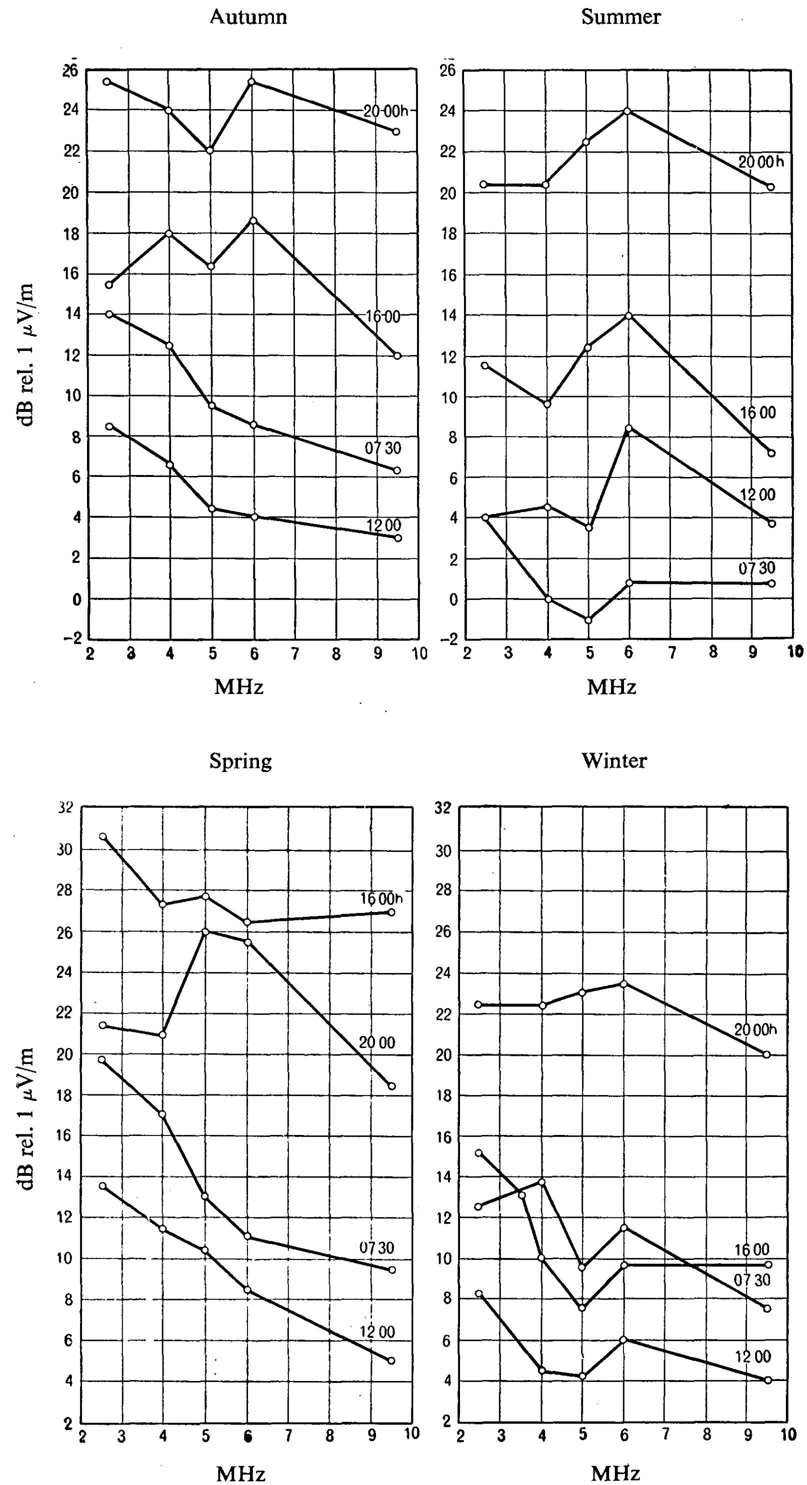


FIGURE 5

Atmospheric radio-noise at Trivandrum

4. Doc. XII/5 (India), 1963-1966. Determination of atmospheric radio noise in India for tropical broadcasting

4.1 *Introduction*

Measurements of atmospheric radio-noise in different locations in India have been continued since 1955 by All India Radio to cover the subject mentioned above. Report 303-1 summarizes the results of measurements contained in various documents, submitted to the C.C.I.R. by India and other countries. The information, presented in this section of the Report, is in continuation of that already used for the preparation of Report 303-1 and in pursuance of the directions embodied in Resolution 32 and Study Programme 1A/XII.

4.2 *Measurement*

The upper decile values of atmospheric radio-noise field strengths, averaged over the period recorded so far, have been presented for all the four seasons at different hours of measurement for the measuring stations at Delhi (28° 35′ N, 77° 05′ E), Trivandrum (8° 29′ N, 76° 57′ E) and Vishakhapatnam (17° 41′ N, 83° 18′ E). These are shown in the form of graphs in the Figures.

For Delhi, the same subjective method of Thomas and Burgess, but suitably modified for broadcasting as reported earlier, was followed to collect data from 1955 till the middle of 1964. Measurements at Trivandrum were started in 1960 and the data presented are up to the middle of 1965. The data for Vishakhapatnam are for the period April, 1964 to July, 1965 and as such these data may be considered to be only tentative.

The values are for the times 0730, 1200, 1600, and 2000 hours IST (IST = GMT + 5½ hr) and at the frequencies 2·5, 3·4, 4·0, 5·0, 6·0, 7·0 and 9·5 MHz. The measurements at 3·4 and 7·0 MHz at Trivandrum were introduced in November, 1963 only. Measurements on 4·0 MHz at Vishakhapatnam were not carried out.

4.3 *Results*

Delhi is a station in the northern part of India and in general, noise intensities in this location are highest at night in summer and lowest at noon in winter. But such a situation is not found for Trivandrum and Vishakhapatnam which are sea-coast stations in the southern part of India. Both for Trivandrum and Vishakhapatnam, unlike Delhi, maximum noise intensities are observed at night in the spring instead of in the summer, although minimum noise values, like Delhi, are obtained during winter noons. Besides, for Trivandrum the variations in noise levels at different frequencies for any particular season appear to be rather anomalous. Trivandrum, apart from being on the sea-coast, is on the Magnetic Equator. Its geomagnetic latitude is 00° 54′ S and magnetic dip is 0°. Before arriving at any significant conclusion in respect of the fact that propagation of noise is likely to be influenced in an anomalous manner due to the nearness of the measuring station to the Magnetic Equator, further measurements and collection of data are necessary. To facilitate the study in detail, noise data from another sea-coast station in Southern India, but away from the Magnetic Equator, namely Vishakhapatnam, are being collected.

Measurements at Trivandrum and Vishakhapatnam are being continued.

4.4 *General remarks*

From a comparison between the data presented earlier for Delhi and Trivandrum and those that are presented now, it may be seen that there is a general increase in noise intensities in these measuring locations. Both propagation and thunderstorm activities seem to be affected by the sun-spot cycle and, therefore, some correlation is to be expected between sunspot activity and propagated atmospheric radio-noise field strengths. But although, till now, no such correlation has been reported, increase in propagated noise field intensities during lower sunspot activities is perhaps expected.

However, before any definite conclusion is arrived at, further studies are necessary.

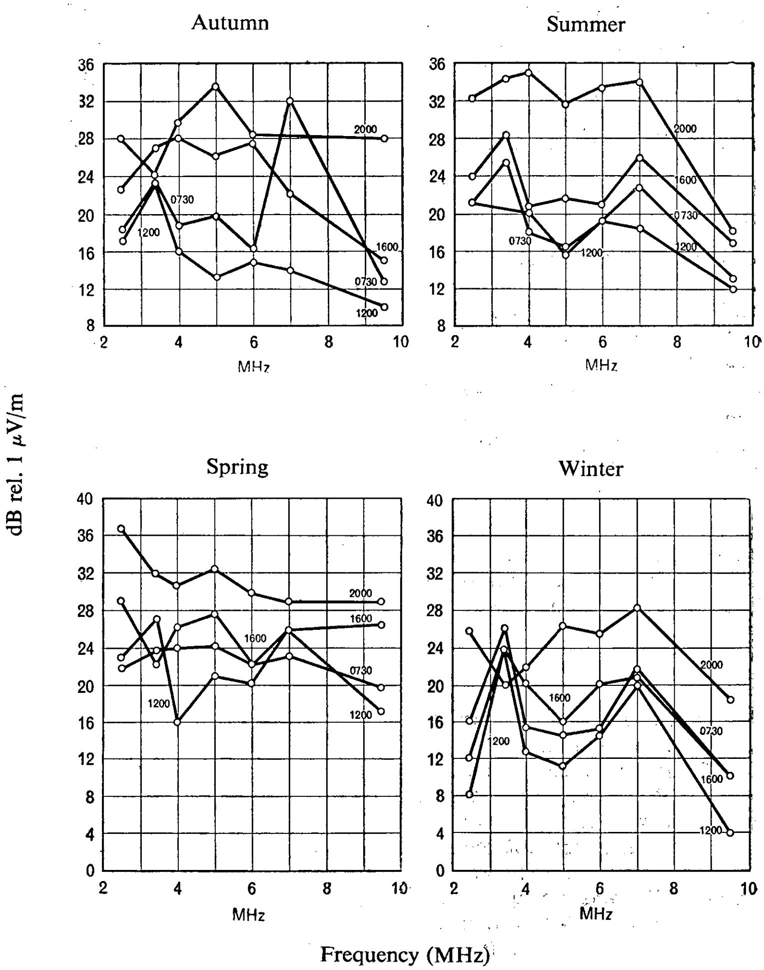


FIGURE 6

Seasonal variations of average upper decile values of atmospheric radio-noise field strengths measured at Trivandrum

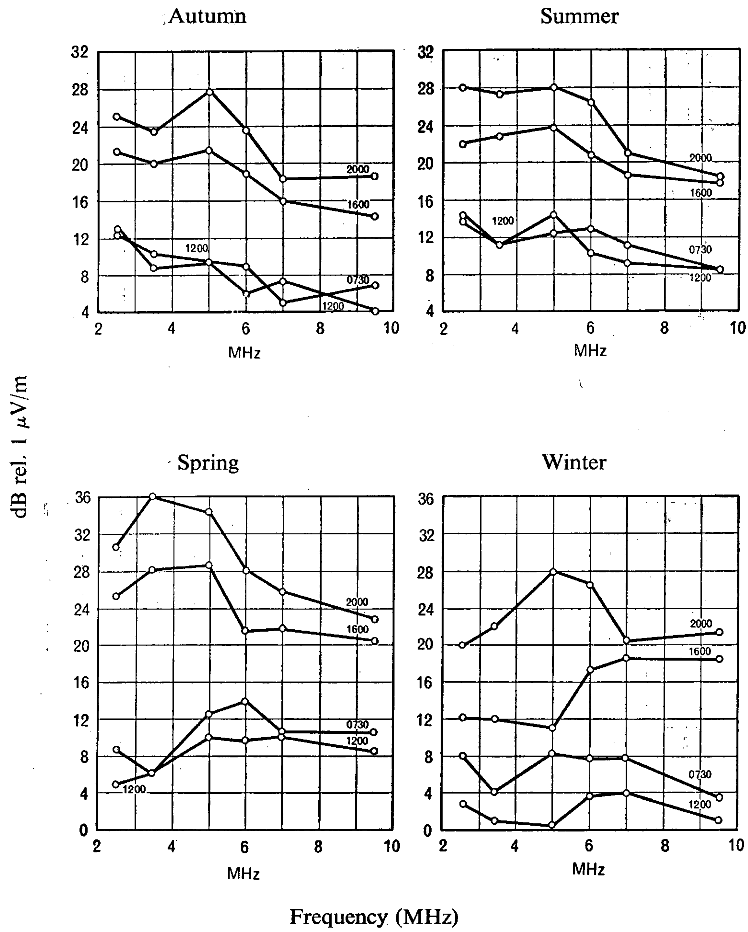


FIGURE 7

Seasonal variations of average upper decile values of atmospheric radio-noise field strengths measured at Vishakhapatnam

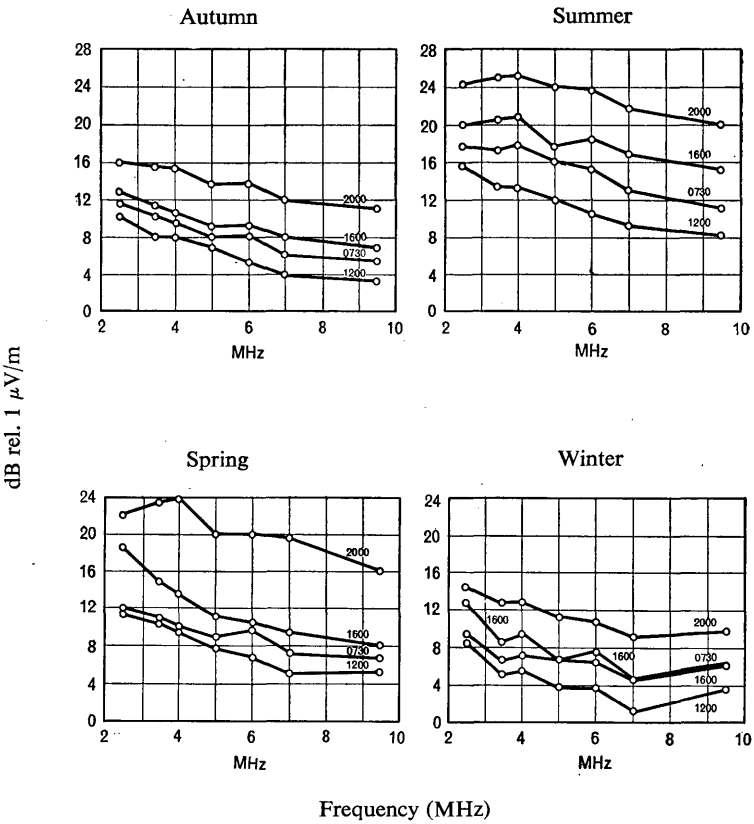


FIGURE 8

Seasonal variations of average upper decile values of atmospheric radio-noise field strengths measured at Delhi

REPORT 304 *

FADING ALLOWANCES FOR TROPICAL BROADCASTING

(Question 4/XII)

(1956—1959—1963)

Question 4/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, 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 MHz, 9 MHz and 15 MHz, 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, 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 Department, All India Radio, using transmissions from four regional short-wave broadcasting stations at Dehli, 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

* This Report, which replaces Report 121, was adopted unanimously.

season for Delhi, Bombay and Calcutta, while daytime 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 midday 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, 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 analysed later in the United Kingdom. The paper presents an analysis of recording 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 analysed in the United Kingdom by means of a level distribution analyser.

For three areas, namely Barbados and Trinidad, Ghana and Singapore, the recordings have been analysed 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 s. Another feature noticed is the increased rate of fading experienced after local sunset.

4. Doc. XII/17, 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 provide 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 analysed previously, showing a tendency for an increased rate of fading after local sunset.

5. Doc. XII/5, 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 Hz.

REPORT 305-1 *

BEST METHOD FOR CALCULATING THE FIELD-STRENGTH PRODUCED BY A TROPICAL BROADCASTING TRANSMITTER

(Question 2/XII)

(1963—1966)

1. Introduction

Docs. 227 and *357*, *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 2/XII were submitted to the IXth Plenary Assembly: *Docs. XII/2 (United Kingdom), XII/3 (French Overseas Territories) and XII/7 (India), 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), Bad Kreuznach, 1962.* These documents, together with Doc. 98 (India), Geneva, 1963, are summarized in §§ 1 to 6 of this Report.

Section 7 is based on *Doc. XII/3 (India), 1963-1966.*

2. Doc. XII/2 (United Kingdom), Los Angeles, 1959

Question 2/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 2/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 2/XII will provide the necessary quantitative data.

* This Report 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), 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 is 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-to-noise protection ratio better than or equal to 40 dB.* 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 wavelength 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 wavelength, transmitting vertically. Fig. 2*b* shows that of a single-slot antenna, at a height of 0·4 wavelength, 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 wavelength, 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 wavelength above ground. The moment considered, for each graph, is 0800 hours LMT, in June ($R = 10$). The frequency is 5 MHz. 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 MHz.

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 wavelength, 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 at 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 wavelength 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), Los Angeles, 1959 and Doc. XII/8 (India), 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

$$| \log\rho | = k (\cos\chi)^n \tag{1}$$

where

$$\rho = \text{apparent reflection coefficient,}$$
$$-\log\rho = \text{measure of absorption,}$$
$$\chi = \text{solar zenith-angle.}$$

Since, however, the exploring wave frequency of 5 MHz 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

$$\left| \log \rho \right| = k'(\cos\chi_{\varphi=0})^m \tag{2}$$

where

$\chi_{\varphi=0}$ 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

$$A_R = A_0\,(1 + C\bar{R}) \tag{3}$$

where

A_R = absorption when the sunspot is R,

A_0 = absorption when the sunspot number is zero,

C = sunspot cycle variation factor,

$\bar{R}$ = running average sunspot number.

The value of C was found to be 0·0017.

4.4 *Night-time absorption*

During most of the time 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

$$\left| \log \rho \right| = k''(f \pm f_L)\text{–}n_f \tag{4}$$

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 to the fact that the value of n_f is slightly less than 2·0 as predicted from theory.

5. **Doc. XII/9 (India), Bad Kreuznach, 1962 and Doc. 98 (India), 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:

$$F = F_0 + a_1 + a_2 - (a_3 + a_4 + a_5 + a_6 + a_7 + a_8) \tag{5}$$

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. omnidirectional),

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 long 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:

$$a_4 = \frac{635n\ (1 + 0{\cdot}0017\bar{R})\ sec\ \varphi}{(f \pm f_L)^2\ [\mathrm{Ch}(R, \chi)]^{0{\cdot}77}}\ \text{(dB)} \tag{6}$$

where

n:	number of hops,
$\bar{R}$:	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 $\chi \leqslant 80°$, $\mathrm{Ch}(R, \chi) \approx \sec \chi$

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 $\cos\chi$ 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 $\cos\chi$ and the sunspot number $\bar{R}$.

Here $$X = \frac{(1 + 0{\cdot}0017\,\bar{R})}{[\mathrm{Ch}(R, \chi)]^{0{\cdot}77}}$$

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 μV/m), at any distance up to 2000 km, is given for the 7 MHz 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.

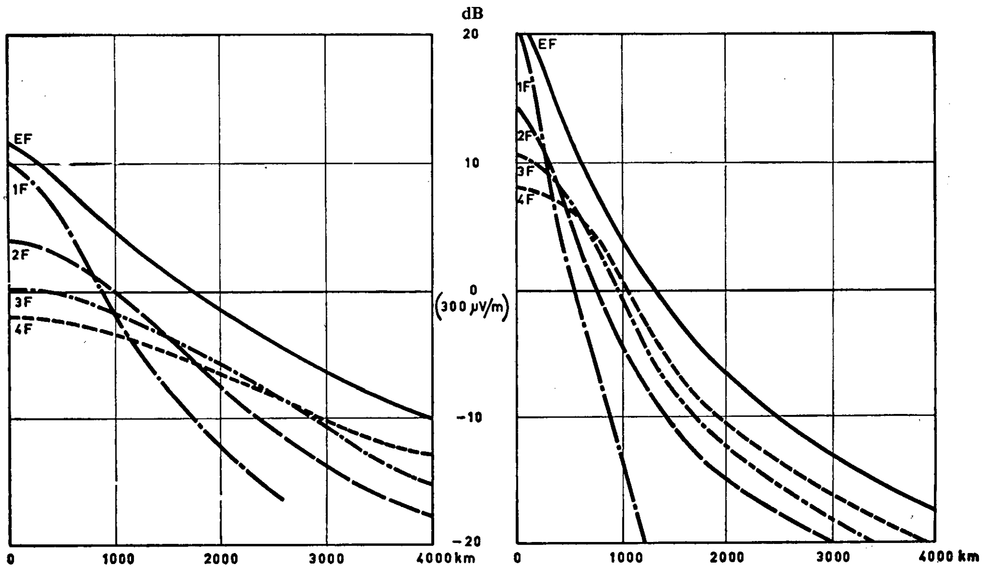
5.6 *Comparison of calculated and measured values of field-strength*

The measured values of field-strength have been compared with the calculated values obtained by C.R.P.L., S.P.I.M., RPU-9, 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 RPU-9.

6. **Doc. XII/18 (United Kingdom), 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 RPU-9 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 RPU-9 values are higher.



Distance

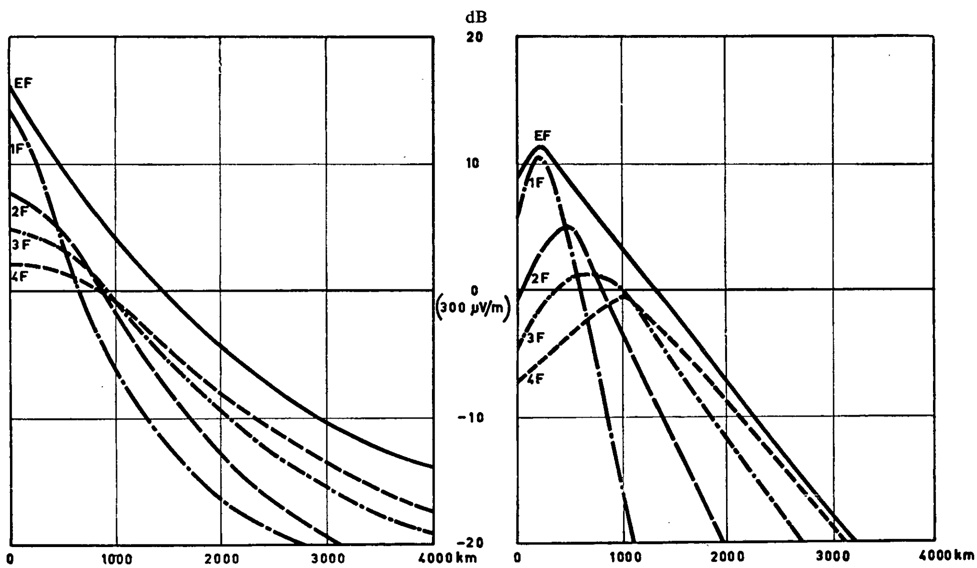
(a) A simple half-wave antenna: $H = 0{\cdot}25\ \lambda$

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

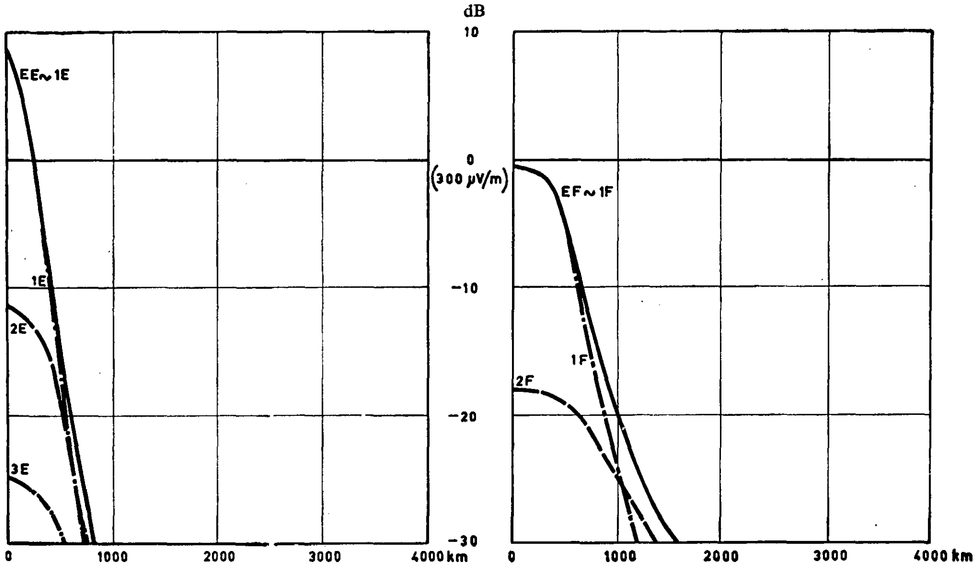
(a) Single-slot antenna—vertical transmission
$H = 0{\cdot}25\ \lambda$

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

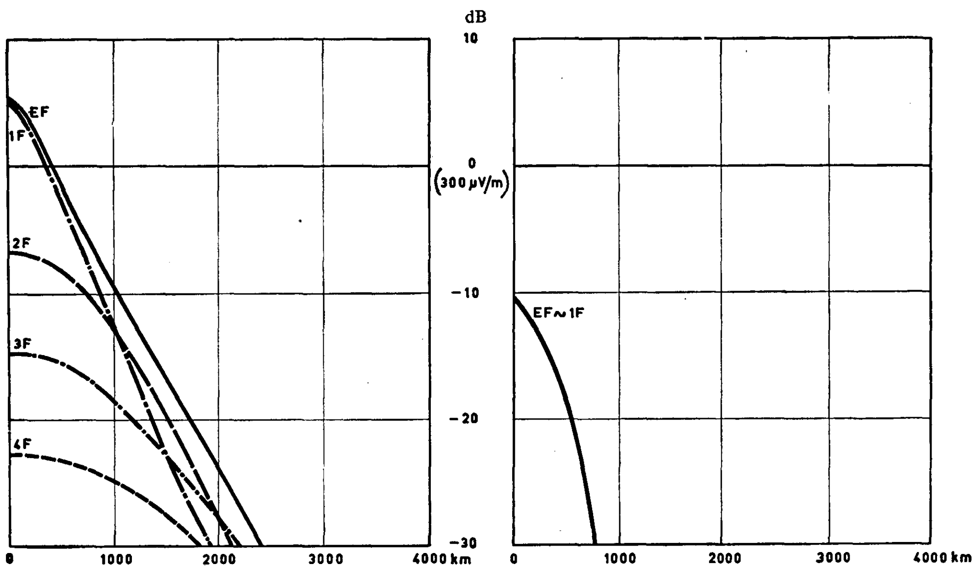
Distance
(b) *F*-layer reflection

FIGURE 3

Comparison between E-layer and F-layer reflections

Dakar, 5 MHz, 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; 7 MHz

Distance (km)
(b) Heavy absorption—
Dakar, June, $\overline{R} = 150$; 1200 hrs LMT; 7 MHz

FIGURE 4

The effect of absorption—Half-wave antenna, $H = 0{\cdot}25\ \lambda$

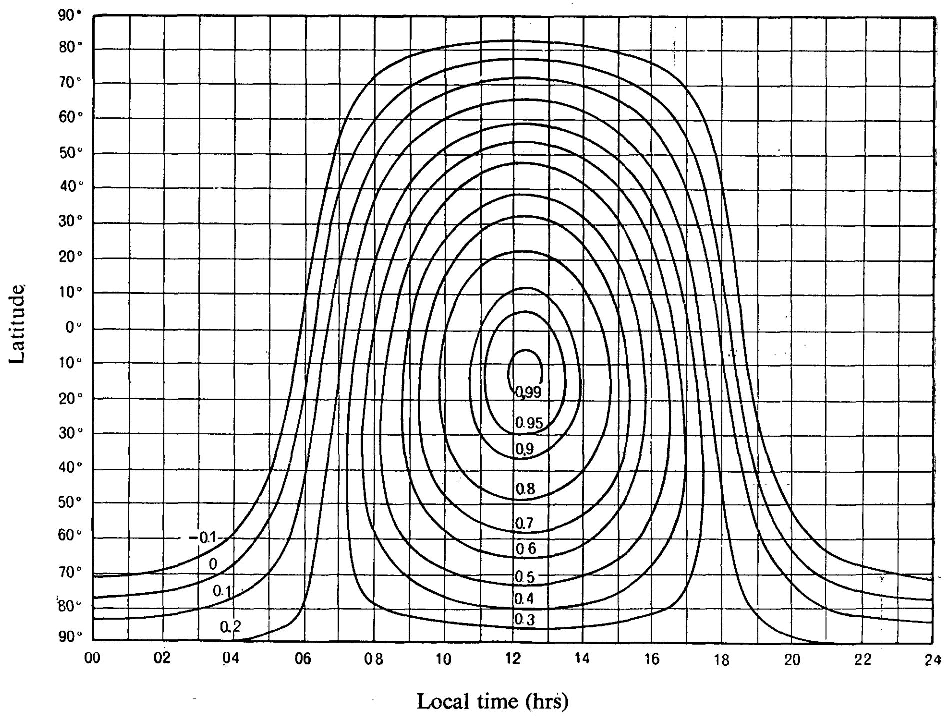


FIGURE 5

Values of cos χ (χ = solar zenith-angle) for February

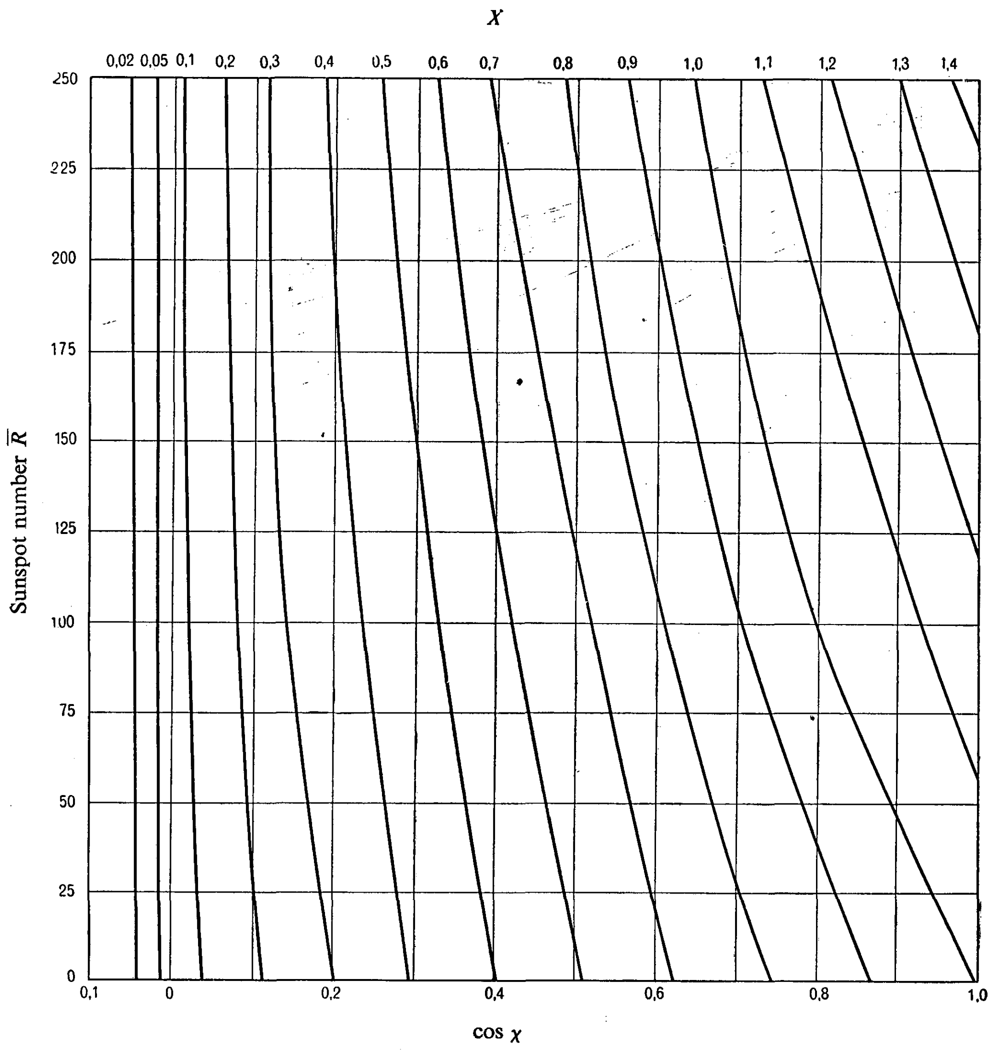


FIGURE 6

Value of X for different values of cos χ and $\bar{R}$

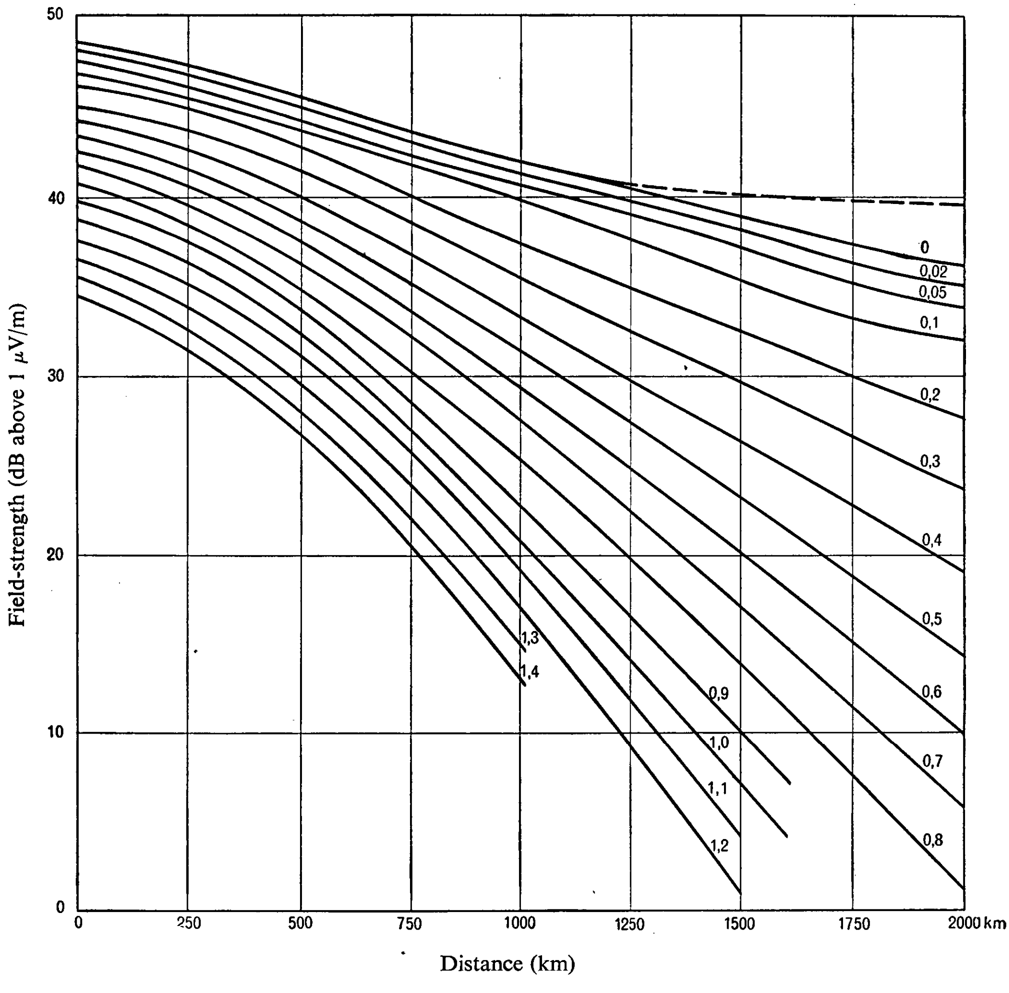


FIGURE 7

Field-strength (dB above 1 $\mu V/m$) for various values of X in the 7-MHz band

(The values of X are shown on the curves)

7. Doc. XII/3 (India), 1963-1966. Extension of the method developed by All India Radio for calculating the sky-wave field-strength in a tropical region for two-hop propagation

7.1 A method for calculating the sky-wave field-strength in the tropical region has been developed in the Research Department of All India Radio. This method is based on the results of ionospheric absorption measurements conducted in the Department for several years. The details of the method are given in §§ 4 and 5 of this Report. To facilitate calculation of field-strength by this method, suitable nomographs have been prepared for 1-F propagation and have been included in this Report. The method has been extended for the case of propagation by two hops via the F-layer, taking into account the losses due to ground reflection. Nomographs for the prediction of E-layer cut-off frequency are also included.

7.2 *Nomographs for 2-F propagation*

The value of the absorption index X is obtained from Fig. 6 of this Report. Knowing the value of X for any required value of $\cos\chi$ and R, the sunspot number, the field-strength values corresponding to a 1-kW transmitter using an omnidirectional antenna may be found from Fig. 8 for the 2-F propagation in the 6-MHz band. Similar curves have been prepared for other broadcast bands. The antenna and the power gain of the transmitter in question have to be added to the figure, and the ground reflection loss subtracted to obtain the actual field-strength. The ground reflection loss depends on the angle of incidence, the frequency of operation and the type of ground. For sea water, this loss is nearly zero for all angles of incidence and for all the frequencies considered above. But for actual ground, this loss varies both with frequency and the angle of incidence. For ready estimation, this loss has been calculated for various frequency bands and for different distances, for:

— soil of poor conductivity;

— soil of good conductivity.

Suitable curves for the estimation of this loss in the two cases are included in Fig. 8.

Actual field-strength measurements are being conducted to check as to how far the above graphs are applicable in practice.

7.3 *E-layer cut-off frequency*

As mentioned in § 5, it is essential to predict the E-layer cut-off frequency for determining the active mode of propagation. On the basis of analysis of the E-layer critical-frequency data over a complete sunspot cycle for a number of stations, a formula for the calculation of foE has been developed by All India Radio which has shown a very good correlation with observed results. This formula has been used for the preparation of nomographs for the calculation of E-region cut-off frequency.

The formula for foE is given by:

$$\text{foE} = \frac{3 \cdot 42\,(1 + 0 \cdot 0015\,\bar{R})\,S}{[\text{Ch}(a, \chi)]^{0 \cdot 34}}$$

where

foE = critical frequency of E-layer for the ordinary component of the ray,

$\bar{R}$ = twelve-month running average of sunspot number,

S = seasonal variation factor ($\approx 1 \cdot 0$)

($S = 1 \cdot 0$ for summer and equinox and $1 \cdot 03$ for winter),

$\text{Ch}(a, \chi)$ = Chapman function for a scale height of 10 km,

when $\chi \leqslant 85°$, $\text{Ch}(a, \chi) \approx \sec \chi$.

Fig. 9 gives the values of foE obtained from the above formula for different values of cosχ and sunspot numbers. E-layer cut-off frequencies depend on the circuit distances. In Fig. 10, the distances at which E-layer cut-off occurs for various broadcast frequency bands have been shown for different values of foE (which may be obtained from Fig. 9 for any values of cosχ and sunspot number). The region bounded by the ordinate, abscissa and the curve for any frequency band is the one where no E-layer occurs for that frequency.

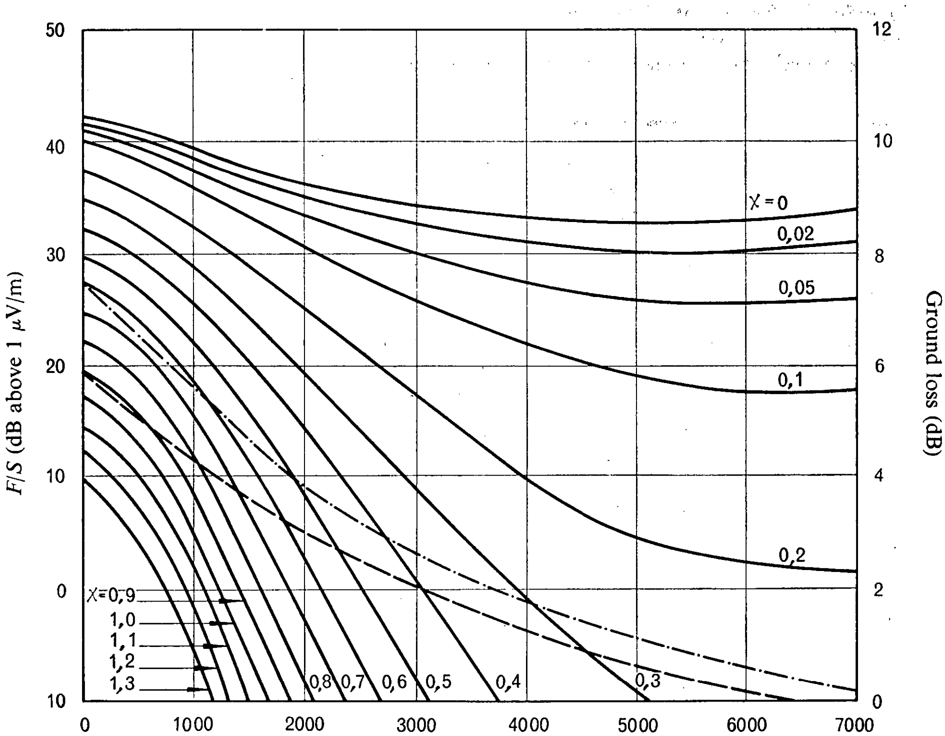


FIGURE 8

Variation of field strength with distance for 2-F transmission (6 MHz band)

—·—·— : $\sigma = 1 \times 10^{-14}$ e.m.u. soil of poor conductivity

——— : $\sigma = 1 \times 10^{-13}$ e.m.u. soil of good conductivity

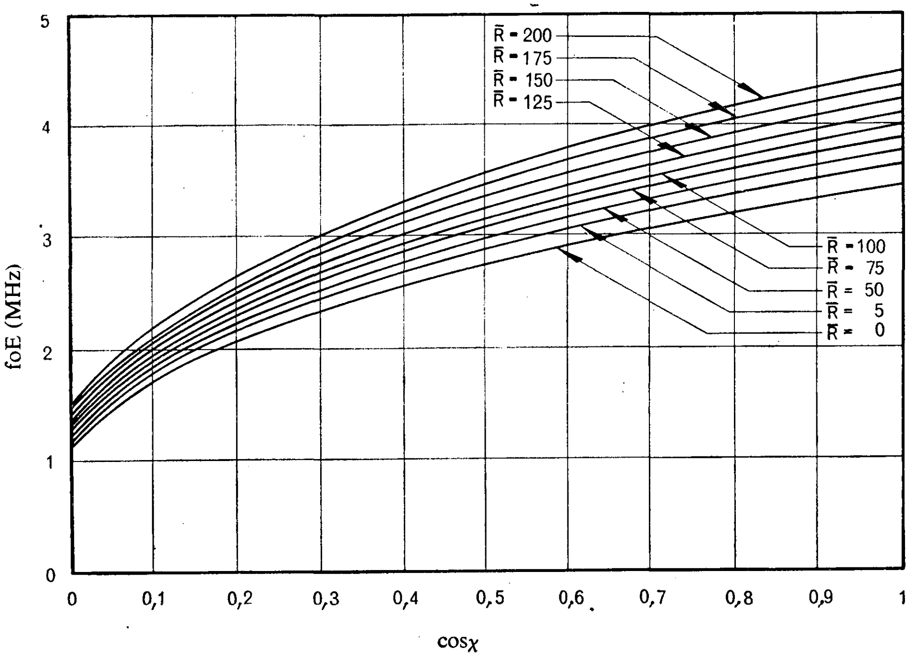


FIGURE 9

Variation of foE with cosχ for different sunspot numbers ($\bar{R}$)

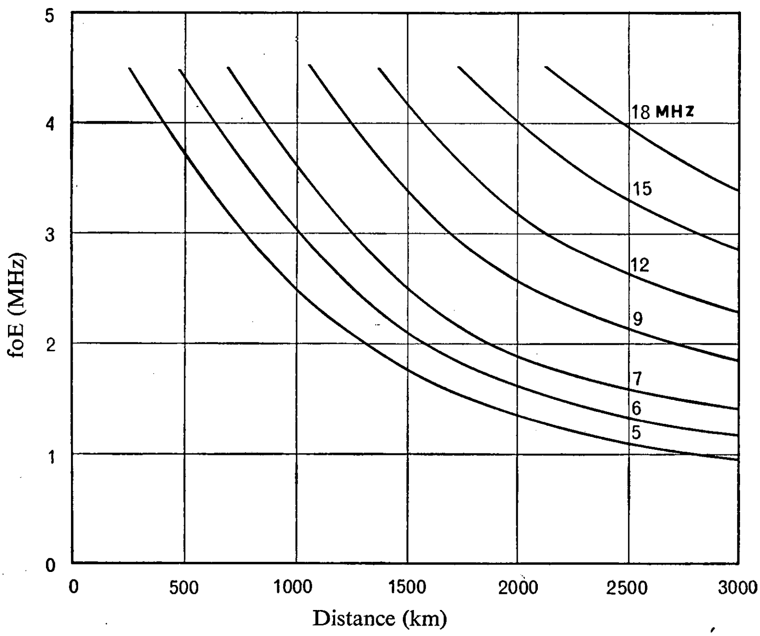


FIGURE 10

E-layer cut-off distance for different values of foE

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)

(1956—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 MHz, 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 MHz. 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 MHz 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 MHz.

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, Warsaw, 1956.

Docs. V/1, V/6, V/12, V/23 and V/27, Geneva, 1958.

REPORT 306 *

RATIO OF WANTED TO UNWANTED SIGNAL FOR COLOUR TELEVISION IN BANDS IV AND V

(Question 119)

(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, § 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 MHz channels in bands IV and V, when adapted for colour transmission with a colour sub-carrier of 4·43 MHz, 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 Hz, 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 418-1, § 3.2.

3.2 *Upper adjacent-channel interference*

The protection ratios are the same as those quoted for monochrome television in Recommendation 418-1, § 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 MHz, 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 418-1). 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 MHz 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 ($\pm$ 1·26 MHz relative to the sub-carrier).

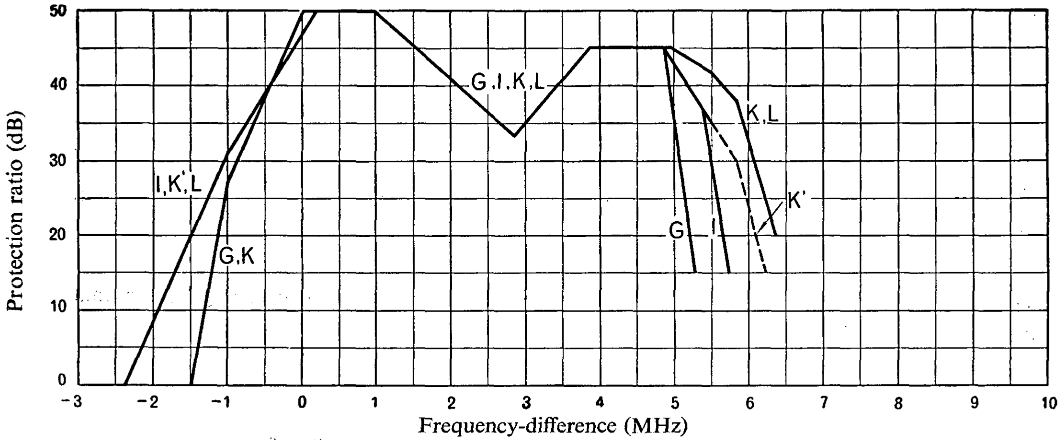


FIGURE 1
Estimated protection ratios for 625-line colour television systems (NTSC system adopted for 625 lines)

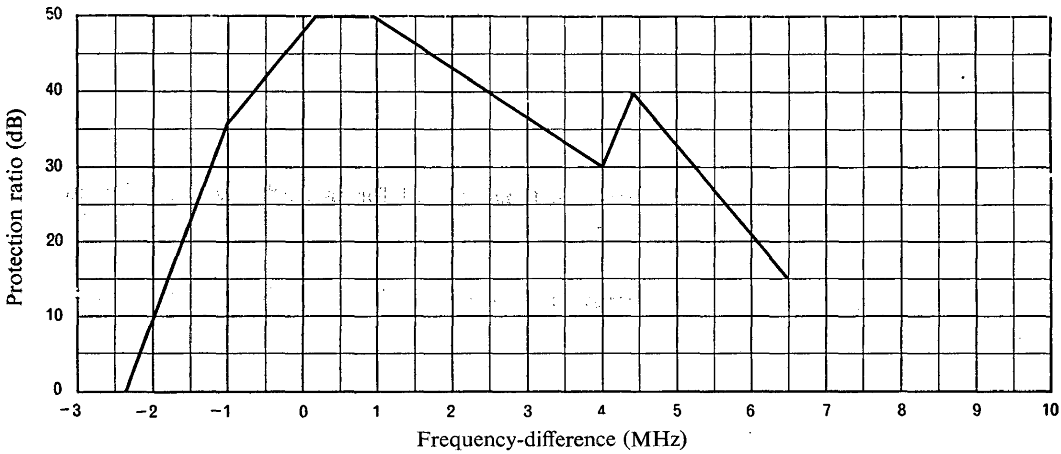


FIGURE 2
Estimated protection ratio for a SECAM 625-line (system L) colour television system

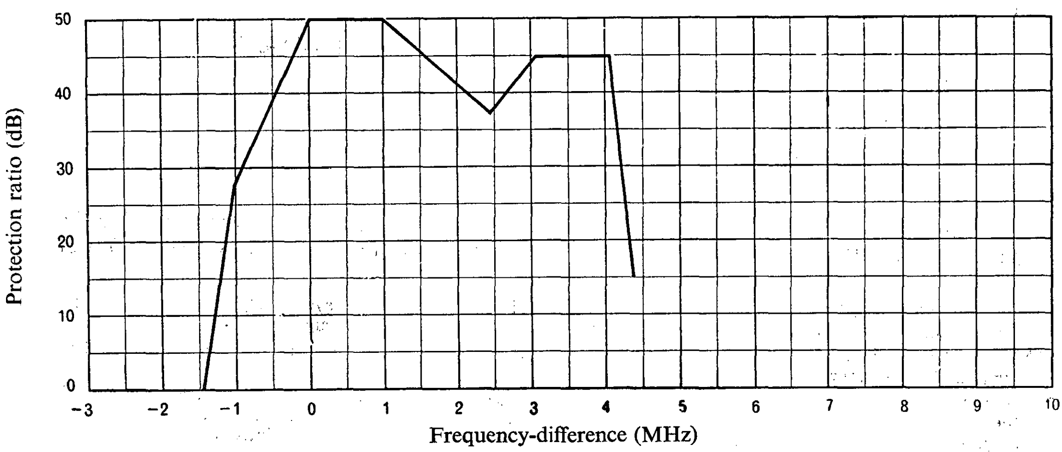


FIGURE 3
Protection ratios for the 525-line NTSC colour television system

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 (described in Doc. XI/47, Bad Kreuznach, 1962), 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 NTSC 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 MHz

(Question 4/XI)

(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 MHz 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 passband of the television receiver

It has been found that, when the radionavigation signal falls within the passband of the television receiver, the required signal-to-interference ratio is:

* 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 Fig. 1.

The protection ratios given in Fig. 1 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 passband of the television receiver

Reference should be made to Recommendation 418-1, § 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.

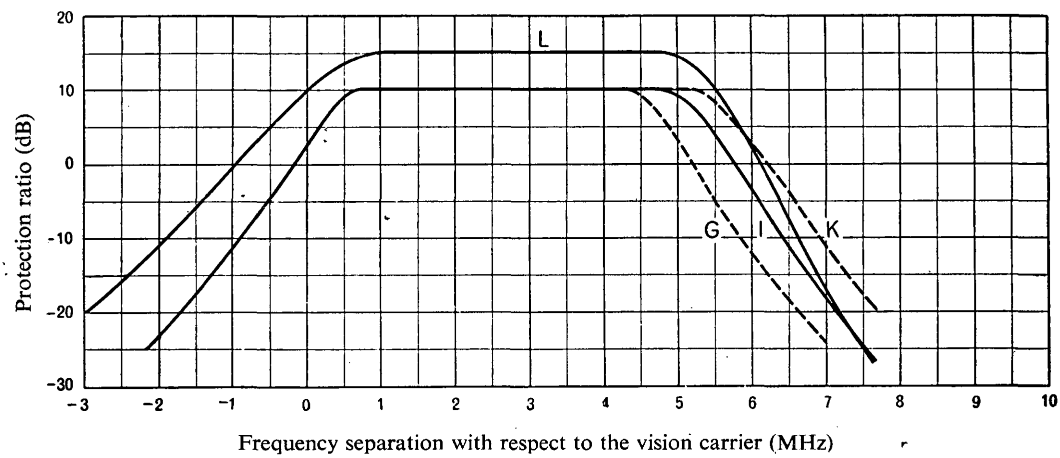


FIGURE 1

Protection ratio required by a picture signal against a radionavigation signal in the 582-606 MHz band

REPORT 308-1 *

CHARACTERISTICS OF MONOCHROME TELEVISION SYSTEMS

(1951—1953—1956—1959—1963—1966)

The following Tables, given for information purposes, contain details of a number of different monochrome television systems in use at the time of the XIth Plenary Assembly of the C.C.I.R., Oslo, 1966.

* This Report was adopted unanimously.

TABLE I — *Characteristics of monochrome television systems*

Item	Characteristics	System A	M (2)	N	B	C	G	H	I	D, K, K1 (3)	L	F	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) (Field)	Left to right * Top to bottom*	Left to right * Top to bottom*		Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * Top to bottom*	Left to right * 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 (MHz)	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 (MHz)	5	6	6	7	7	8	8	8	8 (8·5)	8	7	14
12	Sound carrier relative to vision carrier (MHz)	−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 (MHz)	+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 (MHz) *(v)*	3	4·2		5	5	5	5	5·5	6	6	5	10
15	Nominal width of vestigial sideband (MHz) *(w)*	0·75	0·75	0·75	0·75	0·75	0·75	1·25	1·25	0·75 (1·25) (4)	1·25	0·75	2
16	Type and polarity of vision modulation	A5C * positive	A5C * negative	A5C * negative	A5C * negative	A5C * positive	A5C * negative	A5C * negative	A5C * negative	A5C * negative	A5C * positive	A5C * positive	A5C * positive
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	72·5–77·5		72·5–77·5	22·5–25·5	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		0–7	3–6	0–7	0–7	0–7	3–5	0–7	3–6	5
20	Peak white level as a percentage of peak carrier	100	10–15		10–12·5	100	10–12·5	10–12·5	18–20	10	100	100	100
21	Type of sound modulation	A3	F3, ±25 kHz 75 μs pre-emphasis		F3, ±50 kHz 50 μs pre-emphasis	A3, 50μs pre-emphasis	F3, ±50 kHz 50 μs pre-emphasis	F3, ±50 kHz 50 μs pre-emphasis	F3, ±50 kHz 50 μs pre-emphasis	F3, ±50 kHz 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	10/1–5/1 (4/1)		5/1–10/1	4/1	5/1–10/1	5/1	5/1	2/1–5/1	8/1	4/1	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.

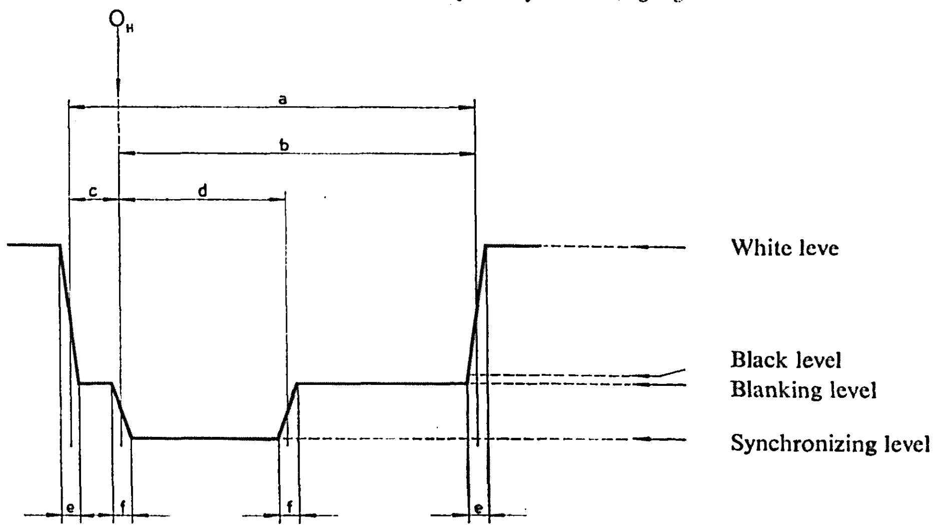
(2) The figures in brackets refer to the Japanese 525-line system.

(3) The figures in brackets refer to standard *K1*.

(4) The Administrations proposing standards *D* and *K* are studying the possibility of increasing the width of the vestigial sideband to 1·25 MHz.

TABLE II

Details of line synchronizing signals



Item	Characteristic	Durations (measured between half-amplitude points on the appropriate edges) for system							
		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	14–16	8·9–10·2				
c	Front porch	1·52–1·95	1·5–2·0	2-4	1·27–2·54			2–2·8	1·3–1·8
d	Synchronizing pulse	8·1–10·1	8–10	6·6–9	4·19–5·7			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.

Item	Durations (measured between half-amplitude points on the appropriate edges) for system											
	C		*I*		*D, K, K*1		*L*		*F*		*E*	
	% *H*	µs	% *H*	µs	% *H* (2)	µs	% *H* (3)	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		12·05 ± 0·25	18·5–19·2	11·8–12·3	19	12·1±0·3	18·4	9–9·4	19	9·2–9·8
b	16·5	10·2–11			16·1–17·3(2)	10·3–11·3(2)	16·7	10·7±0·3	16·4	7·8–8·6	17·8	8·9
c	2·2	1·2–1·6		1·55 ±0·25	2–2·8	1·3–1·8	2·3	1·5±0·2	2	0·8–1·2	1·2	0·5–0·7
d	7·8	4·8–5·2		4·7 ±0·2	7–7·7	4·5–4·9	7·5	4·8±0·2	7·2	3·4–3·8	5·2	2·4–2·6
e	0·5	0·2–0·4		0·3 ±0·1	0·31–0·62	0·2–0·4	0·5	0·3±0·1	0·4	0·1–0·3	0·4	0·17–0·23
f	0·5	0·2–0·4		0·3 ±0·1	0·23–0·46	0·15–0·3	0·25	0·15±0·05	0·4	0·1–0·3	0·25	0·10–0·14

(2) Calculated values.
(3) The values given in % *H* are rounded-off.

TABLE III — *Details of synchronizing signals*

Item	Characteristic	System: *A*		*M* (5)		*N*		*B, H, G* (5)		*C*		*I*		*D, K, K1*		*L*		*F*		*E*	
V	Field period . . . . (ms)	20		16·667		20		20		20		20		20		20		20		20	
H	Line period . . . . (μs)	98·8		63·5		64		64		64		64		64		64		48·84		48·84	
j	Field-blanking period . . . (μs)	(13–15·5) *H* (2) +18·25 (3)		(19–21) H+10·7				(18–22) H+12		(20–21) H+12		(18–22) H +12·05		25 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)	0·25–0·5		≤6·35				≤6		≤6·4		≤6		0·2–0·4		0·2–2		<4·9		<0·2	
l	Duration of first equalizing pulse sequence	(4)		3 H				2·5 H		2·5 H		2·5 H		2·5 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	4 H		3 H				2·5 H		2·5 H		2·5 H		2·5 or 3 H		2·5 H		3·5 H			
n	Duration of second sequence of equalizing pulses			3 H				2·5 H		2·5 H		2·5 H		2·5 or 3 H		2·5 H		3·5 H			
		% H	μs	% H	μs	% H	μs	% H	μs	% H	μs	% H	μs	% H (6)	μs	% H (6)	μs	% H	μs	% H	μs
p	Duration of equalizing pulse . . .			3·6–4	2·29–2·54			3·4–3·75	2·2–2·4	3·7	2·3–2·5		2·3 ±0·1	3·5–3·85	2·25–2·45	3·6	2·3±0·1	3·5	1·6–1·8		
q	Duration of field synchronizing pulse	38·5–42·5	38–42	41·6–44	26·4–28					42	26·8–27·2		27·3 ±0·2			42·5	27·2±0·4	43	20·6–21	41	19–21
r	Interval between field synchronizing pulses	11·5–7·5	11·4–7·4	6–8·8	3·8–5·6			7–7·7	4·5–4·9	7·8	4·8–5·2		4·7 ±0·2	7–7·7	4·5–4·9	7·5	32–9 or 4·8	7·2	3·4–3·8		
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	0·5	0·2–0·4		0·3 ±0·1	0·23–0·46	0·15–0·3	0·25	0·15±0·05	0·4	0·1–0·3	<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.

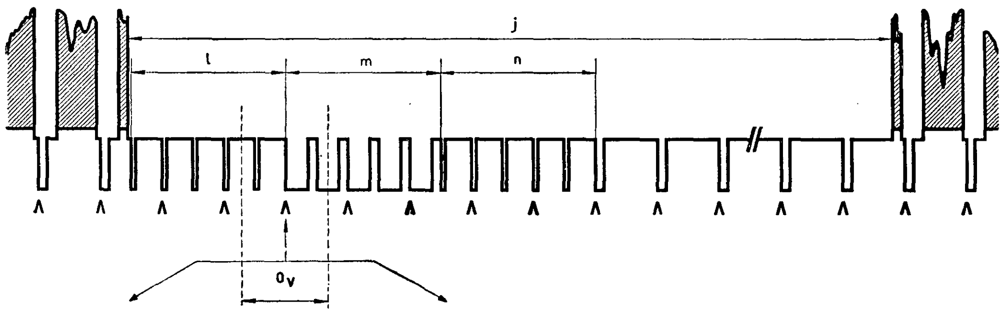
(5) The primary values are those given in μs.

(6) The values given in percentages of H are rounded-off.

TABLE III A

Details of field-synchronizing waveforms

1. Diagrams applicable to all systems except system E



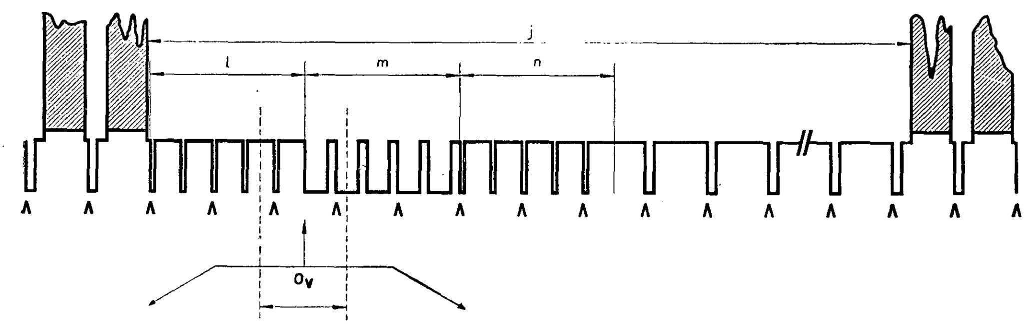
Second field

See Figure 1 *c*

First field

FIGURE 1 *a*

Signal at beginning of each first field



First field

See Figure 1 *c*

Second field

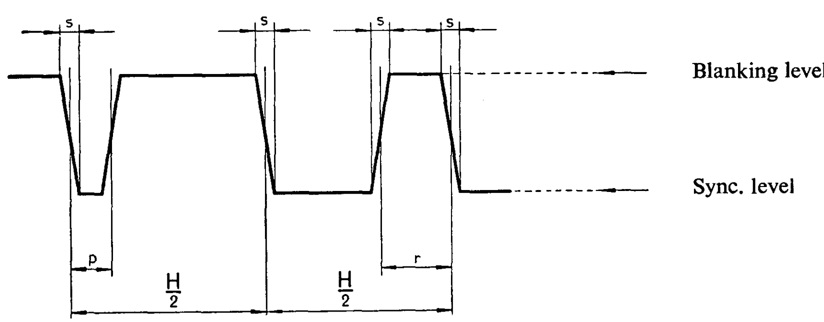
FIGURE 1 *b*

Signal at beginning of each second field

Note 1. — ΛΛΛ indicates an unbroken sequence of edges of line-synchronizing pulses throughout the field-blanking period.

Note 2.—At beginning of each first field, the edge of the field-synchronizing pulse (Ov) coincides with the edge of a line-synchronizing pulse if *l* is an *odd* number of half-line periods as shown.

Note 3.—At beginning of each second field, the edge of the field-synchronizing pulse (Ov) falls midway between the edges of two line-synchronizing pulses 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

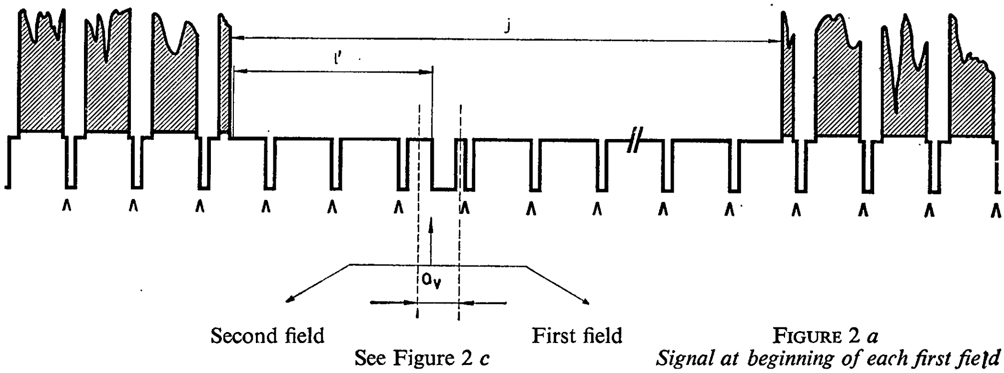


FIGURE 2 *a*
Signal at beginning of each first field

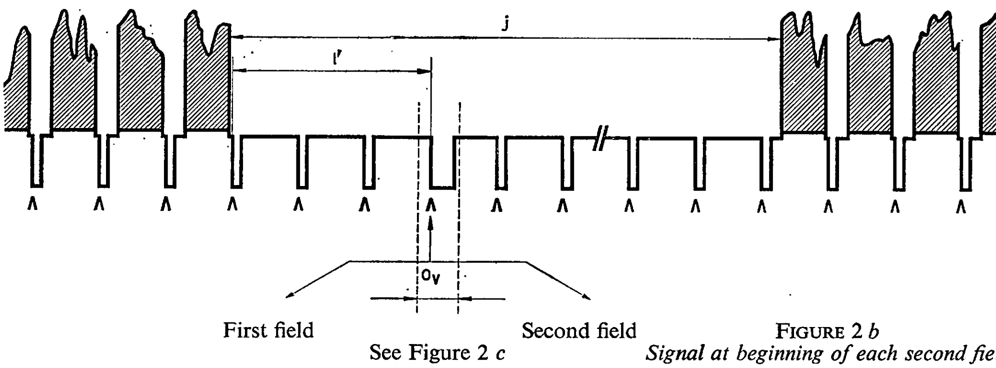
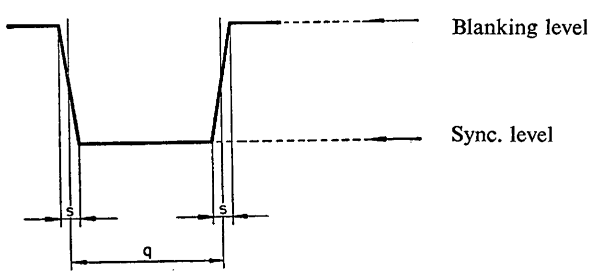


FIGURE 2 *b*
Signal at beginning of each second field

Note 1. — ΛΛΛ indicates an unbroken sequence of edges of line-synchronizing pulses throughout the field-blanking period.

Note 2.—At beginning of each first field, the edge of the field-synchronizing pulse (Ov) coincides with the edge of a line-synchronizing pulse.

Note 3.—At beginning of each second field, the edge of the field-synchronizing pulse (Ov) falls midway between the edges of two line-synchronizing pulses.



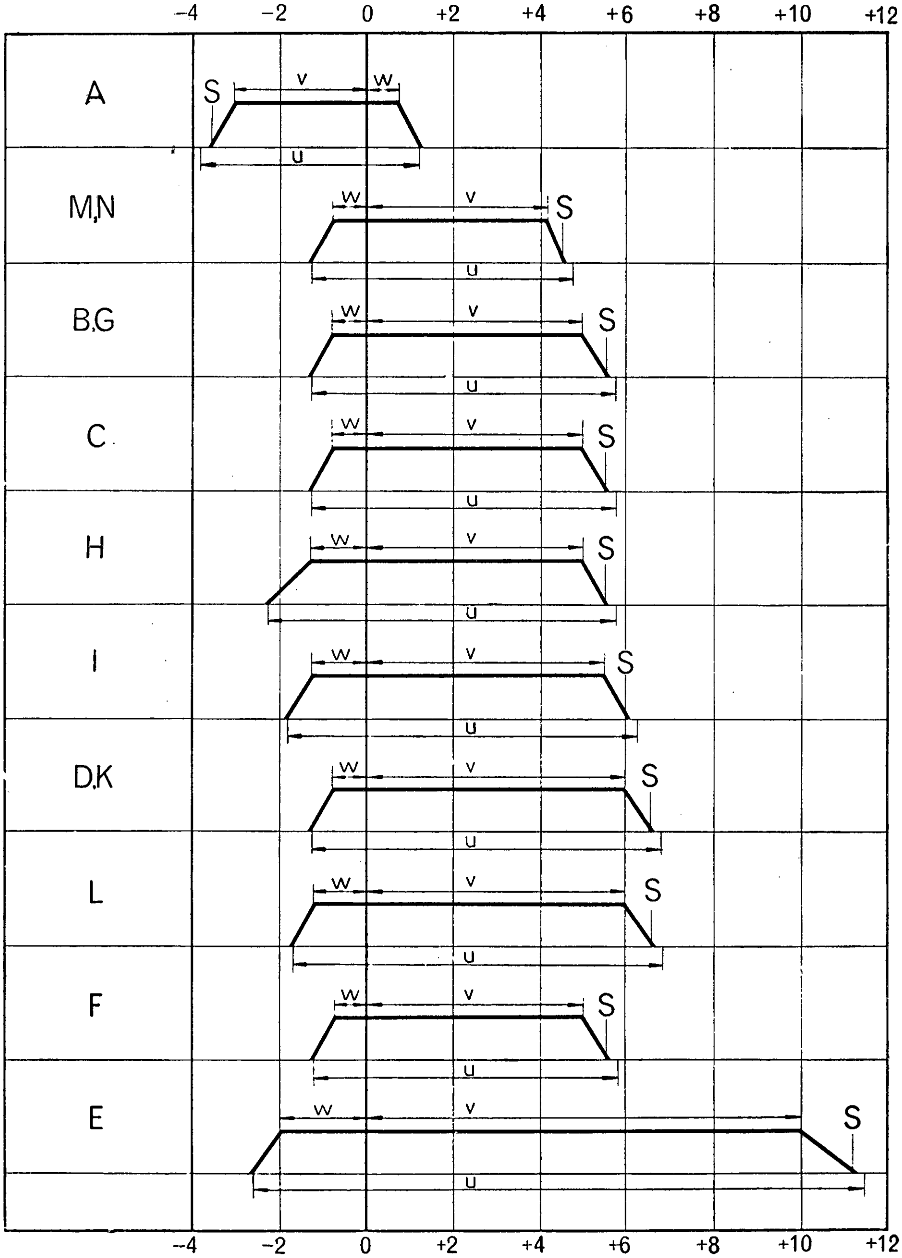
(The durations are measured to the half-amplitude points on the appropriate edges)

FIGURE 2 *c*
Details of equalizing and synchronizing pulses

TABLE IV

Ideal frequency-characteristics for vision transmitters
(See Table I for precise frequency spacings)

System Frequency (MHz) relative to the vision carrier-frequency



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.

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 MHz, in relation to the picture carrier.

Note 3.—The Indications and Notes are based on indications and notes given in Chapter 2 of the " Technical data used by the European VHF/UHF Broadcasting Conference ".

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 MHz 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 MHz 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 MHz 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.

Note 10.—Liberia, accepted for planning purposes Standard B or H but reserves the right to adopt standard M.

Note 11.—Uganda, is already committed to Standard B in band III. Standard G is planned for bands IV and V although further consideration will be given to other standards when bands IV and V stations are to be commissioned.

Note 12.—Indications for Malawi, Rhodesia and Zambia are based on indications for Rhodesia and Nyasaland (Federation of) given in the Final Acts of the African VHF/UHF Broadcasting Conference, Geneva, 1963. Standard B is now in use in band I; no final decision is taken regarding systems to be used in bands III, IV and V.

Note 13.—Sierra Leone, now uses Standard B but reserves the right to use any other standard, compatible with the Plan.

Note 14.—Tanzania, the indications are based on indications for Tanganyika and Zanzibar given in the Final Acts of the African VHF/UHF Broadcasting Conference, Geneva, 1963.

It is intended to use Standard B in bands I and III. Although Standard I is planned for bands IV and V, further consideration will be given to the use of Standards G and H.

Note 15.—Algeria, reserves the right to change later.

Note 16.—United Arab Republic, now studying the adoption of either Standard G or H for bands IV and V.

Note 17.—Cameroon, Congo (D. R. of) and Guinea, planning has been based on Standard K1, but they reserve the right to use any other standard compatible with the Plan when they introduce television.

Note 18.—The indications and Notes 10-17 are based on indications and Notes given in the Final Acts of the VHF/UHF African Broadcasting Conference, Geneva, 1963.

Country	System used in bands:		Number of Note for bands:	
	I–III	IV–V	I–III	IV–V
British East Africa	B *	—		
Algeria (Algerian Democratic and Popular Republic)	B E	G * H *	15, 18	15, 18
Netherlands Antilles	M	—		
Saudi Arabia (Kingdom of)	M	—		
Argentine Republic	N	N *		1
Australia (Commonwealth of)	B	—		
Austria	B	G *		2
Belgium	C F	H *		
People's Republic of Bulgaria	D	K *		
Burundi (Kingdom of)	K1 *	K1 *	18	18
Cameroon (Federal Republic of)	K1 *	K1 *	17, 18	17, 18
Canada	M	M		
Central African Republic	K1 *	K1 *	18	18
Cyprus (Republic of)	—	H *		3
Congo (Democratic Republic of the)	K1 *	K1 *	17, 18	17, 18
Congo (Republic of the) (Brazzaville)	K1 *	K1 *	18	18
Korea (Republic of)	M	—		
Ivory Coast (Republic of the)	K1 *	K1 *	18	18
Dahomey (Republic of)	K1 *	K1 *	18	18
Denmark	B	G *		4
Spain	B	G *		3
United States of America	M	M		
Ethiopia	B *	G *	18	18
Finland	B	G *		4
France	E	L		
Gabon Republic	K1 *	K1 *	18	18
Ghana	B * G *	G *	18	18
Greece	B *	G *		4
Guinea (Republic of)	K1 *	K1 *	17, 18	17, 18
Upper Volta (Republic of)	K1 *	K1 *	18	18
Hungarian People's Republic	D	K *		
India (Republic of)	B	—		
Indonesia (Republic of)	B *	—		
Iran	M	—		
Ireland	A (I *)	I *	5	
Iceland	—	G *		3, 6
Israel (State of)	B *	H *		7
Italy	B	G		
Japan	M	M *		
Jordan	—	—		
Kenya	B *	G * I *	18	18
Liberia (Republic of)	B *	H *	10, 18	10, 18
Libya (Kingdom of)	B *	G *	18	18
Luxemburg	F	H *		3
Malaya	B *	G *		
Malawi	B *	G *	12, 18	12, 18
Malagasy Republic	K1 *	K1 *	18	18
Mali (Republic of)	K1 *	K1 *	18	18
Morocco (Kingdom of)	B	H *		
Mauritania (Islamic Republic of)	K1 *	K1 *	18	18
Mexico	M	—		
Monaco	E	L *		
Niger (Republic of the)	K1 *	K1 *	18	18
Nigeria (Federal Republic of)	B	I *	18	18
Norway	B	G *		4
New Zealand	B	—		
Uganda	B	G *	11, 18	11, 18
Pakistan	B	—		
Panama	M	—		

Country	System used in bands:		Number of Note for bands:	
	I–III	IV–V	I–III	IV–V
The Netherlands (Kingdom of)	B	G		4
People's Republic of Poland	D	K *		
Portugal	B	G *		
Spanish Provinces in Africa	B *	G *	18	18
Portuguese Oversea Provinces	I *	I *	18	18
United Arab Republic	B	G * H *	18	16, 18
Federal Republic of Germany	B	G		
Somali Republic	B *	G *	18	18
Rhodesia	B	G *	12	12
Roumanian People's Republic	D	K *		3
United Kingdom	A	I *		8
Rwanda (Republic of)	K1 *	K1 *	18	18
Senegal (Republic of the)	K1 *	K1 *	18	18
Sierra Leone	B	G *	13, 18	18
South Africa (Republic of)	I *	I *	18	18
Sweden	B	G *		3, 4
Switzerland (Confederation of)	B	G *		3, 9
Tanzania (United Republic of)	B * I *	I *	14, 18	14, 18
Chad (Republic of the)	K1 *	K1 *	18	18
Czechoslovak S.R.	D	K *		3
Oversea Territories in Africa for the international relations of which the Government of the United Kingdom of Great Britain and Northern Ireland are responsible	B * I *	I *	18	18
Oversea Territories of the United Kingdom in the European Broadcasting Area	—	H *		3
Togolese Republic	K1 *	K1 *	18	18
Turkey	—	H *		3, 7
U.S.S.R.	D	K		
Uruguay (Oriental Republic of)	N	—		
Venezuela (Republic of)	M	—		
Yugoslavia (Federal Socialist Republic of)	B	G		
Zambia (Republic of)	B *	G *	12, 18	12, 18

REPORT 309 *

CHOICE OF STANDARDS FOR COLOUR TELEVISION IN THE EUROPEAN AREA

(Question 1/XI)

(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 MHz, 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 NTSC 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 310-1 ***

VIDEO CHARACTERISTICS OF A 625-LINE MONOCHROME TELEVISION SYSTEM PROPOSED FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Question 2/XI)

(1963—1966)

1. Introduction

An examination of the parameters relating to the various monochrome television systems (as given in Report 308-1) 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.

* 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, Bad Kreuznach, 1962; CMTT/6, CMTT/12, CMTT/21, Paris, 1962: 181, 212, 213, 214, Geneva, 1963.

*** This Report was adopted unanimously.

With the object of bringing about such a move, Administrations using 625-line standards have agreed to adopt the parameters set out in the Table below as a unified standard for the international exchange.

Note 1. — This Report is not intended to apply to standard *N*.

Note 2. — For ease of reference, the items listed under the headings " Details of line-blanking interval " and " Details of field-blanking interval " are listed in the same order and designated by the same symbols, as in Report 308-1, to the diagrams of which reference should be made for further information on the definition of the parameters.

2. General details

2.1	The §§ 1, 2, 3 and 4 of Recommendation 212 shall be applied.	
2.2	Number of lines per picture:	625
2.3	Line frequency and tolerance when operated non-synchronously f_H (Hz):	15 625 ± 0·05% [1]
2.4	Field frequency f_v (Hz):	$\frac{2}{625} \times f_H$
2.5	Picture-frame frequency f_p (Hz):	$\frac{1}{625} \times f_H$
2.6	Gamma of picture signal:	approx. 0·4
2.7	Nominal video bandwidth (MHz):	5; 5·5; 6 [2]

3. Details of line-blanking interval [3]

		(μs)
(*H*)	Nominal duration of a line:	64
(*a*)	Line-blanking interval:	12 ± 0·3
(*b*)	Interval between datum (O_H) and back edge of line-blanking signal (average calculated value for information):	10·5
(*c*)	Front porch:	1·5 ± 0·3
(*d*)	Synchronizing pulse:	4·7 ± 0·2
(*e*)	Build-up time (10-90%) of line-blanking edges:	0·3 ± 0·1
(*f*)	Build-up time (10-90%) of line-synchronizing pulses:	0·2 ± 0·1

4. Details of the field-blanking interval

(*j*)	Field-blanking period:	$25H + a$ [4] [5]
(*k*)	Build-up time (10-90%) of field-blanking edges (μs) (as in § *e*):	0·3 ± 0·1
(*l*)	Duration of first equalizing pulse sequence:	$2{\cdot}5H$ or $3H$ [5]
(*m*)	Duration of field-synchronizing pulse sequence:	$2{\cdot}5H$ or $3H$ [5]
(*n*)	Duration of second equalizing pulse sequence:	$2{\cdot}5H$ or $3H$ [5]
(*p*)	Duration of equalizing pulse (μs) (one half the value given in § *d*):	2·35 ± 0·1
(*q*)	Duration of field-synchronizing pulse (average calculated value for information) (μs):	27·3
(*r*)	Interval between field-synchronizing pulses (μs) (as in § *d*):	4·7 ± 0·2
(*s*)	Build-up time (10-90%) of field-synchronizing pulses (μs) (as in § *f*):	0·2 ± 0·1

Notes :

(1) Tighter tolerances will be required for precision offset and colour television.

(2) The attention of Study Groups IX, X and the CMTT is drawn to the desirability of subsequently standardizing tolerances for corresponding transmission and recording characteristics applicable to all 625-line systems. For international routine measurements it is suggested that the test signals be based on a single reference frequency which could be 5 MHz. This value does not exclude the use of test signals with spectra extending beyond 5 MHz, particularly by countries using systems with nominal video bandwidth of 6 MHz (for example, this suggestion is not contrary to the use of a frequency close to 6 MHz in a multiburst test signal).

(3) The nominal value of the picture-synchronizing signal ratio is 7/3. For details of permitted tolerances in long-distance transmissions, see Recommendation 421-1, § 2.3.

(4) 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.

(5) These values may be subject to revision in the case where a single equalizing pulse system might be adopted (see Doc. XI/115, 1963-1966).

BIBLIOGRAPHY

1. C.C.I.R. Doc. XI/73 (O.I.R.T.), Vienna, 1965.
2. C.C.I.R. Doc. XI/115 (U.K.), Vienna, 1965.
3. C.C.I.R. Doc. XI/139 (F.R. of Germany), 1963-1966.
4. C.C.I.R. Doc. XI/160 (Italy), 1963-1966.

REPORT 311-1 *

THE PRESENT POSITION OF STANDARDS CONVERSION

(Question 2/XI, Study Programme 10A/XI)

(1963—1966)

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

* This Report was adopted unanimously.

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.

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 2/XI, §§ 1 and 2, and the two points referred to in Study Programme 10A/XI.

In connection with the first item of Study Programme 10A/XI, mention should be made of work which has been carried out to perfect methods of conversion between television signals having identical and synchronized field frequencies, that may be locked to an electricity supply frequency (if required), but different line frequencies. This work was directed towards the development of standards converters involving no moving parts and no intermediate optical or electron-charge image. Two types of such devices, now known as " line-store converters " [7], have been 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], [11], 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 line-scanning 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 line-store 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 $1\text{-}S(t)$ 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 the line-store converter of the type that uses low-pass filters as the storage elements a compound switching system is used. This arrangement greatly reduces the number of high-speed switches required. The common input or output circuit is connected to 36 high-speed switches, each of which is, in turn, connected to 16 low-speed switches, (i.e. each high-speed switch serves a group of 16 stores within the full array of 576 stores). The fast switches operate at picture-element rate, but the construction is such that the slow switches need operate only at one thirty-sixth of this rate; thus the majority of the switches can be of simple design with a corresponding reduction in cost.

Both converters can be made to reverse the direction of conversion, for example from 625 lines to 405 lines and vice versa. The converter of the type that uses simple capacitors as storage elements coupled with an interpolator that is external to the storage elements (capacitors) can be made to reverse the direction of conversion by the operation of a switch. It is also possible to construct the low-pass filter type of converter so that it, too, may reverse the direction of conversion by means of a switch.

Both designs of line-store converter achieve a much better picture quality than conventional converters [12]. The signal-to-noise, ratio grey scale, horizontal resolution and geometrical linearity are substantially those of the incoming picture. Blurring of movement, inherent in conventional converters, is entirely absent, the static " background " pattern is almost imperceptible and there is no vignetting or loss of resolution in the corners of the picture.

The fact that no valves or cathode-ray devices are used means that the converters are available immediately after switching on and their low-power dissipation results in a high order of stability and reliability. Furthermore, the services of an operator are not required.

In connection with the second item of Study Programme 10A/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 disc 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 disc 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 performs satisfactorily [10]. Following these experiments, further studies have been carried out in Japan [13] and in the United Kingdom [14] with a view to achieving better performance in the conversion between television standards having markedly different field frequencies than is obtained with earlier forms of standards converters. These studies and experiments are in accordance with Question 2/XI, § (*c*), and Study Programme 10A/XI, § 2. In principle, a converter of the type envisaged represents an extension of the ideas incorporated in the line-store converter mentioned in an earlier part of § 4. The field-store converter thus contains no intermediate optical image and may or may not contain moving parts depending upon the availability of ultrasonic delay-lines suitable to replace delays of the type that use a rotating magnetic-recording memory disc. Delay times up to the duration of a field of the television standard to be converted are required. In particular, conversions between 60-field and 50-field standards are envisaged.

Basically, the processes involved are:

- line (store) conversion, in order that the number of lines required for the " output " standard can be obtained from the different number of lines in the standard to be converted or " input " standard. Lines are omitted or duplicated;

- field conversion, in order that the number of fields required for the output standard can be obtained from the different number of fields in the input standard. Fields are omitted or duplicated;

- an adjustment effected to account for the different durations of the scanning lines in the input and output standards;

- interpolation in order to make an estimate of what picture information would have existed in between the scanning lines of the input standard and to make use of this during certain scanning lines of the output standard, when, as will occur in a cyclic manner, the latter (scanning lines of the output standard) would not have been in geometrical coincidence with the former (scanning lines of the input standard);

- compensation for timing errors that occur in the waveform of the output standard.

The order in which the above processes are carried out depends upon the precise design of the field-store converter as well as upon the direction in which the conversion is to take place: 50 fields to 60 fields or vice versa.

In some proposals [14], the line and field conversions may be combined in one unit comprising many delay-lines through which the signal may be switched in accordance with a pre-arranged programme. Using such methods it is possible to convert between standards whose field frequencies are neither in an exact 5-to-6 (or 6-to-5) ratio nor in any fixed ratio; thus conversion is possible between standards whose field frequencies are not precisely related. In other proposals [13], conversion in the latter condition is made possible by the use of an additional timing-error compensator that is used in conjunction with the device for compensating timing errors.

Feasibility studies and experiments indicate that improved performance will be obtained with respect to resolution, movement blur and flicker, tone gradation and geometric distortion as well as greater stability and reliability. Little or no adjustment by an operator will be required. It is also thought that both [13, 14] forms of converters will be capable of further development that will enable them to convert between colour programmes in addition to monochrome. Work in both countries is now in progress on the construction of field-store converters and although the improvements forecast are confidently expected to be realized in practice, final assessment of performance must await tests and field trials conducted with the completed apparatus.

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 line-store conversion, have been perfected. In these methods, no intermediate optical or electron-charge image is used and a more consistent and better quality image is achieved. Furthermore, variation in image quality, due to the human element involved in the operation of standards conversion equipment, are 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 new methods of conversion which do not require the use of the image-transfer method are being developed. These rely upon the development of field-store converters using magnetic-disc stores and/or ultra-sonic delay-lines.

Bibliography

1. Lord, A. V. and Rout, E. R. A review of television standards conversion. *Television Engineering I.E.E.* Conference Report Series 5, 167 (1962).
2. Helsdon, P. B. A universal television standard converter. *Marconi Review*, Vol. 25, **147,** 4th quarter, 217-234 (1962).
3. Benson, K. B. C.B.S. television standards conversion techniques. *JSMPTE,* **70,** 628-632 (August, 1961).
4. (a) C.C.I.R. Doc. XI/2 (Federal Republic of Germany), Bad Kreuznach, 1962.
   (b) Sennhenn, E. Normwandlung von Fernsehsignalen verschiedener Teilbildfrequenzen. (A standards converter for television signals with different frequencies.) *Radio Mentor,* **3,** 184-188 (March, 1961).
5. (a) Lord, A. V. A standards converter for television exchanges between Europe and North America. *E.B.U. Review,* Part A—Technical, **63** (October, 1960).
   (b) Rout, E. R. and Vigurs, R. F. A wide-range standards converter. *J. Tel. Soc.,* 9, **12,** 493-503 (October-December, 1961).
6. C.C.I.R. Doc. XI/31 (Japan), Bad Kreuznach, 1962.
7. C.C.I.R. Doc. 266 (E.B.U.), Geneva, 1963.
8. Rainger, P. A new system of standards conversion. International Television Conference, London (June, 1962).
9. Lord, A. V. and Rout, E. R. An outline of synchronous standards conversion using a delay-line interpolator. International Television Conference, London (June, 1962).
10. (a) Nomura, T. Television standards conversion systems. First International Television Symposium, Montreux (1961).
    (b) C.C.I.R. Doc. XI/33 (Japan), Bad Kreuznach, 1962.
11. Rainger, P. An electronic line-standards converter. *I.E.E. Journal, Electronics and Power,* 165 (May, 1964).
12. Rainger, P. and Rout, E. R. I.E.E. paper in preparation.
13. C.C.I.R. Doc. XI/141 (Japan), 1963-1966.
14. C.C.I.R. Doc. XI/132 (United Kingdom), 1963-1966.

REPORT 312-1 *

CONSTITUTION OF A SYSTEM OF STEREOSCOPIC TELEVISION

(Study Programme 1C/XI)

(1963—1966)

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

* This Report was adopted unanimously.

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, Moscow, 1958; Doc. XI/20 and Doc. XI/34, Bad Kreuznach, 1962; Doc. XI/65 and Doc. XI/66, 1963-1966, and their bibliographies, contain some information on the question of stereoscopic television.

REPORT 313-1 *

ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(Question 3/XI)

(1959—1963—1966)

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 3/XI, in arriving at suitable standard methods for measuring the various kinds of picture distortion in television.

* This Report was adopted unanimously.

Bibliography relating to Question 3/XI

1. C.C.I.R. Doc. XI/3, Moscow, 1958. A simple test picture for the assessment of the quality of monochrome television pictures.
2. C.C.I.R. Doc. XI/11, Moscow, 1958. An equipment for electro-optical measurements of television image quality.
3. C.C.I.R. Doc. XI/12, Moscow, 1958. Method of measurement of interlacing quality on television receivers.
4. C.C.I.R. Doc. XI/24, Moscow, 1958. Direct measurement of noise on the receiver screen.
5. C.C.I.R. Doc. XI/25, Moscow, 1958. Apparatus for the measurement of signal-to-noise ratio in video signals.
6. Jesty, L. C. Relation between picture size, viewing distance and picture quality. *Proc. I.E.E.*, **105,** B (February, 1958).
7. C.C.I.R. Doc. 39, Los Angeles, 1959. Measurement of random noise in television pictures.
8. C.C.I.R. Doc. 124, Los Angeles, 1959. Method of measuring the numerical characteristics of gamma correctors.
9. C.C.I.R. Doc. 125, Los Angeles, 1959. Influence of the colour parameters of the television receiver on the quality of colour reproduction.
10. C.C.I.R. Doc. 126, Los Angeles, 1959. Effect of sub-carrier frequency on luminance.
11. C.C.I.R. Doc. 145, Los Angeles, 1959. Assessment of the luminance and chrominance of television pictures.
12. C.C.I.R. Doc. 383, Warsaw, 1956 and Doc. XI/18, Bad Kreuznach, 1962. Measurement of the quality of television pictures.
13. C.C.I.R. Doc. XI/22, Bad Kreuznach, 1962. Methods of measuring the basic parameter of a television signal.
14. C.C.I.R. Doc. XI/30, Bad Kreuznach, 1962. Psychological aspects of quality assessment.
15. C.C.I.R. Doc. XI/29, Bad Kreuznach, 1962. Ratio of the wanted to the unwanted signal in television.
16. C.C.I.R. Doc. XI/61, 1963-1966. Automatic documentary recording of the video signal waveform. (Refers to Krivosheev, M. I.: *Fundamentals of television measurements*, Moscow, Publishing-House " Sviaz " (1964).)
17. C.C.I.R. Doc. XI/62, 1963-1966. Measurement of signal-to-r.m.s. noise by means of an oscillograph.
18. C.C.I.R. Doc. XI/63, 1963-1966. Automatic measurement of the quality of television signals during the transmission of the monochrome television programme.
19. (a) C.C.I.R. Doc. XI/16, 1963-1966. Subjective assessment of the quality of television pictures. (Refers to Prosser, R. D., Allnatt, J. W. and Lewis, N. W., Quality grading of impaired television pictures ", *Proc. I.E.E.* **112,** 491-502 (March, 1964).
    (b) Allnatt, J. W. and Prosser, R. D. Subjective quality of television pictures impaired by long-delayed echoes. *Proc. I.E.E.*, **112,** 487-492 (March, 1965).
    (c) Prosser, R. D. and Allnatt, J. W. Subjective quality of television pictures impaired by random noise. *Proc. I.E.E.*, **112,** 1099-1102 (June, 1965).
    (d) Lewis, N. W. and Allnatt, J. W. Subjective quality of television pictures with multiple impairments. *Electronics Letter*, **1,** 187-188 (September, 1965).
    (e) Allnatt, J. W. Subjective quality of colour television pictures impaired by gain and delay inequalities between the luminance and chrominance channels. *Proc. I.E.E.*, **112,** 1819-1824 (October, 1965).
    (f) Allnatt, J. W. and Prosser, R. D. Subjective quality of colour-television pictures impaired by random noise. *Proc. I.E.E.*, **113,** 551-557 (April, 1966).
20. C.C.I.R. Doc. XI/31, 1963-1966. Subjective assessment of the quality of television pictures. (Refers to a paper published: Grosskopf, H.: Guide values for the adjustment of optimum conditions for viewing television pictures, *NTZ—CI*, **6,** 262-266 (1963)).
21. C.C.I.R. Doc. XI/149, 1963-1966. Subjective assessment of the quality of television pictures in the international exchange of programmes.

REPORT 314-1 *

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

(Study Programme 12A/XI)

(1963—1966)

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 420-1).

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* This Report was adopted unanimously.

Other signals are used experimentally:

- — signals for testing non-linear response; staircase or sawtooth, with or without superimposed sinewave [2, 4, 5, 7, 8, 9, 11, 12, 14];
- — signals for testing amplitude-frequency response; frequency multiburst or single-frequency reference signal [2, 4, 5, 7, 8, 9, 11, 12, 13, 14, 18];
- — signals for testing transient response: sine-squared pulse and/or bar [8, 9, 11, 12, 14];
- — signals for data transmission: coded pulses [3, 7, 16];
- — the transmission of discrete values of test signals is also considered [10, 15].

6. The proposed position for these signals is given in Table I for various systems.

For 625-line systems, the position of the international signal is indicated in Recommendation 420-1. 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.

Special attention must be drawn to [9, 11, 13 and 14], as these documents could be used as guidance for the international standardization of test signals to be inserted in the field-blanking interval for the 525- and 625-line systems respectively.

7. For 625-line systems, it is proposed that a line or a portion of it should be reserved in Field 1, together with the corresponding line in Field 2, for the measurement or continuous monitoring of signal-to-noise ratio during the field-blanking interval. The particular lines to be reserved for these purposes require further study.

8. **This Report is based on the following C.C.I.R. documents:**

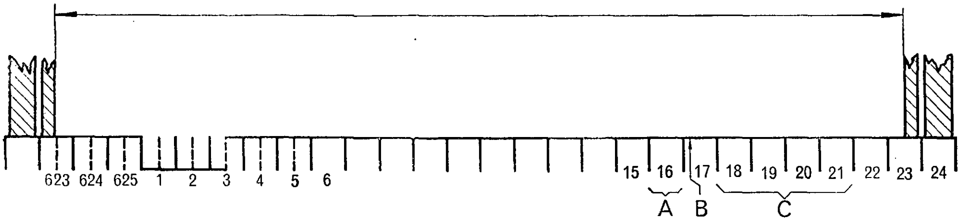
1. Ann. 15 to Doc. 11 (France), Geneva, 1963.
2. Ann. 16 to Doc. 11 (France), Geneva, 1963.
3. Doc. 57 (France), Geneva, 1963.
4. Doc. 180 (Japan), Geneva, 1963.
5. Doc. 211 (O.I.R.T.), Geneva, 1963.
6. Doc. 267 (E.B.U.), Geneva, 1963.
7. Doc. 276 (U.S.A.), Geneva, 1963.
8. Doc. XI/4 (Canada), 1963-1966.
9. Doc. XI/36 (U.S.A.), 1963-1966.
10. Doc. XI/60 (U.S.S.R.), 1963-1966.
11. Doc. XI/74 (O.I.R.T.), 1963-1966.
12. Doc. XI/89 (Australia), 1963-1966.
13. Doc. CMTT/31 (F.R. of Germany), 1963-1966.
14. Doc. XI/159 (E.B.U.), 1963-1966.
15. Doc. XI/161 (Italy), 1963-1966.
16. Doc. XI/176 (France), 1963-1966.
17. Report 411.
18. Doc. XI/166 (France and U.S.S.R.), 1963-1966.

TABLE I

Documents (See § 8)	Duration of field-blanking (lines)	Total number of lines per field to be reserved for all purposes	Number of lines reserved for supervision of characteristics of transmission	Number of lines reserved for data transmission	Line number for lines of column 4	Line number for lines of column 5	Number of unused whole lines between last test line and end of field blanking	Notes
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
525-line systems								
[4]	21	2 (3)	2	(1)	17, 18	(19)	1	The position of the lines refers to the beginning of the field-blanking
[7, 8, 9]	21	2 (3)	2	(1)	18, 19	(20)		
625-line systems								
[1, 3]	23	3	2	1	18, 19 331, 332	17 330	1 1	For line number see Fig. 1
[5]	25	3	3	0	17, 18, 19 330, 331, 332		3 3	
[6]	22	1	1	0	17 / 329 or (16) / 329		2 (3) 3	
[11, 14]	25	2	2	0	17, 18 330, 331		4	
[12]	25	10	9	1	17 to 21/ 330 to 334 (radiated) 12 to 15/ 325 to 328 (not radiated)	21/334	1	
819-line systems								
[2]	41	5	4	1	32, 33, 34, 35 442, 443, 444, 445	31 441	3 2	

First field

Field blanking = 25 lines



Second field

Field blanking = 25 lines

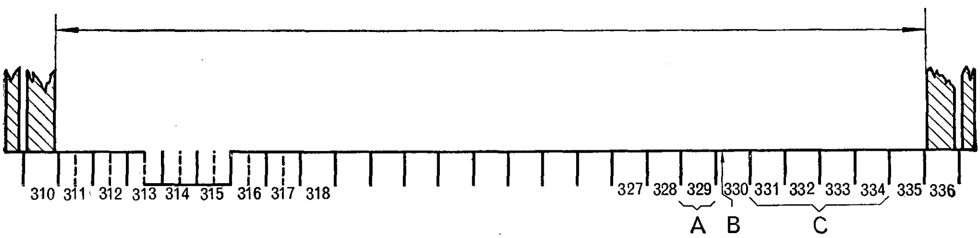


FIGURE 1

Position of special signals in a 625-line system

A: identification signals
B: international signals (see Recommendation 420-1)
C: national signals

REPORT 315-1 *

REDUCTION OF THE CHANNEL CAPACITY REQUIRED FOR A TELEVISION SIGNAL

(Study Programme 11A/XI)

(1963—1966)

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 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 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,

* This Report was adopted unanimously.

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.

Bibliography

1. C.C.I.R. Doc. 170 (U.S.S.R.), Geneva, 1963.
2. C.C.I.R. Doc. 19 (U.S.A.), Bad Kreuznach, 1962.
3. C.C.I.R. Doc. 32 (Japan), 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* **535E** (July, 1962). (Published in *Proc. I.E.E.*, Part C., **110** (1963)).
6. Seyler, A. J. The coding of visual signals to reduce channel capacity requirements. *Proc. I.E.E.*, Part C, **109**, 676-684 (1962).
7. C.C.I.R. Doc. XI/64 (U.S.S.R.), 1963-1966.
8. Lebedev, D. S. and Zukkermann, I. I. *Television and the information theory.* Publishing House "Energia" (1965).
9. Lebedev, D. G. and Lebedev, D. S. Proc. Academy of Sciences, U.S.S.R., **11** (1964).
10. Seyler, A. J. and Budrikis, Z .L. Detail perception after scene changes in television displays. *Trans. IEEE* on information theory, Vol. IT-11, 31-43 (January, 1965).
11. C.C.I.R. Doc. XI/127 (Australia), 1963-1966.

REPORT 404 *

DISTORTION OF TELEVISION SIGNALS DUE TO THE USE OF VESTIGIAL-SIDEBAND TRANSMISSION

(Study Programme 9A/XI)

(1966)

1. Introduction

The transmission of television pictures with vestigial-sideband and their reception with receivers using envelope demodulation with a Nyquist slope give rise to different kinds of distortion:

1.1 Linear distortion, due to group-delay differences in the receiver circuits, both along the Nyquist slope and in relation with the necessary attenuation on the associated sound carrier;

1.2 Non-linearity distortion, theoretically due to the envelope demodulation, in the form of quadrature distortion and to crosstalk between the luminance and the chrominance signals.

The documents summarized below are an assessment of these types of distortion.

2. Doc. XI/23 (O.I.R.T.), 1963-1966

In Doc. XI/23 the experiences obtained by measuring television transmitters in the Fernsehtechnisches Zentralamt der Deutschen Post in Berlin-Adlershof have been recorded.

* This Report was adopted unanimously.

The measurement of monochrome television transmitters is performed between transmitter input and output of Nyquist demodulator. Distortion produced as a result of vestigial sideband transmission can be measured either in frequency domain or in time domain. In frequency domain the amplitude- and envelope-delay characteristics are measured, in time domain the transient characteristic of a pulse is measured. In both cases masks are applied for the values to be measured on the output.

Because no mathematical method is known, by which the masks may be transformed (from time domain to frequency domain and inverse), it is suitable to perform the measurement in time domain. The pulse destined for transmitter measurement has a duration of 4 μs and a rise time equal to $1/2 f_c$ (where f_c is the upper frequency limit). This duration proved useful since, when carrying out measurements by oscillographic method, the leading edge, the trailing edge and the amplitude have to be watched simultaneously. The pulse amplitude is 0·2 V (peak to peak) and it is superimposed on the grey level of 0·15 V. The mask for the transient reponse of the pulse is given in Doc. XI/23, Vienna, 1965. In frequency domain, the measurement of the amplitude characteristic is restricted to those frequencies that are important for the radiation of radio-frequency energy (interference to other transmitters).

3. Doc. XI/28 (O.I.R.T.), 1963-1966

The distortions due to the use of vestigial-sideband transmission depend on the modulation index, the steepness of Nyquist slope and the position of the carrier on the slope. In bands IV and V the oscillator of the receiver will sometimes deviate from the nominal value.

Investigations have been carried out by the Fernsehtechnisches Zentralamt der Deutschen Post in Berlin-Adlershof to perceive the influence of these parameters on wave-form distortion. The distortions were calculated for different modulation indices, slope steepness and carrier positions. The amplitude characteristic of the transmitter-receiver tract was approximated by straight lines. The wave-form distortions were calculated by the paired-echos method [4]. In conclusion it is stated that the steepness of the Nyquist slope equal to 1 MHz (according to the steepness of 0·75 MHz measured as in Recommendation 212) is a good compromise (for systems D and K).

4. Doc. XI/25 (O.I.R.T.), 1963-1966

The experimental and subjective investigations of the picture quality carried out in the People's Republic of Poland have given the following results:

4.1 The broadening of vestigial lower sideband of a modulated radiated signal from 0·75 to 1·25 MHz in general brings an improvement in the quality of the signal assessed subjectively by viewers.

4.2 The degree of quality improvement is directly related to the contents and the character of the picture. The improvement of the picture quality can be considered as imperceptible only in the case of pictures containing few details with small contrast differences.

5. Doc. XI/42 (Czechoslovak S.R.), 1963-1966

The relationships between the amplitude response at radio-frequencies, the group-delay response and transients to a unit-step radio-frequency signal envelope have been investigated, using computers. The analysis was made for the systems D and K and for colour television system with quadrature modulation of sub-carrier.

The main results of the analysis are:

5.1 The reduction in the steepness of the Nyquist slope, from 0·75 to 1 MHz, which may be taken into consideration for systems D and K with respect to the suppression of one of the sidebands at the transmitter site, does not offer a substantial improvement in the transient characteristics. A steepness of the Nyquist slope of 0·75 MHz represents a reasonable compromise.

5.2 The difference in group-delay for the video carrier frequency and for the middle band frequency—corresponding to a Nyquist slope of 0·75 MHz—is approximately 150 ns.

5.3 Non-uniformity in the group-delay in the vicinity of the video carrier frequency higher than 50 ns causes considerable linearity distortion of the transient characteristics.

5.4 The in-phase component of the chrominance signal, which passes through the Nyquist demodulator and the chrominance amplifier, differs slightly from the transient characteristics of the chrominance amplifier.

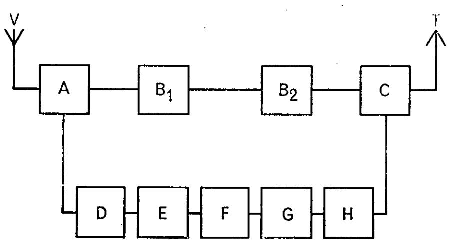
5.5 The quadrature crosstalk of the chrominance signal is predominantly due to asymmetry of the group-delay characteristics in the vicinity of the colour carrier frequency.

5.6 If a correct group-delay compensation is introduced in the vicinity of the video carrier frequency, there is no need for any compensation in the vicinity of the colour carrier frequency. The residual group-delay non-uniformity of the Nyquist demodulator in the vicinity of the colour carrier frequency causes only negligible quadrature crosstalk.

6. Doc. XI/2 (Federal Republic of Germany), 1963-1966

6.1 Docs. XI/25, Bad Kreuznach 1962 and XI/2, Vienna 1965 deal with the quadrature errors which arise in vestigial-sideband transmission. These errors can be removed nearly completely by introducing a rather simple network in the video part of the transmitter. The block diagram of this pre-corrector is given in Fig. 1.

6.2 As far as the transmission of monochrome signals or the luminance component of colour signals is concerned, quadrature errors give rise to increased overshoots, loss in resolution and a change of the pulse ratio with square wave signals. This latter effect reduces the legibility of writing and is, therefore, thought to be of particular importance. With the transmission of colour signals two types of distortion caused by the quadrature component are known so far: incorrect reproduction of the brightness of coloured areas and a phase modulation of the vision carrier, depending on the degree of modulation and on the instantaneous value of the vision carrier.



V — video input
T — output to the transmitter
A — signal divider
B_1 — delay line (constant) } direct channel
B_2 — delay line (variable) } direct channel
C — mixer
D — Low-pass filter with the characteristic $1/2\ \pi f$ } correcting channel
E — phase correction
F — control stage
G — differentiating stage
H — push-pull rectifier

FIGURE 1

Method of quadrature correction

6.3 All the errors mentioned are removed to a great extent by using proper pre-correction. This was examined with laboratory equipment as well as with high-power transmitters of different manufacturers. The additional loss in picture quality, due to the imperfect modulation characteristic of high-power transmitters under operational conditions, has proved to be very small. Hence it can be said that a great measure of fidelity between the signals at the input of the transmitter and at the output of the receiver is possible by applying adequate pre-correction for the linear and non-linear distortions of the vestigial-sideband system.

7. Doc. XI/142 (Federal Republic of Germany), 1963-1966

Subjective tests were carried out with Systems G and B by the Institut für Rundfunktechnik of Munich in order to find out what picture impairment will still be present at the receiver when the linear and non-linear errors are pre-corrected at the transmitter.

The most important results of these tests are given below:

7.1 The improvement obtained by group-delay correction is slightly greater than the further improvement obtained by the addition of quadrature correction as well.

7.2 The results obtained with a high-grade receiver and with a domestic receiver are very similar, but the optimum picture quality that can be reached with a domestic receiver is less.

7.3 The difference in the assessment of the quality of critical and non-critical picture contents is small.

7.4 Provided that the best possible correction is applied, the quality of the output picture can be made practically the same as the original picture.

7.5 In re-broadcasting transmissions with two modulation and demodulation processes, an acceptable output picture quality is only to be obtained if the quadrature errors are also compensated for.

8. Doc. XI/178 (France), 1963-1966

This document describes tests carried out by O.R.T.F. on linear pre-correction with System I with a view to compensating systematic errors in group delay in commercial receivers. The templet for the amplitude/frequency characteristics of the intermediate frequency circuits of these receivers has been determined as well as the typical curve for group delay. Pre-corrections for group delay have been constructed and tested. Some improvement in the transient response was noted, but it was felt that a supplementary non-linear correction would be useful in order to achieve the best possible picture quality.

BIBLIOGRAPHY

1. C.C.I.R. Doc. XI/25 (Federal Republic of Germany), Bad Kreuznach, 1962.
2. HOPF, H. and DINSEL, S. Verbesserung der Übertragungsqualität des Fernseh-Restseitenbandverfahrens durch Einführung einer Quadraturentzerrung (Improving the transmission performance in vestigial-sideband transmission by the introduction of quadrature equalization). *Rundfunktechnische Mitt.* Vol. *5*, 272-280 (1961).
3. DINSEL, S. Neue Untersuchungen über die Entzerrung der Quadraturfehler von Fernsehsendern (Recent investigations into the correction of quadrature errors of television transmitters). *Rundfunktechnische Mitt.* Vol. 8, **5**, 253-265 (1964).
4. DOBESCH and SULANKE. Zeitfunktionen (Time functions), *VEB Verlag Technik*, 2nd edition (In German) (1965).
5. SŹANTÓ, L. Frekvenčné a prechodné charakteristiky vysokofrekvenćného televizreho kanálu. (Frequency and transient characteristics of radio-frequency television channels.) *Slaboproudy obzor*, 25, **8**, 466-475 (1965).
6. DINSEL, S. Quadrature distortion correction for television vestigial-sideband transmission. *Journal of the SMPTE*, Vol. 75, 20-25 (1966).

REPORT 405 *

SUBJECTIVE ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(Study Programme 3A/XI)

(1966)

The following Table gives an outline of the main features of some existing methods of assessing the quality of impaired television pictures under laboratory conditions. Reference should be made to the source material for fuller details of the methods.

Other methods are useful for the assessment of television pictures for operational purposes. Doc. XI/149 (O.I.R.T.), 1963-1966 gives one such method.

Note 1. — Five-grade quality scale:

A (Excellent)
B (Good)
C (Fair)
D (Poor)
E (Bad)

Note 2. — Six-grade impairment scale:

1 Imperceptible
1 Just perceptible
3 Definitely perceptible but not disturbing
4 Somewhat objectionable
5 Definitely objectionable
6 Unusable

Note 3. — Six-grade quality scale:

1 Excellent
2 Good
3 Fairly good
4 Rather poor
5 Poor
6 Very poor

Note 4. — Seven-grade comparison scale:

−3 Much (worse)
−3 (worse)
−1 Slightly (worse)
0 Same as
+1 Slightly (better)
+2 (better)
+3 Much (better)

Note 5. — Five-grade impairment scale:

5 Imperceptible
4 Perceptible but not annoying
3 Somewhat annoying
2 Severely annoying
1 Unusable

* This Report was adopted unanimously.

References	U.K. [1]	E.B.U., O.I.R.T. [3], [4]			F.R. of Germany [2]			Japan [5] ([1])		U.S.A. [6]	Suggested for future recommendation	
Observers												
Type	Non-expert				Non-expert			Non-expert		Non-expert	Non-expert	
Number	20–25	$\geqslant 6$			$\geqslant 10$			20–25		approx. 200	$\geqslant 20$ (Note 9)	
Grading scale												
Type	Quality	Impairment	Quality	Comparison	Impairment	Quality	Comparison	Impairment	Quality	Quality	Impairment	Quality
Number of grades	5 (Note 1)	6 (Note 2)	6 (Note 3)	7 (Note 4)	5	5	5	5 (Note 5)	5 (Note 6)	6 (Note 7)	5	5
Test pictures												
Number	4–8	5			$\geqslant 5$			$\geqslant 3$		2–8	approx. 5	
Viewing conditions												
Viewing ratio	6	4–6			6			8		6–8	6	
Peak luminance on the screen (cd/m²) ([2])	50	41–54			50			approx. 400 (Note 8)		70 (Note 8)	50 (50 fields/second)	
Contrast range of the picture	not specified				not specified			30 : 1		not specified		
Ambient luminance of tube face (cd/m²)	$\leqslant 0 \cdot 5$	$0 \cdot 5$			$\leqslant 0 \cdot 5$			approx. 5		2	$\leqslant 0 \cdot 5$ (50 fields/second)	
Ambient luminance of backcloth (cd/m²) ([2])	1 Illuminant C				approx. $2 \cdot 5$ ([1])							
Room illumination (lx)	3							30–100		$6 \cdot 5$		
Presentation	Random sequence of pictures and impairments				Random sequence of pictures and impairments			Random sequence of pictures and impairments		Random sequence of impairments	Random sequence of pictures and impairments	

([1]) For monochrome only.

([2]) 1 cd/m² = 1 nt = 3·1416 asb = 0·2919 ft-L.

Note 6. — Five-grade quality scale:

5 Excellent
4 Good
3 Fair
2 Bad
1 Very bad

Note 7. — Six-grade quality scale:

1	Excellent	The picture is of extremely high quality, as good as you could desire.
2	Fine	The picture is of high quality providing enjoyable viewing. Interference is perceptible.
3	Passable	The picture is of acceptable quality. Interference is not objectionable.
4	Marginal	The picture is poor in quality and you wish you could improve it. Interference is somewhat objectionable.
5	Inferior	The picture is very poor but you could watch it. Definitely objectionable interference is present.
6	Unusable	The picture is so bad that you could not watch it.

Note 8. — 60-field/s systems permit these higher values of peak luminance.

Note 9. — Tests carried out by expert observers are also to be taken into consideration, but do not replace tests carried out by non-expert observers, who are more representative of television users. The number of expert observers should be, as far as possible, at least 10. When presenting the results of tests, the qualifications of the group of observers should be specified.

Bibliography

1. C.C.I.R. Doc. XI/16 (United Kingdom), 1963-1966 (refers to a published paper: Prosser, R. D., Allnatt, J. W. and Lewis, N. W., Quality grading of impaired television pictures *Proc. I.E.E.*, **111**, 491-502 (March, 1964).

2. C.C.I.R. Doc. XI/31 (F. R. of Germany), 1963-1966 (refers to [1]. Grosskopf, H. Guide values for the adjustment of optimum conditions for viewing television pictures *NTZ*, **6**, 262-266 (1963); also, experience of F. R. of Germany, unpublished).

3. C.C.I.R. Doc. XI/33 (E.B.U.), 1963-1966 (refers to the Report of the E.B.U. *ad hoc* Group on colour television), 2nd edition (February, 1965)

4. C.C.I.R. Doc. XI/45 (C.C.I.R. Secretariat), 1963-1966 (refers to the joint report of E.B.U. and O.I.R.T. on comparative tests of colour television pictures over long international circuits).

5. C.C.I.R. Doc. XI/140 (Japan), 1963-1966 (refers to the following bibliography):
   - 5.1. Yamaguchi, Y. Application of electronic digital computer to psychometric experiments (in Japanese). *J. Inst. Telev. Engrs.* Japan, **18**, 530-534 (1964).
   - 5.2. Hiwatashi, K. *et al.* Subjective tone reproduction of television system and recommendation for density standard of television film (in Japanese). *NHK Tech. Jour.*, **16**, 8-38 (1964).
   - 5.3. Hasegawa, T. Viewing ratio and subjective sharpness of television pictures (in Japanese). *Nat. Conv. Inst. Telev. Engrs.*, Japan (1965).
   - 5.4. Hasegawa, T. *et al.* Optimal viewing distance as a function of television system bandwidth (in Japanese). *Conv. Inst. Elec. Comm. Engrs.*, Japan (1965).
   - 5.5. Ooshima, M. The human factor considerations of television (in Japanese). *J. Inst. Telev. Engrs.*, Japan, **19**, 538-545 (1965).

6. C.C.I.R. Doc. XI/145 (U.S.A.), 1963-1966, which refers to:
   Fredendall, G. L. and Behrend, W. L. Picture quality—Procedure for evaluating subjective effects of interference. Proc. IRE (June, 1960).

REPORT 406 *

COLOUR TELEVISION

(1966)

1. C.C.I.R. Study Group XI met in Vienna in March-April 1965 under the Chairmanship of Mr. Esping, to consider the choice of a colour television system for use in the European Broadcasting Area and in other countries, using one of the 625-line television standards (Reference: Question 1/XI, Study Programmes 1A/XI and 1B/XI, Report 309).

2. Three possible colour television systems were considered by the Study Group namely: NTSC (625 lines), PAL, SECAM III. The detailed parameters of the systems considered are to be found in C.C.I.R. Doc. XI/33, 1963-1966.

3. It was agreed that the three systems satisfied the three basic conditions listed in Report 309 as being " generally considered desirable ", namely:

— colour and monochrome systems should be compatible;

— the signal should be composed of a luminance signal and two signals carrying the colour information, in so far as possible in accordance with the constant luminance principle;

— the chrominance signal should share the luminance frequency band.

4. In considering the technical factors listed in Question 1/XI, the Study Group had before it the documents listed in Annex III.

5. In particular, the Study Group took note of the very extensive laboratory and field tests carried out by broadcasting authorities, Administrations and industrial organizations in a number of countries, the results of which, up to February 1965, were summarized by the E.B.U. in C.C.I.R. Doc. XI/33, 1963-1966.

6. The Study Group reached the following conclusions in relation to the technical factors listed in Question 1/XI:

6.1 *Satisfactory picture (colour and monochrome) and sound quality*

The three colour systems are all capable of producing colour pictures of satisfactory definition and colour rendering under good transmission and reception conditions. However, it should be noted that the overall tolerances for achieving these conditions are different for the various systems (see §§ 6.4 and 6.5).

Some differences also exist in colour resolution of the systems, nevertheless divergent opinions have been expressed as to their importance (see Docs. XI/33, XI/40, XI/46 and XI/77, 1963-1966).

The sound quality is identical with that obtainable on the equivalent monochrome system.

6.2 *Economical use of bandwidth*

The three colour systems require no additional bandwidth as compared with an equivalent monochrome system.

6.3 *Reliable receivers at reasonable cost*

Annex I gives estimates of receiver cost, collected from various sources and it refers to basic manufacturing cost.

* This Report was adopted unanimously.

In an NTSC or simple PAL receiver, a hue control and a saturation control are available and necessary.

In the delay-line PAL receivers, a saturation control is necessary.

In the SECAM III receiver, neither of these controls is essential, but they may be added if desired (see Docs. XI/33, p. 12, § 2.2.2 and XI/35, 1963-1966).

6.4 *Operation*

Annex II contains comparison between the present performance of the transmission chain and the overall tolerances.

6.4.1 *Studio equipment*

All types of colour cameras and film scanners are suitable for use with any of the systems; the differences between the colour systems lie in the coding equipment, the vision fading and mixing equipment, and video-tape recording equipment.

No special difficulties are foreseen with regard to the basic unit (comprising ten distribution amplifiers, two studio mixers and a short link, a few kilometres long, which may be either a coaxial cable or a single-hop radio link), because distribution amplifiers can be made with high precision, as can a short link. Difficulties with regard to the mixer used with the SECAM III system can be overcome by suitable design, at the expense of a reduction of luminance bandwidth to about 3 MHz for the duration of the mix and/or special effects. The effect of this reduction of bandwidth may be partially compensated by the use of crispening techniques.

The magnetic recording of NTSC signals requires a full complement of auxiliary equipment such as automatic timing control devices (see Doc. XI/47, 1963-1966). Furthermore, higher recording carrier frequencies may be required than those used in 625-line monochrome practice. Experience in existing colour television services has shown that the main defects of NTSC magnetic recordings are caused by colour banding and differential phase. Experiments made with a new machine of the latest type has shown that, with good adjustments, the pictures obtained are generally satisfactory; the remaining defect is that of colour banding which is mainly noticeable on certain saturated colours (orange, yellow, red).

When recording PAL signals with the same equipment as used for the recording of the NTSC signals, the pictures obtained are better than with the NTSC system.

The magnetic recording of SECAM III signals presents no problem, in that normal good quality black-and-white video-tape recording machines can be used without modification. Furthermore, the picture quality obtained from a SECAM III recording has been judged to be better than that of PAL and NTSC pictures.

As regards source-noise in the three colour channels, the SECAM III system is slightly more sensitive that NTSC and PAL (see Docs. XI/33, p. 10 and XI/57, 1963-1966).

6.4.2 *Relaying equipment*

Microwave-relay and cable links for the transmission of colour signals from point-to-point require a very high standard of performance in respect of differential gain and differential phase, if they are to be suitable for the NTSC system. Such circuits have been constructed and operated under practical conditions, over distances greater than 4 800 km, using Standard *M*, which requires a nominal bandwidth of

4·2 MHz (see Doc. 4, London, 1964 and Doc. XI/68, 1963-1966). A substantially lower standard of performance could be accepted for SECAM III and PAL (delay-line receiver), in respect of differential phase. As regards differential gain, SECAM III has an advantage. If asymmetric sideband distortion occurs in the chrominance signal channel during transmissions on some long-distance cable links, the PAL system shows advantages.

Some existing long-distance circuits will require a substantial improvement, in particular as regards the amplitude/frequency response and signal-to-noise ratio, whatever colour system be adopted.

Note concerning §§ *6.4.1 and 6.4.2* :

The colour system used in this equipment need not necessarily be the same as that used for transmitting equipment (§ 6.4.3), because transcoders for several systems have been shown to be feasible. A new corrector for differential phase and gain, based upon three sub-carrier pilot bursts at black, grey and white levels inserted into the line-blanking interval, can be used to reduce the figures for differential gain and phase by factors of twice and three times respectively.

6.4.3 *Transmitting equipment*

All transmitters could be modified so as to make them adequately free from distortion for any of the three systems. Difficulties are likely to be experienced in obtaining a suitable amplitude/frequency response with C.C.I.R. Standard *G* at the upper end of the video channel; this will mainly affect the NTSC system. It is believed that an adequate response and adequate stability can be obtained for the NTSC system, but there may be additional complexity and maintenance problems, compared with SECAM III and PAL.

For all systems it is necessary to standardize the group-delay time difference between the modulated luminance signal and the modulated chrominance signal. For economic reasons, it is furthermore desirable to correct in the transmitters for the group-delay errors of an average receiver. Doc. XI/155, 1963-1966 contains a proposal for such a correction for standards *B*, *G*. Doc. XI/178, 1963-1966 contains information of such a correction for standard *L*.

Transposers of modern design, which perform the frequency-changing operation on the vision and sound signal in one operation, generally have adequate linearity for dealing with any of the three colour systems.

With the transposers having separate conversion of sound and vision, the problems are similar to those of transmitters. For all the colour systems, it may be necessary to limit the power output of existing transposers designed for black-and-white operation, so as to achieve the linearity necessary to avoid the reintroduction of the unwanted sideband. Differential phase requirements, particularly in the case of NTSC, will also restrict the power output. It is not known which of these effects will be the limiting factor.

Experiments with the three systems have shown that three transposers may be used in tandem without deleterious effects due to the equipment being observed.

6.5 *Susceptibility to interference*

Colour television signals are sensitive to CW interference at frequencies in the region of the vision carrier, in the same way as monochrome signals; in addition, they are more sensitive to interference at frequencies within the chrominance band. In general, however, there is little difference between the susceptibilities of the three systems to CW interference of uncontrolled frequency.

Under conditions of multipath reception, where the received picture is on average of fairly good quality, the PAL system shows a slight advantage. This slight advantage is also present for the SECAM III system, provided there is adequate field strength at the receiving site (see Docs. XI/33 and XI/51, 1963-1966).

For signal-to-noise ratios corresponding to a picture quality ranging between excellent and poor, the sensitivity of the three systems to random noise is appreciably the same. However, within this range of picture quality, the advantage of NTSC and PAL varies from 1 to 2 dB. But if this ratio deteriorates so as to give pictures of poor or very poor quality, SECAM III is 3 dB more sensitive to noise than NTSC and PAL.

6.6 *Compatibility*

When a colour signal is displayed on a monochrome receiver, the chrominance signal gives rise to visible effects on the reproduced picture. These effects are regular patterns in coloured areas for NTSC and PAL and irregular patterns all over the picture in the case of SECAM III.

The assessments of observations made on picture monitors using Standards *G*, *I* and *L* have shown that the compatibility of NTSC is " slightly better " to " better " than that of the other systems. PAL has a slight advantage over SECAM III.

Further results show the assessments made during observations on domestic receivers. In these results, the most favourable assessment is for NTSC and, from observations made on Standard I, the percentage of assessments having a grade greater than 3·5 A (see Annex II, Remarks) is noticeably less than that for either of the other two systems for very saturated camera pictures viewed under the conditions laid down by the *ad hoc* Group of the E.B.U. The average absolute assessments for SECAM III and PAL are equal.

Observations made on Standard *G* and using domestic receivers show that on average PAL is " very slightly worse " than NTSC (see Doc. XI/33, 1963-1966). More recent tests (see Doc. XI/53, 1963-1966) show that under normal receiving conditions NTSC and PAL were found to be practically equal. SECAM III was found to be slightly worse than NTSC and PAL.

Tests conducted with domestic receivers on Standard *L* have shown that when, due to random noise, the picture quality is between good and fairly good, the compatibilities of the three systems are practically the same (see Doc. XI/59, 1963-1966).

Tests made with domestic receivers on Standard *K* in normal reception conditions showed that there was no difference between the NTSC and SECAM III systems. The majority of the test pictures came from slides (see Doc. XI/44, 1963-1966).

The system for which a colour receiver is designed does not affect its ability to reproduce monochrome signals in monochrome.

6.7 *Frequency planning*

The main consideration in frequency planning is the susceptibility of the wanted signal to co-channel interference. The planning standards already adopted in UHF for monochrome are considered satisfactory for colour.

When the frequency stabilities of the wanted and interfering signals are adequate for advantage to be taken of the offsetting and when the interfering carrier falls within the chrominance band, the NTSC and PAL systems are better. If these conditions are not achieved the SECAM III system is on the average as good as the NTSC system.

Problems in connection with coverage are mentioned under §§ 6.5, 6.10 and 6.11.

6.8 *International exchange of programmes*

Programmes may be exchanged between countries having the same scanning standards by direct relay (see § 6.4.2) and by means of video-tape recordings (see § 6.4.1); or by means of film recordings which may be used whatever the scanning standards. In the latter case, there are no experimental data available at present to the C.C.I.R. that would define objectively the picture quality that could be obtained. Nevertheless, the experts of certain countries consider that the various systems may yield different picture qualities, particularly with regard to vertical resolution (see § 6.1) and other characteristics.

For exchanges between countries using the 625-line standard with different video bandwidths (e.g.5,5 · 5 or 6 MHz) by means of direct relay or video-tape recording, problems arising from the different bandwidths are not serious whichever colour system is used. As to programme exchange by line, however, the PAL system, using a delay line, offers some advantages, especially for Standard *G*, insofar as limiting of the chrominance band does not affect colour crosstalk.

A special problem exists for programme exchanges between countries using the 525-line and 625-line standards.

Direct broadcasting without signal processing of signals on one standard for reception by receivers designed for the other, is not envisaged. In all cases, programme exchange requires a transformation by a broadcasting organization of the signal received, to adapt it for broadcasting over the national network. This transformation requires special electronic equipment.

6.8.1 If the conversion is done by simple translation of the frequency of the chrominance signal, the resulting colour-television signal differs in number of lines and in field frequency from the normal signal used in the country in question. This solution requires a decision about the adoption of dual-standard television in the country concerned.

It is probable, from a theoretical standpoint, that the translation could be done with a loss of luminance information which is slightly less for NTSC than that obtained for the other systems, although the amount of this loss is not adequately known. With the same restrictions, it is possible that PAL is a little better than SECAM III and very close to NTSC.

6.8.2 If the conversion is to result in a signal conforming to the system of the receiving country, the difficulty of the conversion increases and it is probable that the differences between the colour systems are reduced (see Docs. XI/33, XI/48 and XI/49, 1963-1966 and Doc. 10, London, 1964).

6.9 *Scope for development*

As far as future prospects are concerned, it can be said that the NTSC system seems more easily adaptable to the single-gun tube. The PAL system is a little less adaptable and the SECAM III system is still less adaptable. Further work is still needed.

The NTSC system preserves the vertical resolution, in colour, to a greater extent than does the SECAM III system with the PAL system as intermediate.

The PAL and, above all, the SECAM III systems will permit video-tape recording more easily.

6.10 *Differences between Bands I and III compared with Bands IV and V*

Experience indicates that multipath propagation effects are less serious in Bands IV and V because much better antenna directivity can be obtained than in Bands I and III (see Doc. 23, London, 1964).

6.11 *Effects due to the simultaneous presence of several different types of distortion*

A certain number of results have been obtained concerning the effects of a combination of simultaneous distortions (see Docs. XI/12, XI/33, XI/34, XI/51, XI/56, XI/67, 1963-1966).

For certain distortion combinations, consisting of differential gain and/or unwanted attenuation of the chrominance signal, for which noise occurs at a high level, the SECAM III system has proved to be more sensitive than the NTSC or PAL systems.

With other combinations, especially when a high degree of non-linear distortion is present, the SECAM III system has proved to be less sensitive than NTSC.

ANNEX I

COST AND PERFORMANCE OF THE COLOUR RECEIVER

1. Introduction

1.1 The basis of cost comparison was a table-type receiver in a wooden cabinet, generally similar to the RCA-CTC 15.

1.2 The price of the receiver was calculated as the cost ex-works, inclusive of all works charges and of packing in a corrugated cardboard box; no provision was made for any distributor's costs, sales or other taxes, etc.

1.3 The basic NTSC receiver was assumed to be valve operated. The costs of additional circuits for the other systems were calculated on the basis of valve or transistor circuits as judged most advantageous by the manufacturers concerned.

1.4 The cost figures have been put forward on the basis of existing designs, and used for the most part during the tests. Improvements in design due to the use of transistors or other circuit improvements could possibly apply to all types of receiver.

1.5 The cost comparison was based on a quantity of a hundred thousand receivers per annum per country.

1.6 In the cost calculations, no provision was made for patent royalties.

2. As a result of discussions, the values set out in the Table were established. These values are subject to the following notes:

2.1 The cost of the delay-line is as stated in the headings of the columns, but the cost of the crystal for the NTSC system is considered as varying between $1 and $1.50.

2.2 The performance of a steel delay-line costing 14 French francs has proved satisfactory in the SECAM III receiver. The performance of a glass delay-line costing 20 DM has proved satisfactory in the PAL receiver.

2.3 All manufacturers (subject to § 2.8 regarding the Netherlands), used the same basis as regards circuit technique for the cost calculation of the NTSC receiver. In receivers for the SECAM III and PAL systems, the costs have been based on the circuit realization which manufacturers in each country considered appropriate. This may explain some of the variations in the values given in columns 3 and 4, and the consequent variations in other columns.

2.4 The entries given in the Table are the result of study by the principal manufacturers in the countries concerned.

2.5 The NTSC receivers taken into consideration for the Table did not include automatic gain control in the chrominance circuit. The additional cost of this control would be approximately 0·3%. Some manufacturers, however, do not consider the addition of this control to be necessary.

2.6 The vision channel a.g.c. normally used in a colour receiver is considered satisfactory for a SECAM III receiver, but if separate luminance and saturation controls are desirable, their inclusion would have no appreciable effect on the cost of the receiver.

2.7 The German representatives considered that a new design of the PAL receiver does not require a sub-carrier crystal and that the omission of this component would reduce the price of the PAL receiver by 0·73%.

2.8 The figures submitted by the Netherlands refer to existing receivers of comparable performance on all three systems, although their reference NTSC receiver has a performance somewhat better than the CTC 15. In their judgement, the figures submitted by the Netherlands representatives most clearly represent the position. However, figures relative to the reference NTSC type CTC 15 receiver would be, in columns 5 and 6, values of 7·3 and 8·0 respectively.

2.9 The chrominance chassis for SECAM III type PVL 2 uses the luminance channel for the amplification of the chrominance signals, which allows the separation at a high level with a consequent simplification of the circuit. In this case, the differences between the NTSC and SECAM III receivers are not due solely to the chrominance decoder, but to the combination of the chrominance and luminance circuits after the output of the detector and before the input to the matrix circuits.

TABLE

Cost data on colour receivers relative to the costs of an NTSC receiver

(Type RCA-CTC 15, see §§ 1.1 and 2.8)

Country	NTSC Chroma percentage of total cost	Delay-line at			
		$5		14 F. fs.	20 DM approx. $5
		Relative cost of chroma circuit relative to NTSC		Percentage additional cost relative to NTSC total cost	
		SECAM III	PAL	SECAM III	PAL
(1)	(2)	(3)	(4)	(5)	(6)
France	4·88	1·38	—	−0·35 (1)	—
Italy	5·0	—	1·72 (3)	2·3	3·6 (3)
Netherlands	5·0	2·0	2·15	5 (2)	5·7
Germany	6·5	1·7	1·7 (3)	3	4·5 (3)
United Kingdom	4·2	1·41	1·83	1·1 (1)	3·5

(1) These figures relate to recent receivers (end of 1964). The sign (—), which indicates an advantage for the SECAM system, concerns a PVL2 receiver, which did not participate in the demonstrations described in Doc. XI/46, 1963-1966, except for a single set, which was not subjected to the tests described in Docs. XI/58 and XI/33, 1963-1966.

(2) This relative cost is not based on the cost of a delay-line of 14 French frs., but of 20 DM.

(3) Following recent developments, Doc. XI/78, 1963-1966, new designs will enable a considerable reduction to be made in the cost of PAL receivers. However, the receivers of this type were not subjected to the tests described in Doc. XI/33, 1963-1966. An initial assessment for Italy would be 1·90% instead of 3·60% and for Germany 2·5% instead of 4·5%.

ANNEX II

COMPARISON BETWEEN THE PRESENT PERFORMANCE OF THE TRANSMISSION CHAIN AND THE OVERALL TOLERANCES FOR PICTURE GRADES 2·5*A* AND 3·5*A*

References (Doc. 33, Vienna, 1965)	Individual performance figures	Centre, or null output, frequency of receiver chrominance discriminator and centre frequency of coder frequency modulator (kHz)		Chrominance signal phase errors independent of luminance signal magnitude		Level-dependent phase of the chrominance signal (differential phase)		Ratio of the amplitude of the chrominance signal to that of the luminance signal (dB)		Level-dependent amplitude of the chrominance signal (differential gain) (2) (%)		Group-delay of the chrominance signal with respect to that of the luminance signal; tolerance at frequency of sub-carrier (ns)	
§ 3.4	Receiver	± 5 (1)		—		± 5°		—		10		?	
§ 3.3	Transmitter	—		?		± 5°		± 1		10		with pre-corrector	
§ 3.2.1	Distribution network (3)	—		—		± 10° (9)		± 2		8		25	
§ 3.1.1	Studio centre " basic unit "	—		?		± 3°		?		5		± 10	
§ 3.1.2	Tape recorder	— (1)		± 5°		± 4° (4)		?		2 (4)		?	
	Arithmetic sum (5)	?		?		± 27°		?		35		?	
	Quadratic sum (5)	?		?		± 13°		?		17		?	
	Overall tolerances (6), (7), (8)	Grade		Grade		Grade		Grade		Grade		Grade	
		2.5*A*	3.5*A*	2.5*A*	3.5*A*	2.5*A*	3.5*A*	2.5*A*	3.5*A*	2.5*A*	3.5*A*	2.5*A*	3.5*A*
§ 2.4 Table II	NTSC	—	—	± 12°	± 15°	± 12°	± 20°	± 2·5	± 4	30	40	+ 200 − 300	+ 350 − 500
	SECAM III	+ 12 − 23	± 30	—	—	± 40°	± 50°	± 2·5	± 4	65	70	+ 200 − 300	+ 450 − 500
	PAL_d, PAL_n	—	—	± 40°	± 50°	± 40°	± 50°	± 2·5	± 4	30	40	+ 200 − 300	+ 350 − 500
	PAL_s	—	—	± 12°	± 15°	± 12°	± 20°	± 2·5	± 4	30	40	+ 200 − 300	+ 350 − 500

— Considered to be unimportant or of negligible value or easily adjustable or irrelevant.

? Insufficient information available.

(1) Applies to SECAM III only.

(2) 100 (1 – m/M) where m is the minimum amplitude of the chrominance signal and M is its maximum value. Although this formula always gives results which are positive, some compensation is possible when several pieces of equipment are connected in tandem.

(3) For a video section. The figures of the Table are not applicable to a more complex network composed of several " video to video " sections in cascade.

(4) These figures represent the best results obtainable at present on a new-model machine. It is assumed that further improvements will be such that these figures will correspond to performance in normal operating conditions.

(5) It is not known how the distortions indicated by the figures in any one column of the Table will add in practice. Two examples (arithmetic and quadratic) of additions are given.

(6) It is also not known what the effect upon the overall tolerances would be when more than one distortion giving rise to the same grade of picture impairment exists simultaneously. Recent tests with NTSC have shown, however, that the simultaneous presence of differential phase and differential gain each giving, alone, an impairment of grade 3·5*A* result in an impairment of grade 4·1*A*. The result for single impairments of grade 2·5*A* is grade 3·1*A*. In order that, with the two distortions simultaneously present, the grading shall be either 3·5*A* or 2·5*A*, the respective overall tolerances may be multiplied by approximately 0·8. The probability of the simultaneous presence of the two distortions at overall tolerance values is not known.

(7) The overall tolerances are intended to apply to those parts of the colour television transmission chain between and including both coder and decoder.

(8) The gradings of picture quality correspond to the Table below:

Absolute grades (A)

(a) Impairment

1*A*: Imperceptible
2*A*: Just perceptible
3*A*: Definitely perceptible, but not disturbing
4*A*: Somewhat objectionable
5*A*: Definitely objectionable
6*A*: Unusable

(b) Quality

1*A*: Excellent
2*A*: Good
3*A*: Fairly good
4*A*: Rather poor
5*A*: Poor
6*A*: Very poor

(9) Experience in the U.S.A. is given in Doc. 4 (Rev.), London 1964 and indicates that the corresponding figure for a network comprising more than one video-to-video section is ± 4·5°, which includes 96% of the measured samples.

ANNEX III

LIST OF DOCUMENTS CONCERNING QUESTION 1/XI
COLOUR TELEVISION STANDARDS

Doc. XI 1963-1966	Submitted by	Title
1.	**London, 1964: Colour Sub-Group of Study Group XI**	
1	Japan	Separate luminance colour television system. Standards for video colour television signals.
2	United States of America	Survey of colour television receivers.
3	United States of America	A summary of practical experience with colour television in the United States.
4 and Rev.	United States of America	Differential gain and phase measurements on long-distance television transmission circuits.
5	Federal Republic of Germany	Colour television standards. Standards for an experimental 625-line, 5 MHz colour television system of the NTSC type.
6	Federal Republic of Germany	Colour television standards. Standards for an experimental 625-line, 5 MHz colour television system of the PAL type.
7	E.B.U.	Colour television standards. Report of the E.B.U. *ad hoc* Group on Colour Television.
8	United Kingdom	Comparison of colour systems.
9	United Kingdom	Separate and constant luminance.
10	Netherlands	On the choice of sub-carrier-, line- and field-frequencies for a European colour television system.
11	Netherlands	On the use of a line-time delay line in a decoder for the NTSC system.
12	Netherlands	Some experiments on the performance of the PAL colour television system.
13	Netherlands	Delay-line tolerance in the PAL-decoder.
14	United States of America	Colour errors in colour television cameras using the NTSC system.
15	E.B.U.	Colour television standards.
16	France	Colour television standards—SECAM system.
17	U.S.S.R.	Study of the influence of variations in signal levels in colour television systems.
18	U.S.S.R.	Influence of the accuracy of establishment of phase relations in colour television systems with modulation of the sub-carrier in quadrature.
23	E.B.U.	Comparative field trials of three colour television systems in shadow areas.
24	France	Quality of compatible black-and-white pictures in colour television systems NTSC, SECAM III and PAL.
29	Chairman, Colour Sub-Group, S.G. XI	Questionnaire by the Chairman of the Colour Sub-Group of Study Group XI.
32	United Kingdom	Compatibility with camera pictures and domestic receivers.
33 33 (1st Rev.) and Corr. 1 33 (2nd Rev.)	Colour Sub-Group, S.G. XI	Report of Study Group XI, Colour Sub-Group.
34 and Corr. 1	C.C.I.R.	Answers to the Questionnaire in Doc. 29.

2. **Interim Meeting of Study Group XI, Vienna 1965**

Doc. XI 1963-1966	Submitted by	Title
1	C.C.I.R.	Final Report of Study Group XI Colour Sub-Group (London, Doc. 33 (2nd Rev.)).
12	United States of America	Relationship of aural to visual received powers—New York City UHF television project.
26	O.I.R.T.	Investigation of compatibility of the SECAM colour television system.
29	United States of America	Comparison of the receivers for NTSC, PAL and SECAM colour television systems.
33	E.B.U.	Colour television standards: Report of the E.B.U. *ad hoc* Group on Colour Television.
34	United States of America	Influence of clutter on the ratio of picture and sound terminal voltage.
35	United States of America	The need for receiver colour controls in any system of colour television.
38	E.B.U.	Colour television standards.
39	United Kingdom	Controllability of NTSC receivers.
40	United States of America	Comments on C.C.I.R. Doc. 33 (2nd Rev.), London 1964: Report of Study Group XI Colour Sub-Group.
41	United Kingdom	Colour television.
43	United Kingdom	Proposed sub-carrier pilot for NTSC-type colour television.
44	P. R. of Poland	Comparative assessment of the compatibility of the NTSC and SECAM III systems.
45	E.B.U./O.I.R.T.	Comparative tests of the transmission of colour television pictures over long international circuits.
46	France	Some results of comparative measurements on the SECAM, PAL and NTSC colour television systems—Demonstrations offered by the O.R.T.F. to the members.
47 (X/44)	France	Colour television recording.
48	France	Exchange of colour programmes between countries with different standards.
49	United Kingdom	Choice of sub-carrier line and field frequencies for a dual-standard colour television system.
51	Switzerland	Tests of colour reception with domestic receivers.
52	Italy	Standards for radiated colour-television signals—Investigation on the manual tuning of domestic monochrome and colour television receivers.
53	Italy	Compatibility of NTSC, SECAM III and PAL emissions using domestic receivers.
54	Italy	Colour picture of NTSC, SECAM III and PAL emissions using domestic receivers.
55	P. R. of Poland	Comparison of NTSC and SECAM III systems.
56	P. R. of Poland	Behaviour of the NTSC and SECAM III colour television systems under the simultaneous influence of various distortions and disturbances.
57	Federal Republic of Germany	Colour television standards—Behaviour of the SECAM III colour television system in the presence of statistically distributed noise.

Doc. XI 1963-1966	Submitted by	Title
58	France	Experiments in colour television broadcasting with the SECAM system.
59	France	Compatibility of the NTSC, SECAM and PAL colour television systems on commercial receivers.
67	United Kingdom	The behaviour of the SECAM system in the presence of distortions encountered on existing long-distance transmission circuits.
68	Japan	Transmission of colour television signals over long distances.
70	United Kingdom	Colour television standards: Comments on Doc. XI/33.
72	United Kingdom	Compatibility of NTSC, SECAM III and PAL colour television systems.
75	United Kingdom	Statement by the United Kingdom delegation.
77	France	Outline of reply to Doc. XI/40, submitted by the United States of America.
78 and Corr. 1	Italy	Example of a PAL colour television receiver.
79	Federal Republic of Germany	Statement as regards the choice of a colour television system.
80	Netherlands	Statement by the Netherlands delegation.
81	P. R. of Poland	Statement regarding the choice of a colour television system.
82	U.S.S.R.	Statement on the choice of a single-colour television system.
84	P. R. of Bulgaria	Statement regarding the choice of a colour television system.
85	Italy	Statement by the Italian delegation.
87	Japan	Statement by the Japanese delegation.
92	Spain	Statement on the choice of a colour television system.
93	France	Letter to Chairman of Study Group XI.
94	France	Note on the comments made on the SECAM system.
96	United States of America	Statement regarding the choice of a colour television system.
112	Poland	Remarks concerning Doc. XI/96.
116	Working Party XI-A	Report by the Chairman of Working Party XI-A.

3. Later documents of Study Group XI, period 1963-1966

143	Federal Republic of Germany	Central correction of the phase error in PAL colour television signals.
154	People's Republic of Poland	Use of monochrome television equipment now in operation in Poland for colour television.
155	Netherlands	Correction in transmitters for group-delay errors.
167	Switzerland	Contribution to the theoretical study of the problem of colour television multipath reception.
178	France	Linear pre-correction of system *L* television transmitters.

REPORT 407 *

CHARACTERISTICS OF COLOUR TELEVISION SYSTEMS **

(Question 1/XI)

(1966)

The documents listed below, the texts of which are reproduced for information, contain details of a number of different colour television systems either in use or taken into consideration at the time of the XIth Plenary Assembly, Oslo 1966.

Doc. XI/128 (U.S.A.)	NTSC 525 lines
Doc. XI/217 (U.S.A.)	NTSC 625 lines, System *N*
Doc. XI/153 (E.B.U.)	NTSC 625 lines
Doc. XI/164 (France and U.S.S.R.)	SECAM III 625 lines
Doc. XI/174	PAL 625 lines
Doc. XI/169 (France and U.S.S.R.)	SECAM IV 625 lines
Doc. XI/218 (France)	SECAM System *M*
Doc. XI/219 (France)	SECAM System *N*

A. — CHARACTERISTICS OF THE COLOUR TELEVISION SYSTEM IN USE IN THE U.S.A. ***

The following Tables, given for information, contain details of the 525-line colour television system in use in the United States of America at this time. Inasmuch as the reference point of the standard signal in the U.S.A. is at the 10% point or 90% point of each pulse rather than the 50% point, the figures given are, in many cases, only approximate. The numbering, lettering and format of the various items are, where possible, in accordance with Report 308-1.

TABLE I

Characteristics of the 525-line (System M) colour television system

1. *Video characteristics*

Number of lines per picture (frame):	525
Field frequency (fields/second):	59·94
Interlace:	2/1
Picture (frame) frequency (pictures/second):	29·97
Line frequency (lines/second):	15 734·264
Tolerance (lines/second):	± 0·044
Aspect ratio (width/height):	4/3
Scanning sequence (line):	Left-to-right
(field):	Top-to-bottom
System capable of operating independently of power supply frequency:	Yes

* This Report was adopted unanimously.

** It did not prove possible for Study Group XI to make a recommendation for a single-colour television system. An Annex to this document gives the Report of Working Party XI-A-2 whose terms of reference were to seek a solution in the manner indicated below.

*** These characteristics are those which appear in Doc. XI/128 (U.S.A.), 1963-1966.

Approximate gamma of picture signal:	0·45 (1/2·2)
Nominal video bandwidth (MHz):	4·2
Chrominance sub-carrier frequency (MHz):	3·579545
Tolerance (Hz):	± 10

A burst of at least 8 cycles at the frequency of the chrominance sub-carrier occurs during each horizontal blanking period after the line-synchronizing pulse and at least 0·006 H from the trailing edge of that pulse and lasts until not more than 0·125 H from the leading edge of the same line-synchronizing pulse. The zero axis of the colour-burst is at the blanking level and its peak-to-peak amplitude about the blanking level is from 0·90 to 1·1 of the difference between the levels of the synchronizing pulses and the blanking level.

This colour burst is omitted during the field-blanking period.

1.1 *Composition of the colour-picture signal*

1.1.1 $E_M = E'_Y + \left[E'_Q \sin (\omega t + 33°) + E'_I \cos (\omega t + 33°) \right]$

where

$$E'_Q = 0{\cdot}41\,(E'_B - E'_Y) + 0{\cdot}48\,(E'_R - E'_Y).$$
$$E'_I = -0{\cdot}27\,(E'_B - E'_Y) + 0{\cdot}74\,(E'_R - E'_Y).$$
$$E'_Y = 0{\cdot}30\,E'_R + 0{\cdot}59\,E'_G + 0{\cdot}11\,E'_B.$$

For colour-difference frequencies below 500 kHz (see § 1.1.2), the signal

$$E_M = E'_Y + \left\{ \frac{1}{1{\cdot}14} \left[\frac{1}{1{\cdot}78} (E'_B - E'_Y) \sin \omega t + (E'_R - E'_Y) \cos \omega t \right] \right\}$$

where

E_M is the total video voltage, corresponding to the scanning of a particular picture element, applied to the modulator of the picture transmitter.

E'_Y is the gamma-corrected voltage of the monochrome portion of the colour picture signal, corresponding to the given picture element.

E'_Q and E'_I are the amplitudes of two orthogonal components of the chrominance signal corresponding respectively to narrow-band and wide-band axes.

E'_R, E'_G, and E'_B are the gamma-corrected voltages corresponding to red, green and blue signals during the scanning of the given picture element.

ω is the angular frequency and is 2π times the frequency of the chrominance sub-carrier.

The portion of each expression between brackets in § 1.1 represents the chrominance sub-carrier signal which carries the chrominance information.

The phase reference in the E_M equation in § 1.1 is the phase of the burst + 180°. The burst corresponds to amplitude-modulation of a continuous sine-wave.

1.1.2 The equivalent bandwidths assigned prior to modulation to the colour difference signals E'_Q and E'_I are as follows:

Q-channel bandwidth:

at 400 kHz, less than 2 dB down;
at 500 kHz, less than 6 dB down;
at 600 kHz, at least 6 dB down.

I-channel bandwidth:

at 1·3 MHz, less than 2 dB down;
at 3·6 MHz, at least 20 dB down.

1.1.3 The gamma-corrected voltages E'_R, E'_G, and E'_B, are suitable for a colour picture tube having primary colours with the following chromaticities in the C.I.E. system of specification:

	x	y
Red (R)	0·67	0·33
Green (G)	0·21	0·71
Blue (B)	0·14	0·08

and having a transfer gradient (gamma exponent) of 2·2 associated with each primary colour. The voltages E'_R, E'_G, and E'_B may be respectively of the form $E_R^{1/\gamma}$, $E_G^{1/\gamma}$ and $E_B^{1/\gamma}$, although other forms may be used with advances in the state of the technique.

1.1.4 The radiated chrominance sub-carrier vanishes on the reference white of the scene.

Note. — The numerical values of the signal specification assume that this condition will be reproduced as standard illuminant C ($x = 0{\cdot}310$, $y = 0{\cdot}316$) of the International Lighting Commission (C.I.E.).

1.1.5 E'_Y, E'_Q, E'_I and the components of these signals match each other in time to 0·05 μsecs.

1.1.6 The angle of the sub-carrier measured with respect to the burst phase, when reproducing saturated primaries and their complements at 75% of full amplitude, are within ± 10° and their amplitudes are within ± 20% of the values specified above. The ratios of the measured amplitudes of the sub-carrier to the luminance signal for the same saturated primaries and their complements fall between the limits of 0·8 and 1·2 of the values specified for their ratios.

2. *Radio-frequency characteristics*

Nominal radio-frequency bandwidth (MHz):	6
Sound-carrier relative to vision-carrier (MHz):	+ 4·5
Sound-carrier relative to nearest edge of channel (MHz):	− 0·25
Nominal width of main sideband (MHz):	4·2
Nominal width of vestigial sideband (MHz):	0·75
Type of polarity of vision modulation:	A5C, negative
Synchronizing level as a percentage of peak carrier:	100
Blanking level as a percentage of peak carrier:	72·5–77·5
Difference between black level and blanking level as a percentage of peak carrier:	2·875–6·75
Peak-white level as a percentage of peak carrier:	10–15
Type of sound modulation:	F3, ± 25 kHz 75 μs pre-emphasis
Ratio of effective radiated powers of vision and sound:	10/1–5/1

TABLE II

Details of line-synchronizing signals

	% H	µs
Line period (H):	100	63·556
Line-blanking interval (a):	16·5–18	10·5–11·4
Interval between time datum (H_o) and back edge of line-blanking signal (b):	12·7–16	8·06–10·3
Front porch (c):	⩾ 2	⩾ 1·27
Synchronizing pulse (d):	6·6–8	4·2–5·1
Build-up time (10-90%) of the edges of the line-blanking signal (e):	⩽ 0·75	⩽ 0·48
Build-up time (10-90%) of line-synchronizing pulses (f):	⩽ 0·4	⩽ 0·25

TABLE III

Details of synchronizing signal

Field period (V) (ms):	16·683	
Line period (H) (µs):	63·556	
Field-blanking period (j) (µs):	1168–1335 (0·07–0·08) V (ms) Approx. (18–21) H	
Build-up times (10-90%) of the edges of field-blanking pulses (k) (µs):	⩽ 6·36	
Duration of first equalizing pulse sequence (l):	3 H	
Duration of synchronizing pulse sequence (m):	3 H	
Duration of second sequence of equalizing pulses (n):	3 H	
	% H	µs
Duration of equalizing pulse (p):	3·6	2·29
Duration of field-synchronizing pulse (q):	41·6–44	26·4–28·0
Interval between field-synchronizing pulses (r):	6–8·8	3·8–5
Build-up times (10-90%) of edges of synchronizing signals (s):	⩽ 0·4	⩽ 0·25

B. — SPECIFICATIONS OF THE NTSC, PAL AND SECAM III SYSTEMS:

(January, 1966)

(These Tables are extracted from Doc. XI/153 (E.B.U.), 1963-1966)

Item	Characteristics		Standards (1) I	Standards (1) G	Standards (1) L
1	*General specification*				
	Luminance component	NTSC, PAL, SECAM III	Amplitude-modulation of the picture carrier		
	Chrominance component	NTSC, PAL	Simultaneous pair of components transmitted as amplitude-modulated sidebands of a pair of suppressed sub-carriers in quadrature having a common frequency.		
		SECAM III	A pair of components transmitted alternately on successive lines as the frequency-modulation of a sub-carrier.		
2	*Colour sub-carrier* f_{sc}				
		NTSC	$f_{sc} = 4{\cdot}4296875$ MHz $\pm$ 1 Hz	$f_{sc} = 4{\cdot}4296875$ MHz $\pm$ 10 Hz	$f_{sc} = 4{\cdot}429687$ MHz
		PAL	$f_{sc} = 4{\cdot}43361875$ MHz $\pm$ 1 Hz	$f_{sc} = 4{\cdot}43361875$ MHz $\pm$ 10 Hz	$f_{sc} = 4{\cdot}43361875$ MHz
		SECAM III	$f_{sc} = 4{\cdot}4375$ MHz $\pm$ 2 kHz	$f_{sc} = 4{\cdot}4375$ MHz $\pm$ 2 kHz	$f_{sc} = 4{\cdot}4375$ MHz $\pm$ 2 kHz
3	*Frequency spectrum of composite colour picture and sound signals*		(MHz)	(MHz)	(MHz)
	Vision-to-sound spacing	NTSC	6	5·5	6·5
		PAL	6	5·5	6·5
		SECAM III	6	5·5	6·5
	Main sideband (luminance)	NTSC	5·5	5·0	6
		PAL	5·5	5·0	6
		SECAM III	5·5	5·0	6
	Vestigial sideband	NTSC	1·25	0·75	1·25
		PAL	1·25	0·75	1·25
		SECAM III	1·25	0·75	1·25
	Chrominance sidebands				
	E'_I signal	NTSC	$f_{sc} \begin{cases} +1{\cdot}07 \\ -1{\cdot}60 \end{cases}$	$f_{sc} \begin{cases} +0{\cdot}57 \\ -1{\cdot}30 \end{cases}$	$f_{sc} \pm 1{\cdot}57$
	E'_Q signal	NTSC	$f_{sc} \pm 0{\cdot}8$	$f_{sc} \pm 0{\cdot}4$	$f_{sc} \pm 0{\cdot}6$
	E'_U signal, E'_V signal	PAL	$f_{sc} \begin{cases} +1{\cdot}07 \text{ max.} \\ -1{\cdot}6 \text{ max.} \end{cases}$	$f_{sc} \begin{cases} +0{\cdot}57 \text{ max.} \\ -1{\cdot}3 \text{ max.} \end{cases}$	$f_{sc} \pm 1{\cdot}57$ max.
	D'_R, D'_B	SECAM III	$f_{sc} \begin{cases} +1{\cdot}07 \\ -1{\cdot}40 \end{cases}$	$f_{sc} \begin{cases} +0{\cdot}57 \\ -1{\cdot}40 \end{cases}$	$f_{sc} \pm 1{\cdot}40$

(1) The monochrome systems the characteristics of which are given in Table I of Report 308-1.

Item	Characteristics	Standards (1)		
		I	*G*	*L*
4	*Transmitted colour picture signal waveform*	Complies with Report 308-1: " Characteristics of monochrome television systems ", with the following modifications:		
	Colour synchronization — NTSC	Sub-carrier burst Duration : 13 ± 1 cycle Start : 5·5 ± 0·2 μs after the leading edge of line-synchronizing pulses Amplitude : 0·5 ± 0·1 of line-synchronizing amplitude Omitted during equalizing and field-pulse periods		
	PAL	Sub-carrier burst Duration : 13 ± 1 cycle Start : 5·5 ± 0·2 μs after the leading edge of line-synchronizing pulses Amplitude : 0·5 ± 0·1 of line-synchronizing amplitude Omitted during field-blanking periods for 9 lines Phase sequence: (See § 9, Phase reference) 1st field (even) commencing on line 7 } + 135° on odd lines 2nd field (odd) commencing on line 319 } − 135° on even lines 3rd field (even) commencing on line 6 } + 135° on even lines 4th field (odd) commencing on line 320 } − 135° on odd lines		
	SECAM III	Sub-carrier signal modulated in frequency and amplitude to correspond to a sawtooth colour-difference signal, D'_B or D'_R during six lines of each field-blanking period.		
		Deviation and amplitude } Correspond to maximum D'_B or D'_R Duration: active line period. Sequence, 1st field (even) { $-D'_B$ on lines 11, 13, 15 { $-D'_R$ on lines 10, 12, 14 2nd field (odd) { $-D'_B$ on lines 323, 325, 327 { $-D'_R$ on lines 324, 326, 328	Amplitude Deviation Duration Sequence } As Standard I	Amplitude Deviation Duration Sequence } As Standard I

Item	Characteristics	Standards [1] *I*	*G*	*L*
4 (*contd.*)		3rd field (even) – D'_B on lines 10, 12, 14 – D'_R on lines 11, 13, 15 4th field (odd) – D'_B on lines 324, 326, 328 – D'_R on lines 323, 325, 327		
	Duration of colour sub-carrier protection interval SECAM III	Starts 5·7 ± 0·3 μs after leading edge of line-synchronizing pulse.		
5	*Delay characteristic of the transmitted signal* NTSC PAL SECAM III	 Uniform to 4 MHz 0·08 μs at f_{sc} 0·27 μs at 5·5 MHz	 ? ? ?	 ? ? ?
6	*Luminance component* Attenuation/frequency characteristics NTSC, PAL, SECAM III	Uniform 0 to 5·5 MHz (notch filter at f_{sc} permissible)	Uniform 0 to 5·0 MHz	Uniform 0 to 6·0 MHz (notch filter at f_{sc} permissible)
7	*Scanning* Line-scanning frequency f_{line} NTSC	$15\,625\text{ Hz} = f_{sc} \times \frac{2}{567}$	$15\,625\text{ Hz} = f_{sc} \times \frac{2}{567}$	$15\,625\text{ Hz} = f_{sc} \times \frac{2}{567}$
	PAL	$15\,625\text{ Hz} = \frac{4 f_{sc} - 2 f_{field}}{1135}$	$15\,625\text{ Hz} = \frac{4 f_{sc} - 2 f_{field}}{1135}$	$15\,625\text{ Hz} = \frac{4 f_{sc} - 2 f_{field}}{1135}$
	SECAM III	$15\,625\text{ Hz} \approx \frac{f_{sc}}{284}$	$15\,625\text{ Hz} \approx \frac{f_{sc}}{284}$	$15\,625\text{ Hz} \approx \frac{f_{sc}}{284}$
	Gamma NTSC, PAL, SECAM III	Corresponds to display gamma of 2·2	Corresponds to display gamma of 2·2 (provisional)	Corresponds to display gamma of 2·2

Item	Characteristics	Standards (1)		
		I	*G*	*L*
8	*Synchronizing and blanking wave-forms*	Comply with Report 308-1: Characteristics of monochrome television systems		
9	*Equation of complete colour signal* NTSC	$E_M = E'_Y + \{E'_Q \sin(\omega t + 33°) + E'_I \cos(\omega t + 33°)\}$		
	E_M : total video voltage applied to modulator of transmitter	below 0·8 MHz	below 0·4 MHz	below 0·6 MHz
		$E_M = E'_Y + 0{\cdot}493\,(E'_B - E'_Y) \sin \omega t + 0{\cdot}877\,(E'_R - E'_Y) \cos \omega t$		
	E'_Y : voltage of the luminance component of the composite signal	where $E'_Q = 0{\cdot}41\,(E'_B - E'_Y) + 0{\cdot}48\,(E'_R - E'_Y)$		
	E'_R, E'_G and E'_B : gamma-corrected voltages corresponding to the red, green and blue signals	$E'_I = -\,0{\cdot}27\,(E'_B - E'_Y) + 0{\cdot}74\,(E'_R - E'_Y)$ $E'_Y = 0{\cdot}30\,E'_R + 0{\cdot}59\,E'_G + 0{\cdot}11\,E'_B$		
	$\omega = 2\pi f_{sc}$			
	Phase reference	Colour-burst phase + 180°	Colour-burst phase + 180°	Colour-burst phase + 180°
	C.I.E. primary colour chromaticities of picture tube for which E'_R, E'_G and E'_B (above) are suitable	Red ($x = 0{\cdot}67$, $y = 0{\cdot}33$) Green ($x = 0{\cdot}21$, $y = 0{\cdot}71$) Blue ($x = 0{\cdot}14$, $y = 0{\cdot}08$)	Red ($x = 0{\cdot}67$, $y = 0{\cdot}33$) Green ($x = 0{\cdot}21$, $y = 0{\cdot}71$) Blue ($x = 0{\cdot}14$, $y = 0{\cdot}08$)	Red ($x = 0{\cdot}67$, $y = 0{\cdot}33$) Green ($x = 0{\cdot}21$, $y = 0{\cdot}71$) Blue ($x = 0{\cdot}14$, $y = 0{\cdot}08$)
	C.I.E. white	Illuminant C ($x = 0{\cdot}310$, $y = 0{\cdot}316$)	Illuminant C ($x = 0{\cdot}310$, $y = 0{\cdot}316$)	Illuminant C ($x = 0{\cdot}310$, $y = 0{\cdot}316$)
	Equivalent bandwidths of colour-difference signals before modulation			
	E'_Q	at 800 kHz < 2 dB down at 1.0 MHz < 6 dB down at 1.2 MHz < 6 dB down	at 400 kHz < 2 dB down at 500 kHz < 6 dB down at 600 kHz < 6 dB down	
	E'_I	at 1.6 MHz < 2 dB down at 4·0 MHz < 20 dB down	at 1.3 MHz < 2 dB down above 3·6 MHz < 20 dB down	
	Maximum transmission time difference of E'_Y, E'_Q and E'_I	± 40 ns	± 50 ns	± 50 ns

Item	Characteristics	Standards (1)		
		I	*G*	*L*
9 (*contd.*)	PAL (E_M, E'_Y, E'_R, E'_G, E'_B and ω have the same significance as in the NTSC system)	$E_M = E'_Y + E'_U \sin \omega t + E'_V \cos (\omega t \pm \pi/2)$ where $E'_U = 0{\cdot}493\,(E'_B - E'_Y)$ and $E'_V = 0{\cdot}877\,(E'_R - E'_Y)$ The argument of the cosine is $\omega t + \pi/2$ during the odd lines of the 1st and 2nd fields and during the even lines of the 3rd and 4th fields. It is $\omega t - \pi/2$ during the even lines of the 1st and 2nd fields and during the odd lines of the 3rd and 4th fields, as under Item 4 (Colour synchronization). N.B. — The colour-difference signals (E'_U) and (E'_V) may be formed by matrixing E'_Y, E'_I and E'_Q video signals having the bandwidths specified for the NTSC system and the appropriate standard *I*, *G* or *L*. The bandwidth of either of the colour-difference signals E'_U and E'_V respectively will therefore not exceed the bandwidth of the appropriate E'_I signal. $E'_U = -\,0{\cdot}545\,E'_I + 0{\cdot}839\,E'_Q$ $E'_V = 0{\cdot}839\,E'_I + 0{\cdot}545\,E_Q$		
	Phase reference	E'_U axis		
	SECAM III (The significance of E_M, E'_Y, E'_R and E'_B is as described for NTSC)	In large areas of colour $E_M = E'_Y + A \cos (\omega_{sc} + E'_c\,\Delta\omega_{sc})\,t$ where E'_c is a colour-difference signal D'_R or D'_B, and $\Delta\omega_{sc}/2\pi$ is the frequency deviation corresponding to unit amplitude of the pre-emphasized colour-difference signal; $D'_R = -\,1{\cdot}9\,(E'_R - E'_Y)$ and $D'_B = 1{\cdot}5\,(E'_B - E'_Y)$ A is a function of $E'_c\,\Delta\omega_{sc}$ and determines the amplitude of the chrominance signal. In the absence of colour, for $E'_{Y\,max.} = 1{\cdot}0$, this function has the following values:		
		$A = 0{\cdot}1$	$A = 0{\cdot}115$	$A = 0{\cdot}1$
	The equivalent bandwidths of the colour-difference signals before pre-emphasis and modulation D'_B D'_R	at 1·0 MHz < 2 dB down at 1·5 MHz > 5 dB down at 2·0 MHz < 20 dB down	1·4 MHz	1·4 MHz
	Transmission-time difference of E'_Y, D'_R and D'_B	± 40 ns	?	± 50 ns

The following characteristics apply to the SECAM III system only.

Item	Characteristics	Standards (1) I	G	L
10	*Colour sub-carrier modulating signal*	Alternately, the colour-difference signal D'_R or the corresponding signal D'_B, as in Item 4 (Colour synchronization).		
	Pre-emphasis of signals D'_R and D'_B before modulation	Time constant = 1·12 μs (+ 14 dB at 1 MHz)	Time constant = 1·12 μs (+ 14 dB at 1 MHz)	Time constant = 1·12 μs (+ 14 dB at 1 MHz)
	Frequency-modulation of colour carrier	Δf_{sc} = 230 kHz per unit amplitude of D'_R and D'_B after pre-emphasis	Δf_{sc} = 230 kHz per unit amplitude of D'_R and D'_B after pre-emphasis	Δf_{sc} = 230 kHz per unit amplitude of D'_R and D'_B after pre-emphasis
	Maximum sub-carrier deviation	$\Delta f_{sc} \pm 500 \pm 50$ kHz	$\Delta f_{sc} \pm 500 \pm 50$ kHz	$\Delta f_{sc} \pm 500 \pm 50$ kHz
11	*Supplementary amplitude-modulations of the chrominance sub-carrier*			
	Radio-frequency pre-emphasis of the chrominance sub-carrier	0 dB at f_{sc} 5 to 6·2 dB at $f_{sc}\pm$230 kHz 10·8 to 11·6 dB at $f_{sc}\pm$500 kHz	0 dB at f_{sc} 5 to 6·2 dB at $f_{sc}\pm$230 kHz 10·8 to 11·6 dB at $f_{sc}\pm$500 kHz	0 dB at f_{sc} 5 to 6·2 dB at $f_{sc}\pm$230 kHz 10·8 to 11·6 dB at $f_{sc}\pm$500 kHz
	Cross-colour corrective modulation of the sub-carrier for luminance signal components near sub-carrier frequency	6 dB for $E'_Y = 1{\cdot}0$ 0 dB for $E'_Y < 0{\cdot}2$	3·5 to 6 dB for $E'_Y = 1{\cdot}0$ 0 dB for $E'_Y < 0{\cdot}5$	3·5 to 6 dB for $E'_Y = 1{\cdot}0$ o dB for $E'_Y < 0{\cdot}5$
		(The value of E'_Y corresponding to white = 1·0)		
	Equalization of chrominance sub-carrier amplitude on successive lines	Permissible	Permissible	Permissible
12	*The phase of the chrominance sub-carrier during the protection interval*	Either 0° or 180° with respect to a reference oscillator f_R (see § 2)	Either 0° or 180° with respect to a reference oscillator f_{sc} (see § 2)	Either 0° or 180° with respect to a reference oscillator f_{sc} (see § 2)
	Polarity of the chrominance sub-carrier	When phase, as defined above, is 0°, the polarity is *positive*, when 180°, the polarity is *negative*.	When phase, as defined above, is 0°, the polarity is *positive*, when 180°, the polarity is *negative*.	When phase, as defined above, is 0°, the polarity is *positive*, when 180°, the polarity is *negative*.
	Polarity of the composite signal	Reversed during every third line and additionally during every alternate field.	Reversed during every third line and additionally during every alternate field.	Reversed during every third line and additionally during every alternate field.

C. — SPECIFICATIONS OF THE SECAM III COLOUR TELEVISION SYSTEM *

1. General specification

Luminance component:
Amplitude-modulation of the picture carrier by the signal

$$E'_Y = 0{\cdot}30\, E'_R + 0{\cdot}59\, E'_G + 0{\cdot}11\, E'_B,$$

where E'_R, E'_G and E'_B are the voltages of the gamma-corrected primary signals, assumed to be variable in relative value between 0 and from black to white.

Chrominance component:

Two signals transmitted line-sequentially by frequency-modulation of the sub-carrier

a — D'_R (see § 9)

b — D'_B (see § 9)

Display gamma equal to 2·2.

2. Colour sub-carrier (frequency corresponding to the absence of chrominance components)

While line is used for D'_R: $f_{scR} = 4{\cdot}4375$ MHz, or 284 f_h

While line is used for D'_B: $f_{scB} = 4{\cdot}4375$ MHz or 284 f_h

Tolerances: ± 2 kHz

3. Frequency spectrum of the composite picture signal and of the sound signal

Spectrum organization: in accordance with standards *L, K, I, G*.

Approximate band of the modulated colour-signal spectrum:

from 3 MHz to 5·8 MHz (standards *L* and *K*)

5·5 MHz (standards *I*)

5·0 MHz (standards *G*)

4. Waveform of the transmitted picture-signal

During a few lines of each field-blanking period, the line carries the sub-carrier signal in a modulation characterizing in alternate lines the two signals transmitted sequentially.

Colour synchronization:

Trapezoidal modulation *on 6 lines* during each field return: Lines 10 to 15 and 323 to 328. Modulated sequentially (frequency);

4.1 by D'_R varying linearly over the duration of the line from 0 to + 2·7 with amplitude limitation at 2·2;

4.2 by D'_B varying linearly over the duration of the line from 0 to − 2·7 with amplitude limitation at 1·9;

* This specification is reproduced from Doc. XI/164 (France and U.S.S.R.), 1963-1966.

4.3 for the first even field and the second odd field:

D'_R on the even lines,

D'_B on the odd lines;

4.4 for the third even field and the fourth odd field:

D'_R on the odd lines,

D'_B on the even lines.

Chrominance sub-carrier on the line-blanking interval:

The sub-carrier begins $5 \cdot 7 \pm 0 \cdot 3$ μs after the leading edge of the synchronization signal.

5. Delay characteristics of the transmitted signal

Not specified.

6. Luminance component

Uniform from 0 to 6 MHz (standards L and K)
Uniform from 0 to 5·5 MHz (standards I)
Uniform from 0 to 5 MHz (standards G)

7. Scanning

Line frequency f_h: 15 625 Hz
Field frequency f_v: 50 Hz.

8. Synchronizing and blanking wave-forms

In accordance with standards L, K, I and G, as defined in Report 308-1: Characteristics of monochrome television systems.

9. Equation of complete colour signal

E_M — Total video voltage applied to modulator of transmitter:

In large colour areas

$$E_M = E'_y + A \cos (\omega_{sc} + E'_C \, \Delta \, \omega_{sc})t$$

with:

— for modulation by the colour-difference signal D'_R

$$E'_C = D'_R = -\, 1 \cdot 9 \, (E'_R - E'_Y)$$

and $\omega_{sc} = 2\pi \, f_{scR}$

— for modulation by the colour-difference signal D'_B

$$E'_C = D'_B = 1 \cdot 5 \, (E'_B - E'_Y)$$

and $\omega_{sc} = 2\pi \, f_{scB}$

— the frequency deviation $E = \dfrac{\Delta \, \omega_{sc}}{2\pi}$

(Δf) corresponding to unit amplitude of the pre-emphasized colour-difference signal

— A is a function of $E'_C \Delta\omega_{sc}$ which determines the amplitude of the chrominance signal (see § 11).

Video pre-correction of the chrominance signals:
relative gain function,

$$g_{vf} = \frac{1 + jf/f_1}{1 + jf/Kf_1};$$

asymptotic gain: $K = 5{\cdot}6$;
characteristic frequency: $f_1 = 70$ kHz;
bandwidth of chrominance signals before modulation,
about 1·4 MHz at −3 dB after pre-emphasis.

10. Modulated colour sub-carrier

Peak-to-peak amplitude of the colour sub-carrier:

for 700 mV amplitude of the black-to-white luminance signal,

for f_{scR}: $2\,A_R = 140$ mV (see § 2),

for f_{scB}: $2\,A_B = 140$ mV (see § 2).

In the G standards, the value $2\,A_R = 2\,A_B = 160$ mV is used.

Frequency modulation:

nominal deviation: Δf (see § 9),

230 kHz for modulation by $D'_R = \pm\,1$,

230 kHz for modulation by $D'_B = \pm\,1$,

where one amplitude of the black-to-white signal is taken as unity.

Limitation of frequency deviation,

$$\Delta f_{max} = \begin{matrix} +\ 350\ \text{kHz} \\ -\ 450\ \text{kHz} \end{matrix}$$

11. Supplementary amplitude-modulation of the colour sub-carrier

Sub-carrier pre-emphasis:
relative gain function,

$$g_{rf} = \frac{1 + j\,16\,F}{1 + j\,1{\cdot}26\,F}$$

with $F = \dfrac{f}{f_0} - \dfrac{f_0}{f}$;

band at 3 dB: 240 kHz;
asymptote: 14 dB;
central frequency of the pre-emphasis curve,
$f_0 = 4{\cdot}4375$ MHz.

Cross-colour corrective modulation for a peak-to-peak amplitude $(E'_y)_{ch}$ of the luminance components in the filtered chrominance band:

gain 0 dB for $(E'_y)_{ch} \leqslant 0{\cdot}2$,

6 dB for $(E'_y)_{ch} = 0{\cdot}4$.

12. Phase of the colour sub-carrier

Unmodulated carrier: 0° or 180° with respect to a reference oscillator.

Polarity of the colour sub-carrier: positive when the phase below is 0°.

Polarity of the line signal: reversed during every third line and additionally during every alternate field.

13. Optimalization of certain parameters

To exploit to the full the possibilities offered by the SECAM III system, the optimalization of certain parameters has been studied, on the assumption that it will be used with the various European standards *L, K, I, G.*

This offers, in particular, improved protection against noise and against any attenuation of the upper sideband of the chrominance signal.

The optimalized values are indicated below, with reference to the preceding sections.

13.1 *Frequencies corresponding to the absence of chrominance components* (see § 2)

$f_{scR} = 4{\cdot}40625$ MHz or $282\,f_h$

$f_{scB} = 4{\cdot}25000$ MHz or $272\,f_h$

same tolerance.

13.2 *Colour synchronization* (see § 4)

Trapezoidal modulation on *9 lines* during each field return: lines 7 to 15 and 320 to 328.

Sequential frequency-modulation:

§ 4.1 by D'_R varying linearly from the beginning of the line for 10 to 20 μs, followed by an interval at

$D'_R = 1{\cdot}25 \pm 0{\cdot}13$;

§ 4.2 by D'_B varying linearly from the beginning of the line for 15 to 30 μs, followed by an interval at

$D'_B = -\,1{\cdot}50 \pm 0{\cdot}17$;

§§ 4.3, 4.4: no change.

13.3 *Video pre-correction of chrominance signals* (see § 9)

$K = 3$,

$f_1 = 85$ kHz.

13.4 *Peak-to-peak amplitude of the chrominance sub-carrier* (see § 10)

For the minimum of the radio-frequency pre-emphasis curve
(on f_o — see § 11): 160 mV;

whence it may be deduced that:

— for f_{scR}: $2\,A_R = 206$ mV;

— for f_{scB}: $2\,A_B = 166$ mV.

Frequency modulation:

Nominal deviation Δf,

280 kHz for modulation by $D'_R = \pm 1$;

230 kHz for modulation by $D'_B = \pm 1$.

Limitation of the frequency deviation:

for D'_R

$$\Delta f_{max} \begin{cases} + 350 \pm 35 \text{ kHz} \\ - 500 \pm 50 \text{ kHz;} \end{cases}$$

for D'_B

$$\Delta f_{max} \begin{cases} + 500 \pm 50 \text{ kHz} \\ - 350 \pm 35 \text{ kHz.} \end{cases}$$

13.5 *Central frequency of the pre-emphasis curve* (see § 11)

$f_o = 4 \cdot 28600$ MHz.

D. — SPECIFICATIONS OF THE PAL SYSTEM *

(June 1966)

The specifications of the PAL colour television system for Television Standards *B, I, G* and *L* were first given by the E.B.U. in Doc. 7 of the London meeting of Study Group XI Colour Sub-Group, February, 1964.

A revised specification is given in Doc. XI/33, 1963-1966. Amendments to Doc. XI/33, 1963-1966 are to be found in Doc. XI/153, 1963-1966. There have been submitted to the E.B.U. *ad hoc* Group on Colour Television, a few further minor amendments to the PAL specification and the present document incorporates all amendments to date.

* These specifications are reproduced from Doc. XI/174, 1963-1966.

SPECIFICATIONS OF THE PAL SYSTEM : JUNE 1966

Item	Characteristics	Standards (1)		
		I	G	L
1	*General specification* Luminance component Chrominance component	Amplitude-modulation of the picture carrier Simultaneous pair of components transmitted as amplitude-modulated sidebands of a pair of suppressed sub-carriers in quadrature having a common frequency		
2	*Colour sub-carrier* f_{sc}	$f_{sc} = 4{\cdot}43361875$ MHz $\pm$ 1 Hz		
3	*Frequency spectrum of composite colour vision and sound signals* Vision-to-sound spacing Main sideband Vestigial sideband Chrominance sideband E'_U signal E'_V signal	6 MHz 5·5 MHz 1·25 MHz $f_{sc} \begin{cases} +1{\cdot}07 \text{ MHz max.} \\ -1{\cdot}6 \text{ MHz max.} \end{cases}$	5·5 MHz 5·0 MHz 0·75 MHz $f_{sc} \begin{cases} +0{\cdot}57 \text{ MHz max.} \\ -1{\cdot}3 \text{ MHz max.} \end{cases}$	6·5 MHz 6 MHz 1·25 MHz $f_{sc} \pm 1{\cdot}57$ MHz max.
4	*Transmitted colour video signal waveform* Colour synchronization	Complies with Report 308-1: Characteristics of monochrome television systems, with the following modifications: Sub-carrier burst: Duration: 10 $\pm$ 1 c Start: 5·5 $\pm$ 0·2 μs after the leading edge of line-synchronizing pulses Ampl.: 0·5 $\pm$ 0·1 of line-synchronizing amplitude Omitted during field-blanking periods for 9 lines Phase sequence: (see § 9, Phase reference) 1st field (even) commencing on line 7 } + 135° on odd lines 2nd field (odd) commencing on line 319 } − 135° on even lines 3rd field (even) commencing on line 6 } + 135° on even lines 4th field (odd) commencing on line 320 } − 135° on odd lines		
5	*Delay characteristic of the transmitted signal*	Uniform to 4 MHz 0·08 μs at f_{sc} 0·27 μs at 5·5 MHz	? ? ?	? ? ?
6	*Luminance component* Attenuation/frequency characteristic	Uniform 0 to 5·5 MHz (notch filter at f_{sc} permissible)	Uniform 0 to 5·0 MHz	Uniform 0 to 6·0 MHz (notch filter at f_{sc} permissible)
7	*Scanning* Line-scanning frequency f_{line}	$15\,625 \text{ Hz} = \dfrac{4 f_{sc} - 2 f_{field}}{1135}$		

(1) The monochrome systems whose characteristics are given in Table I of Report 308-1.

Item	Characteristics	Standards (1)		
		I	*G*	*L*
8	*Synchronizing and blanking waveforms*	Comply with Report 308-1: Characteristics of monochrome television systems.		
9	*Equation of colour picture signal* E_M = total video picture signal voltage applied to modulator of transmitter	$E_M = E'_Y + E'_U \sin \omega t \pm E'_V \cos \omega t$ where $E'_Y = 0{\cdot}30\, E'_R + 0{\cdot}59\, E'_G + 0{\cdot}11\, E'_B$ $E'_U = 0{\cdot}493\, (E'_B - E'_Y)$ $E'_V = 0{\cdot}877\, (E'_R - E'_Y)$		
	E'_Y = Voltage of luminance component of composite signal E'_R, E'_G and E'_B = gamma-corrected voltages corresponding to the red, green and blue signals. The gamma corresponds to a display gamma of 2·2 for Standards *I* and *L* and provisionally for Standard *G* $\omega = 2\,\pi f_{sc}$	The polarity of $E'_V \cos \omega t$ is positive during odd lines of the first and second fields and during even lines of the third and fourth fields as in § 4 (colour synchronization) *N.B.* — The colour-difference signals E'_U and E'_V may be formed by matrixing E'_I and E'_Q video signals having the bandwidths specified in § 10 for the NTSC system and the appropriate Standard *I*, *G* or *L*. The bandwidth of either of the colour-difference signals E'_U and E'_V, respectively, will therefore not exceed the bandwidth of the appropriate E'_I signal. $E'_U = -\,0{\cdot}545\, E'_I + 0{\cdot}839\, E'_Q$ $E'_V = 0{\cdot}839\, E'_I + 0{\cdot}545\, E'_Q$ $E'_I = -\,0{\cdot}27\, (E'_B - E'_Y) + 0{\cdot}74\, (E'_R - E'_Y)$ $E'_Q = 0{\cdot}41\, (E'_B - E'_Y) + 0{\cdot}48\, (E'_R - E'_Y)$		
	Phase reference	E'_U axis		
	Maximum transmission time difference between E'_Y, E'_U and E'_V	± 40 ns	± 50 ns	± 50 ns
	C.I.E. primary colour chromaticities of picture tube for which E'_R, E'_G and E'_B (above) are suitable	Red ($x = 0{\cdot}67$, $y = 0{\cdot}33$) Green ($x = 0{\cdot}21$, $y = 0{\cdot}71$) Blue ($x = 0{\cdot}14$, $y = 0{\cdot}08$)		
	C.I.E. White	Illuminant *C* ($x = 0{\cdot}310$, $y = 0{\cdot}316$)		
10	*Equivalent bandwidths of colour-difference signals before modulation*			
	E'_Q	at 800 kHz < 2 dB down at 1·0 MHz < 6 dB down at 1·2 MHz > 6 dB down	at 400 kHz < 2 dB down at 500 kHz < 6 dB down at 600 kHz > 6 dB down	—
	E'_I	at 1·6 MHz < 2 dB down at 4·0 MHz > 20 dB down	at 1·3 MHz < 2 dB down above 3·6 MHz > 20 dB down	

E. — SPECIFICATION OF THE SECAM IV COLOUR TELEVISION SYSTEM *

In view of Doc. XI/162, submitted by Belgium with reference to the NIIR—SECAM IV colour television system, the Delegations of France and the U.S.S.R. consider it necessary to publish on behalf of their respective Administrations the documents annexed hereto which describe the said SECAM IV system that has been jointly developed and tested by French and Soviet experts.

Both Delegations consider that the annexed documents constitute the only source of information capable of giving a precise idea of this version of the SECAM system.

Both Delegations wish to point out that the SECAM III version is better prepared for industrial production than the SECAM IV variant, that successful international demonstrations have been made of it in transmissions by radio-relay and via the Soviet satellite Molniya I, whereas the SECAM IV version—although also at a high technical level—has no decisive advantage over SECAM III and is still being developed. France and the U.S.S.R. therefore prefer the SECAM III version.

CHIEF TECHNICAL CHARACTERISTICS

1. Signals transmitted

SECAM IV is compatible with standard black-and-white 625-line television systems. The luminance signal is obtained from gamma-corrected primary signals E'_R, E'_G, E'_B, and corresponds to the equation:

$$E'_Y = 0{\cdot}30\, E'_R + 0{\cdot}59\, E'_G + 0{\cdot}11\, E'_B$$

The colour information is transmitted by two colour-difference signals:

$$D'_R = \frac{1}{1{\cdot}14}\,(E'_R - E'_Y)$$

$$D'_B = \frac{1}{2{\cdot}03}\,(E'_B - E'_Y)$$

Before modulation, the frequency band of the colour-difference signals occupies more than 1·5 MHz.

2. Transmission procedure

The colour-difference signals are transmitted by modulation of a sub-carrier. They are differentiated from one line to the next as follows:

Signal transmitted during one of the lines

$$E_{S1} = \left(\sqrt{D'^2_R + D'^2_B} + E_p \cos\,(\omega_o t + \varphi\,(t)\right)$$

Signal transmitted during the following line

$$E_{S2} = \left(\sqrt{D'^2_R + D'^2_B} + E_p \cos\,(\omega_o\, t + \varphi_o)\right)$$

where E_p is a d.c. voltage equal to 10% of the maximum signal

$$\sqrt{D'^2_R + D'^2_B}$$

and where

$$\varphi\,(t) = \text{arc tan}\; D'_B/D'_R$$

* This specification is reproduced from Doc. XI/169 (France and U.S.S.R.), 1963-1966.

3. Frequency of the colour sub-carrier

The frequency of the colour sub-carrier is equal to: $f_0 = 4.43361875$ MHz. It is related to the line sweep frequency $f_{line} = 15.625$ Hz by the following equation:

$f_0 = (284 - 1/4) f_{line} + 25$ Hz.

4. Colour synchronization signal

The receiver switch is synchronized by synchronization signals transmitted with the composite video signal. They represent six wave trains of the colour sub-carrier, each train lasting about 40 μs. They are transmitted during the field returns in the 6th–11th lines of the first field and in the 319th–324th lines of the second field. During the even lines, the sub-carrier phase in the train is $\varphi = 90°$, and during all the odd lines $\varphi = 180°$. The amplitude of each wave train is equal to 30% of the composite signal E'_Y measured between the white and black levels.

5. Reception procedure

The colour-difference signals D'_R and D'_B are obtained by multiplication of the transmitted signals E_{2n+1} and E_{2n}, each signal being delayed in turn by the duration of one line. The level of the signal E_{2n} must be 10 to 20 times higher than that of the signal E_{2n+1}.

To obtain the correct polarity for the signals E'_{R-Y} and E'_{B-Y} at each line, a switch working to the line periodicity is used.

ANNEX

REPORT BY SUB-GROUP XI-A-2

Sub-Group XI-A-2 met on 7 and 8 July, under the chairmanship of Mr. E. Esping and with the participation of the following delegations: U.S.A., France, Italy, Netherlands, Fed. Rep. of Germany, United Kingdom, Switzerland, Czechoslovak Socialist Republic, U.S.S.R. and Federal Socialist Republic of Yugoslavia.

1. The Sub-Group considered first whether a compromise could be reached on recommending a single world-wide colour television system. The conclusion was quickly reached that this was impossible in view of the fact that the system already in public service in countries using the 525-line standard was not generally acceptable elsewhere. The U.S.A. suggested that for international programme exchange, colour television signals could be relayed on 625 lines either in NTSC or PAL form, according to the wishes of the receiving country. Alternatively, the Sub-Group suggested that world-wide adoption of the ART (Additional Reference carrier Transmission) system for broadcasting would in its view offer the advantage of permitting the use of existing NTSC receivers on the ART transmission. In the view of the delegation of the U.S.A. this system would also appear to offer the same advantages as SECAM or PAL. These two proposals received no support.

2. Attention was therefore turned to the possibility of agreeing on a single system of 625-line colour television for use in countries which have adopted this line standard, and to begin with in the area in which several countries have announced their intention of starting regular colour television services towards the end of 1967.

3. During the discussions, Doc. XI/179 (Denmark) was referred to by the U.K. delegate. In this document is proposed a compromise system. The delegate specially referred to § 8 in the document: “ The Danish delegation suggests that a questionnaire be addressed to those

members of the Study Group operating or contemplating the introduction of 625-line colour television, asking whether they would be prepared to support this system if all other such delegations were prepared to do the same."

To find out if unanimous agreement on this suggestion would be possible, the Chairman consulted the members of the Sub-Group. The result of this consultation was that no agreement could be reached.

4. Noting that the SECAM IV system has been the only system proposed, even by certain supporters of PAL, as being capable of constituting a possible compromise leading to the adoption of a single European colour television standard, the French delegation—speaking on behalf of the other delegations present who have already accepted SECAM III—declared itself ready to abandon SECAM III and to adopt SECAM IV.

Such a decision would necessarily imply a delay (which could be reckoned at about six months), in the introduction of a regular colour television system in countries of the European area which have decided to introduce such a system in autumn 1967. All the countries interested in the introduction of a colour television system in Europe should put this period to good use by pooling the necessary resources to perfect the final version of SECAM IV.

Since the possible adoption of SECAM IV by France and its partners represents the extreme limit of what these countries are prepared to sacrifice in this respect, it goes without saying that all the countries interested in starting a regular colour television system in autumn 1967 will have to participate, within the full measure of their resources, in this research and development work during the period of six months or more in which the final version of SECAM IV is perfected. It is also understood that they will accordingly refrain from any measures which, particularly as regards the manufacture of receivers, might run counter —directly or indirectly—to the common work which they would have defined.

Moreover, in view of the imperative need to avoid any useless delay, it should be clearly understood that agreement to the above-mentioned principles should be given as soon as possible, and in any case early enough before the end of the present Plenary Assembly of the C.C.I.R.

Having heard the replies of the delegations of the United Kingdom and of the Federal Republic of Germany (given below), the French delegation, noting that these two delegations did not accept its proposal which was supported by the delegations of the Czechoslovak Socialist Republic, the U.S.S.R. and the Federal Socialist Republic of Yugoslavia, declared that it was obliged to withdraw it.

Statement of the delegations of the Federal Republic of Germany and of the United Kingdom

The delegations of the Federal Republic of Germany and of the United Kingdom said that, quite apart from the fact that the system SECAM IV, unlike PAL, is not yet ready for commercial exploitation, the proposal advanced by the French delegation raised other difficulties. The questions (*a*) of setting back the dates by which colour television services would be introduced, involving modification of the decisions of governments, and (*b*) of agreeing to abstain from all industrial development incompatible with the joint development of SECAM IV (see the text of the French proposal), were quite outside the competence of the C.C.I.R.

It would therefore be clearly impossible to obtain decisions on these matters by the time limit set by the French proposal. Nevertheless, it was desired to have a more precise definition of the proposals for the consideration of Administrations and governments.

In any case the delegations of the Federal Republic of Germany and the United Kingdom would be happy to continue the joint study of SECAM IV.

REPORT 408 *

ATTENUATED-SIDEBAND CHARACTERISTICS FOR VESTIGIAL-SIDEBAND TRANSMISSION OF TELEVISION SIGNALS

(Question 8/XI, Study Programme 8B/XI and 8A/XI)

(1966)

1. Study Programme 8B/XI relates to the possibility of relaxation of the attenuation characteristic of the vestigial sideband of low-power television transmitters. In order that interference from the upper adjacent channel shall not exceed limits laid down in Recommendations 417-1 and 418-1, it is possible either to adopt a vestigial-sideband characteristic in the interfering transmission that restricts adequately the radiation of unwanted energy or to reduce the power of the interfering transmission or, further, to increase the distance that separates the interfering transmitter from the station whose service is to be protected. For example, the use of double-sideband transmission would not cause interference greater than that permitted by C.C.I.R. Recommendations, if the effective radiated power were 20 dB (Recommendation 212, § 9) below the permitted maxima given in Recommendations 417-1 and 418-1.

In view of the above remarks, it would seem that for low-power television transmitters a double-sideband characteristic may be permitted, provided that the geographical distance between the interfering station and the point in the service area of the protected transmission nearest to it is sufficient to ensure that Recommendations 417-1 and 418-1 are complied with. The effective radiated power of the interfering upper adjacent channel transmission must, of course, be small enough for the above conditions to be fulfilled in a practical case.

A modification to Recommendation 212 would seem to be indicated.

2. Study Programme 8A/XI relates to the possibility of relaxation of the attenuation characteristic of the vestigial sideband for monochrome and colour transmissions in bands IV and V.

If, for frequency planning purposes, in bands IV and V, the worst case of interference from an upper adjacent channel television transmission to an adjacent television transmission would be that occurring when the wanted and unwanted field strengths are equal, and receiving antenna directivity be taken into account, it can be shown that at the receiver input terminals the wanted signal strength would exceed the unwanted signal strength by 16 dB. In these conditions, the degree of attenuation of the vestigial (lower) sideband of the interfering transmission can be less than that given in Recommendation 212, § 9. Tests on Standard I using domestic receivers have confirmed this conclusion.

Taking into account the statistical spread of the values of received field strength from a number of transmissions emanating from a single station-site, it is proposed that for 625-line Standards *G*, *H*, *I*, *K*, *L* used in bands IV and V, the unwanted sideband should be so attenuated that the radiated field strength is reduced by at least 20 dB and 30 dB at 3 MHz and 4·4 MHz respectively below the frequency of the vision carrier. Administrations concerned are invited to study this problem.

It should be noted that to reduce interference to services other than television, it may be necessary to limit more severely the unwanted sideband energy from television transmissions occurring at the limits of television bands, for example, channels 21 and 39. Attenuations

* This Report was adopted unanimously.

considerably greater than those mentioned above may be needed in such cases. The actual attenuations required would, of course, depend upon the proximity of the services other than television that must be protected.

BIBLIOGRAPHY

1. C.C.I.R. Doc. XI/17 (United Kingdom), 1963-1966.
2. C.C.I.R. Doc. XI/144 (Canada), 1963-1966.

REPORT 409 *

BOUNDARIES OF THE TELEVISION SERVICE AREA IN RURAL DISTRICTS HAVING A LOW POPULATION DENSITY

(Recommendation 417-1)

(1966)

Where television services are to be provided for a sparsely populated region, in which better receivers and antenna installations are likely to be employed than those considered in Recommendation 417-1, Administrations may find it desirable to establish the appropriate median field strength for which protection against interference is planned as low as:

Band	I	III
dB rel. 1 μV/m	+46	+49

These values refer to the field strength at a height of 10 m above ground level.

In such areas, without co-channel interference, it is generally observed that the public begin to lose interest in installing television reception equipment when, in the case of band III transmissions the median field strength falls below + 40 dB relative to 1 μV/m at 10 m above ground level.

The values given in this Report have been obtained from field party investigations of the service area limits and picture quality in rural districts of Australia (Doc. XI/168, 1963-1966).

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* This Report was adopted unanimously.

REPORT 316-1 *

REQUIREMENTS FOR THE TRANSMISSION OF TELEVISION SIGNALS OVER LONG DISTANCES

(Question 1/CMTT)

(1963—1966)

Introduction

The joint C.C.I.R./C.C.I.T.T. Committee for Television Transmission (CMTT), 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.

With this in view, the CMTT has examined Recommendation 421-1, 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.

Note. — The material of this Report has been taken into account in formulating Recommendation 421-1.

1. Definitions

1.1 *Definition of a long-distance international television connection*

As in Recommendation 421-1.

1.2 *Definition of the hypothetical reference circuit*

As in Recommendation 421-1.

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 421-1.

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 421-1.

3.2 *Insertion gain variations*

As in Recommendation 421-1.

3.3 *Noise*

3.3.1 *Continuous random noise*

A new text is required. Three methods may be used to specify the circuit performance:

* This Report was adopted unanimously.

— 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. CMTT/21, Paris, 1962).

3.3.2 *Periodic noise*

The existing text (Recommendation 421-1) 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 4/XI.

3.3.3 *Impulsive noise*

As in Recommendation 421-1.

3.3.4 *Crosstalk*

This matter is still under study.

3.4 *Non-linearity distortion*

3.4.1 *Field-time non-linearity distortion*

As in Recommendation 421-1.

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 421-1) 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 Docs. CMTT/5 and CMTT/6, Paris, 1962).

— A staircase signal with a superimposed sine-wave at the frequency of the colour sub-carrier (see Doc. CMTT/21, 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. CMTT/12, 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 $\pm 2°$ respectively are accepted for NTSC signal transmission over the hypothetical reference circuit. The adequacy of these tolerances has been confirmed by subjective tests carried out in the U.S.A. and described in Doc. CMTT/56, 1963-1966. Differential gain and phase measurements, on many long-distance circuits under normal working conditions, have been made in the U.S.A. over a long period, and are detailed in Doc. CMTT/34, 1963-1966.

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 0·27 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*

As in Recommendation 421-1.

3.5.2 *Line-time waveform distortion*

As in Recommendation 421-1.

3.5.3 *Short-time waveform distortion*

The existing text (Recommendation 421-1) must be modified. It must take account of the short-time waveform distortion for the modulated sub-carrier. Doc. CMTT/21, Paris, 1962 and Doc. CMTT/32, 1963-1966, offer methods for determining this characteristic. Further studies are required.

3.6 *Steady-state 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 Docs. CMTT/5 and CMTT/6, Paris, 1962 and Doc. CMTT/32, 1963-1966);

— 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. CMTT/2, Paris, 1962.

The tolerances for amplitude/frequency and envelope-delay/frequency characteristics will be more stringent than those accepted for monochrome signals in Recommendation 421-1.

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 ($\pm$ 0·5 MHz) of the colour sub-carrier.

REPORT 410 *

SINGLE VALUE OF THE SIGNAL-TO-NOISE RATIO FOR ALL TELEVISION SYSTEMS

(Question 1/CMTT)

(1966)

Recommendation 421-1 contains design objectives for the signal-to-weighted-noise ratio, for continuous random noise. Several values are given for the different monochrome television systems, and various weighting characteristics are recommended. Several methods of measurement of the r.m.s. amplitude of noise are also mentioned in Recommendation 421-1. Doc. CMTT/18 (XI/62) (U.S.S.R.), 1963-1966, presents a further method of video noise measurement.

While the above design objectives, weighting characteristics and methods of measurement are proving useful, it is thought that the international exchange of television programmes would be

* This Report was adopted unanimously.

facilitated if differences among these items on video noise were minimized. Further study of this matter is required with a view to achieving unified treatment in terms of video noise-weighting characteristics, signal-to-noise ratio requirements and measuring methods.

Docs. CMTT/5 (Canada) and CMTT/15 (U.S.A.), 1963-1966, point out a possible step towards reaching such a goal, namely, standardization of test conditions and parameters for the determination of the weighting characteristic. The conditions and parameters relating to the assessment of the quality of impaired television pictures under laboratory conditions enumerated in Report 405, are areas where standardization is important in connection with the experimental determination of weighting characteristics. The spectral content of the noise source employed in such determinations would appear to be another area where standardization is important, keeping in mind that noise spectra of specific shapes are encountered in practical television circuits.

Doc. CMTT/55 (U.S.A.), 1963-1966, gives examples of spectral characteristics of noise found in television links and utilizes this information in the evaluation of the usefulness to colour television of existing monochrome weighting characteristics.

Finally, a method for normalizing the presentation of the weighting characteristics in the different television systems would also be very helpful.

Administrations are invited to consider these problems, with a view to reaching agreement on a Recommendation at the XIIth Plenary Assembly.

Bibliography

1. C.C.I.R. Doc. CMTT/5 (Canada), 1963-1966. Single value of the signal-to-noise ratio for different television systems.
2. C.C.I.R. Doc. CMTT/15 (U.S.A.), 1963-1966. Single value of the signal-to-noise ratio for different television systems.
3. C.C.I.R. Doc. CMTT/18 (XI/62), (U.S.S.R.), 1963-1966. Measurement of signal-to-r.m.s. noise ratio by means of an oscillograph.
4. Krivosheev, M. I. Fundamentals of television measurements (in Russian). Moscow, *Sviaz* (1964).
5. C.C.I.R. Doc. CMTT/124 (Japan), Geneva, 1963. Comparison of the visibility of random noise in different television systems.
6. C.C.I.R. Doc. CMTT/125 (Canada), Geneva, 1963. Single value of signal-to-noise ratio for different television systems—Video noise weighting.
7. C.C.I.R. Doc. CMTT/55 (U.S.A.),1963-1966. A comparison of random noise requirements for NTSC colour and monochrome television transmission.

REPORT 411 *

AUTOMATIC REMOTE MONITORING OF THE PERFORMANCE OF TELEVISION CHAINS

(Study Programme 1A/CMTT)

(1966)

1. Introduction

Due to the development of television chains and the increase of television programme exchanges between countries and different cities, Administrations may wish to employ automatic remote monitoring and control of the qualitative parameters of television chains [1, 2, 3, 4].

* This Report was adopted unanimously.

The application of the method of monitoring television chains by means of test-lines, makes it possible to check quickly what part of the chain introduces distortions, and to carry out many checks in the course of the transmission. Furthermore, the test-lines enable any distortions arising at various parts of the television chain to be observed on an oscilloscope. Manual control of distortion correcting networks can be based on the observation of the waveforms of the signals on an oscilloscope. For a documentary recording, it is necessary to photograph the screen and to process the photographic material, but in operational use this delay is unacceptable.

A new element in this problem is the use of the test-line signals for the automatic documentary recording of the performance of television chains and the transmission of this information for remote monitoring, signalling and automatic control. The use of the test-line method for these purposes is achieved by deriving a low-frequency analogue of the video test signal [1, 5]. It is therefore possible to use low-frequency recording and display devices to obtain automatically the results of measurements; the remote monitoring, signalling and control of the parameters of the chain are carried out by means of a telephone circuit.

In addition, by comparing signals with their reference waveform, given as an electrical analogue (for example as pulses or slowly changing voltages, etc.), error signals are obtained, which are used for automatic indication of deviations outside the specified tolerances, as well as for the automatic signalling and control of corresponding correctors [1, 4, 5, 7, 11, 13]. This is particularly important for monitoring the performance of television chains at unattended stations.

The conversion of video test-signals into low-frequency signals makes it possible to facilitate routine measurements based on the use of standard monitoring signals. Here, as well as with the use of test-line signals, it is possible to record the measurement results and also supervise the chain at a given point. If the converted signals are returned over a narrow-band channel, they may also be displayed at the transmitting end of the chain.

Thus, automatic remote monitoring facilitates:

— automatic documentary recording of the complete test-signal waveform or its most important characteristic points;

— automatic display for a short period of time (" rapid monitoring ") of the deviation from an accepted standard. This information may be used for distortion correction and for the rapid detection of faults in a television chain.

In solving these problems in accordance with Study Programme 1A/CMTT, certain results have already been obtained.

At the present time the above problems are being solved in the following ways.

2. Automatic documentary recording of a test-signal waveform

As the performance of a television chain is normally determined by measuring its waveform response to a prescribed test signal using a suitable mask (as given, for instance, in Recommendation 421-1), the necessity for documentary recording of the signal waveform is obvious. For this purpose the signals on the test-lines at the receiving end can readily be spectrum-converted into a low-frequency signal. For recording this low-frequency signal, chart recorders, magnetic tape recorders, low-frequency oscilloscopes etc. can be used. Almost any form of test signal may therefore be recorded.

Various methods can be used for this conversion. For example, the merit of stroboscopic spectrum-conversion consists in using a relatively simple means to obtain sufficiently accurate reproduction of the special signals inserted into the test-lines. It is also possible to check the waveforms of the synchronizing and blanking pulses, and, if markers are used, the duration of all components of the special signals and synchronizing pulses can be monitored.

The design parameters of such a system are considered in [1, 5], and some experimental results are given in [2, 4, 6], where low-frequency control signals were transmitted to the monitoring point over a telephone line using a frequency-modulated carrier.

The time required for conversion, and consequently the duration of the documentary recording of a test signal, is determined by the use intended for this system.

It may be possible to use a different speed of read-out for different kinds of test signals. It may also be feasible to use a spectrum converting arrangement (" rapid monitoring "), in which the waveform is sampled at a small number of points and although the resolution would be reduced the salient features of the test signal may still be determined [5, 6, 7]. For instance, two speeds of reading out are used in [8, 9, 10], which describe documentary recording of test signal waveforms. As the rate of change of video signal is very fast in some parts of the test-line and relatively slow in others, it is advantageous to vary the sampling interval and in this system this is achieved by sampling in two stages; firstly over the whole line period and secondly over the shorter period occupied by the sine-squared pulse. The two groups of samples are multiplexed by time division so as to appear sequentially on the display device. Where a telephone channel is used for the telemeter link, it is normal to employ frequency-modulation with the carrier-frequency set at a value determined by the type of line plant.

The preferred characteristics for systems of this type are as follows:

Duration of sampling scans:	2 μs and 64 μs switched alternately
Conversion time for each sampling scan:	10 s
Conversion time for a complete test-line:	20 s

3. Rapid monitoring and signalling

The task of rapid monitoring is to find, during a short period of time, the deviations of only the most significant points of the test signals outside the specified tolerances. The signal form corresponding to these tolerances is given by an electrical analogue. Rapid monitoring of the video path can be achieved in two ways. In the first case the same methods and equipment as described above in § 2 are used, but in a different mode of operation. In each test signal certain significant points in the waveform are chosen and the spectrum conversion is performed using only these points. The information as to the distortion at each point is transmitted sequentially over a narrow-band return channel to the transmitting end. The value of distortion is indicated by means of various display devices, printing arrangements and so forth. The signal errors may be recorded and they can also be used for signalling fault conditions and for controlling automatic distortion correctors.

The time during which the information is transmitted depends on the number of significant points to be converted and on the number of fields during which the conversion must be performed [7].

So if, for instance, the recording shows:

black level during 2 fields

white level during 2 fields

synchronizing pulse level during 2 fields

total amplitude of the sine-squared pulse during 5 fields

the first leading overshoot during 5 fields

the first lagging overshoot during 5 fields

the sub-carrier amplitude on the sawtooth waveform during 10 fields, the whole information will be transmitted during 31 fields (or 0·6 s in a 50-field/second system).

In the second case, rapid monitoring and signalling are performed by using threshold devices to indicate those signal parameters which exceed specified limits [11]. A separate threshold detector is used for each parameter.

The automatic monitoring device is divided into a waveform distortion measuring unit and a noise measuring unit. There are six parameters covering waveform distortion and the signal-to-noise ratio.

The monitoring of waveform distortion includes the following measurements:

— amplitude of video signal

— amplitude of synchronizing signal

— $2T$ pulse/bar ratio

— streaking on bar

— test-signal amplitude.

Measurement of these parameters is performed by time-division for each vertical blanking period, and the measurement is completed in 0·1 s.

An alarm signal, " caution " or " trouble ", is issued when predetermined thresholds are exceeded.

4. Method of transmitting the discrete values of test signals

The method of transmitting the discrete values of the test signal [5, 7] allows simplification of remote monitoring. In this method any number of test signals are inserted sequentially into the appropriate field-blanking interval.

In measuring the amplitude-frequency response, this method is realized as follows. At the transmitting end of the circuit, in the appropriate field-blanking interval, discrete bursts of sine wave of different frequencies corresponding to the video-frequency band are inserted in turn. The envelope of the overall amplitudes of these bursts, obtained at the receiving end as a result of detection, will characterize the amplitude-frequency response of the video circuit. To obtain the required accuracy, it is necessary for the sine-wave bursts inserted in the consecutive fields to be at frequency intervals of about 250 kHz. Then for a 6-MHz video bandwidth the frequency response as a whole will require the transmission of 24 bursts taking a total time of 0·48 s, for 50-field systems.

The low-frequency signal characterizing the amplitude-frequency response or its deviations outside the accepted tolerances are transmitted over a narrow-band channel back to the monitoring point. It is feasible to perform the recording of these deviations. It is possible in a similar way, to monitor other characteristics of the video path, for instance, the non-linearity, etc.

5. Automatic monitoring during the transmission of the colour television signals

In the remote monitoring of the fundamental parameters of colour television chains, it may be possible to apply the methods and the arrangements described above in §§ 2, 3, 4.

For the monitoring of the insertion loss of the luminance signal and of the colour sub-carrier, it is possible to transmit a test-line signal, which comprises a white bar, corresponding to Recommendation 420-1 and a burst of colour sub-carrier frequency of the same peak-to-peak amplitude inserted into the unused part of the line [12]. Automatic analysis, recording and remote monitoring of this information is very simple and does not require complex facilities.

It may be required to monitor differential gain and phase in colour television chains and also to correct these distortions [15, 17].

The equipment for recording the differential gain and differential phase, and the gain inequality between the luminance and chrominance signals by means of a special signal inserted in the field-blanking interval, is described in [14]. With this equipment, the recording of indicated characteristics is provided directly during the transmission of the programme. For this purpose the form of this special signal was chosen in such a way, that it was possible to compensate in the equipment the measuring errors due to the noise. This equipment, associated with data processing by means of a suitable programmed computer, was used for an experimental investigation carried out to assess the stability of television radio links [16]. One may consider this system to be promising for the future establishment of a reliable automatic supervision of the whole network.

Investigations [18] on the feasibility of automatic monitoring of the quality of a complete television network, consisting of radio links and transmitters, seem to indicate that the essential parameters to be monitored during colour television transmissions are: amplitude response, group-delay response, differential gain and phase, non-linearity, signal-to-noise ratio. Essential information on these parameters can be obtained by means of a signal consisting of a three-level staircase, on which sine waves of small amplitude and appropriate frequency are superimposed in time sequence. This type of signal seems to allow a simplification of the measuring equipment.

Bibliography

1. Krivosheev, M. I. New principles of design of television chain monitoring systems. *Tekhnika kino i televidenia*, **10** (1962).
2. O.I.R.T. Doc. TK-III-27 (U.S.S.R.), Bucharest, 1962. Method of automatic remote monitoring and measurement of television chains. OIRT Technical Commission III.
3. C.C.I.R. Doc. 254 (O.I.R.T.), Geneva, 1963. Automatic remote monitoring of the fundamental qualitative parameters of television chains.
4. C.C.I.R. Doc. 256 (O.I.R.T.), Geneva, 1963. Method of automatic remote monitoring and measurement of television chains.
5. Krivosheev, M. I. *Fundamentals of television measurements.* Moscow, Publishing House Sviaz (1964).
6. C.C.I.R. Doc. XI/27 (O.I.R.T.), 1963-1966. Some parameters of a system for automatic remote supervision of the fundamental qualitative indices of television circuits.
7. C.C.I.R. Doc. XI/60 (U.S.S.R.), 1963-1966. Monitoring of some characteristics of television chains by transmission of discrete values of the pilot signal.
8. C.C.I.R. Doc. CMTT/54 (U.K.), 1963-1966. Developments in test-line monitoring systems.
9. Independent Television Authority. Interim Technical Memorandum 1/63.
10. Independent Television Authority. A system for remote monitoring of television signal quality by means of a telephone line. Interim Technical Memorandum 8/64.
11. C.C.I.R. Doc. XI/21 (CMTT/8) (Japan), 1963-1966. A method for the automatic monitoring of television chains.
12. C.C.I.R. Doc. CMTT/31 (Federal Republic of Germany), 1963-1966. Insertion of special signals in the field-blanking interval of a 625-line television signal.
13. C.C.I.R. Doc. XI/4 (CMTT/7) (Canada), 1963-1966. Use of test and reference signals in the vertical-blanking interval on Canadian television networks.
14. C.C.I.R. Doc. CMTT/35 (Italy), 1963-1966. Automatic remote monitoring of the fundamental qualitative parameters of television chains. (Design of recording equipment.)
15. Castelli, E. On the causes of differential gain and phase on television links. *E.B.U. Review*, part A, H.67 (June, 1961).
16. C.C.I.R. Doc. IX/80 (CMTT/23) (Italy), 1963-1966. Radio-relay systems for television.
17. MacDiarmid, I. F. and Shelley, I. J. Correcting colour signal distortion. *Wireless World* (March, 1965).
18. C.C.I.R. Doc. CMTT/67 (XI/161) (Italy), 1963-1966. Automatic monitoring of the performance of television circuits.

REPORT 412 *

TIME DIFFERENCES BETWEEN THE SOUND AND VISION COMPONENTS OF A TELEVISION SIGNAL

(Question 4/CMTT)

(1966)

1. Introduction

Lack of simultaneity between vision and sound is a phenomenon that man experiences frequently. During a storm, the flash of lightning is followed by the sound of thunder several seconds later.

With the invention of sound motion pictures, specifications and standards were established to maintain synchronism between sound and vision. Improper threading of the motion picture projector can produce a condition of a lack of synchronism between sound and picture. In large motion picture theatres, a viewer will experience a delay of sound relative to vision due to the acoustical delay of sound in air, when the loudspeaker is located far from the viewer.

In the early days of long-distance television transmission, when the video and sound were transmitted via different facilities, there occasionally existed a perceptible lack of simultaneity between sound and vision. Over the intervening years, the networks have been improved. Today, even though the sound and vision of a television programme may be transmitted via different facilities, the transmission velocities used are such that little or no lack of simultaneity between sound and vision is experienced.

With the advent of satellite communication systems, where the sound and vision signals may be transmitted via different media, difficulties, because of the lack of synchronization of sound and vision, may exist at the receiver location.

2. Conclusions based on observer reaction

Studies of observer reaction to non-simultaneous presentation of pictures and associated sound were reported in Doc. CMTT/1 (Canada) and Doc. CMTT/12 (U.S.A.), submitted to the Interim Meeting of the CMTT, Geneva, 1965. General conclusions may be drawn from these experiments.

2.1 *Qualitative conclusions*

— the observer is more sensitive to sound advances than to sound delays with respect to the correlated visible action,

— observer tolerance to sound/vision time differences varies according to the nature of the action. For example, the objectionable effects of the more easily correlated actions and sounds (such as the percussive sound produced by an object being struck), are detected at considerably shorter time differences than are lip motions of a speaker and the corresponding sounds. For scenes of people moving about, correlation between sound and action becomes more difficult for the observer to detect.

2.2 *Quantitative conclusions*

Although the conditions under which the Canadian and U.S.A. experiments were conducted differed widely, the results were in broad agreement. In terms of these results, it is possible to derive some provisional figures for overall tolerance to sound delay and advance from sound source to observer.

* This Report was adopted unanimously.

2.2.1 *Sound delayed*

For sound delayed with respect to vision, 140 ms will produce, approximately, a " just perceptible impairment " for 50% of the observers.

2.2.2 *Sound advanced*

For sound advanced with respect to vision, 70 ms will produce, approximately, a " just perceptible impairment " for 50% of the observers.

The above figures are perhaps more stringent than may be tolerated in some circumstances, but they allow for some evidence that sensitivity to sound/vision time differences is greater for some languages than for English in which the experiments were conducted.

3. The problem of division of time differences among the links of a built-up connection

3.1 The figures cited in § 2.2 must be divided between acoustic links (source to studio microphone, and television receiver to observer) and electrical links. The electrical links may in turn be subdivided between the broadcasting facilities and the telecommunications transmission networks. Very little information is available on which a practical division may be based.

As an example, in the United States, where a variety of programme material is transmitted, it has been found economically feasible on transmission networks to limit sound delay relative to the vision portion of a television programme by not more than 50 ms, and sound advance by not more than 25 to 30 ms, at the receiving location. The advance or delay of sound of a television signal that may be introduced because of the difference in transmission velocities on network facilities, can be determined. The advance or delay figures of sound indicated are primarily concerned with the long-distance portion of the network and do not include the intra-city or other contributing sources to the time difference of sound and vision components of the television signal. Other electrical and acoustic links make up the remainder of the sound/vision time difference.

4. Further work

Contributions are invited from various Administrations based on experience and practice with regard to the following:

— division of the overall sound/vision time difference among acoustic and electrical links, and the appropriate division of responsibility for the application of corrective measures,

— methods of controlling sound/vision time differences, arising on the long-distance connection,

— new experiments which introduce conditions beyond those previously used.

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. Areas of study

1.1 During the period 1963-1966, there was continued and increased participation by Administrations in the work assigned to the Study Group. The three major areas of study were augmented by inclusion of direct broadcasting service from satellites for joint study by Study Groups IV, X, XI.

1.2 In conformity with the terms of reference, the major areas of study were related to:

1.2.1 *Audio-frequency and video-frequency* recording and reproducing on tape and film; measurements of programme level, wow and flutter, and a newly adopted Question on the determination of subjective loudness.

1.2.2 *LF, MF and HF broadcasting* including specification of service areas, protection ratios, satisfactory reception, antennae and compatible single-sideband broadcasting systems.

1.2.3 *VHF-FM broadcasting* including stereophonic broadcasting, two or more sound programmes in frequency-modulation and television, emission polarization by frequency-modulation stations, and monitoring of stereophonic transmissions.

2. Subjects studied resulting in a Recommendation

2.1 *Measurement of wow and flutter. (Rec. 409-1)*

Continued work on Study Programme 161 resulted in a clarification of peak-to-peak and r.m.s. measurements, and included further information related to technical specifications when using r.m.s. values. It is hoped that a single measuring technique can be agreed upon during the current period.

2.2 *Single-track recording on magnetic tape. (Rec. 261-1)*

As the state of techniques progresses and amendments and clarifications become desirable, this Recommendation will continue to reflect agreed specifications as it has for many years. It will be re-examined in the light of advances in recording and reproducing technology.

2.3 *Two-track stereophonic recording on magnetic tape. (Rec. 408-1)*

This Recommendation correlates applicable standards of Recommendation 261-1 and audio-frequency parameters covered in Report 293-1 with pertinent stereophonic specifications for the international exchange of sound broadcast programmes.

2.4 *Sound recording for the international exchange of programmes. (Rec. 407-1)*

This Recommendation provides guidance to Administrations and broadcasting organisations in applicable standards, and exception thereto by the U.S.A. and the O.I.R.T., for international exchange of monophonic and stereophonic sound programmes on disc and tape.

2.5 *Standards for the international exchange of monochrome television programmes on film. (Rec. 265-1)*

This amendment to Recommendation 265 provides for the inclusion of a new type of film, 35 COMMAG, to those already specified and includes for the first time specific numerical values for image densities. Future programme exchange on films will be facilitated by these amendments.

2.6 *HF broadcasting, effects of closer spacing between carriers. (Rec. 262-1)*

A minor but important amendment to Recommendation 262 relates this Recommendation to current studies of protection ratios.

2.7 *HF broadcasting, conditions for satisfactory reception. (Rec. 411-1)*

This Recommendation finally concludes studies of radio-frequency signal-to-interference, wanted signal-to-atmospheric noise, and wanted signal-to-industrial noise ratios, referred to the C.C.I.R. in 1948 by the Mexico City HF Broadcasting Conference. Report 119 and Question 39 are thereby terminated.

2.8 *Definitions of signal-to-interference ratios in amplitude-modulation sound broadcasting. (Rec. 447)*

It is important in studies of this nature that all Administrations utilize the same definitions in submission of their data and observations, in order that conclusions may be drawn respecting identical quantities. This Recommendation defines both audio-frequency and radio-frequency ratios pertinent to such work and clarifies their use.

2.9 *Presentation of results of measurements of radio-frequency protection ratios for amplitude-modulation sound broadcasting. (Rec. 413-1)*

Recent work has resulted in more meaningful and less ambiguous means of comparing measurements of radio-frequency protection ratios in terms of uniform understandable parameters.

2.10 *Radio-frequency protection ratio curves, amplitude-modulation sound broadcasting. (Rec. 449)*

This Recommendation presents two curves for radio-frequency protection ratios related to low and high modulation compression at the transmitter input, and explains their validity.

2.11 *Radio-frequency protection ratios for LF/MF sound broadcasting. (Rec. 448)*

The value of 40 dB protection ratio is defined in its application to co-channel transmissions under different conditions of the wanted and unwanted signals. This

Recommendation should prove of value to future planning conferences dealing with LF/MF broadcasting.

2.12 *HF broadcasting, use of synchronized transmitters. (Rec. 205-1)*

The use of such transmissions for both overlapping and non-overlapping service areas for no appreciable deterioration in reception is elaborated.

2.13 *Stereophonic systems for VHF-FM broadcasting. (Rec. 450)*

Beginning in 1959, the Study Group has conducted exhaustive work on stereophonic systems for VHF-FM broadcasting. This work included:

— mathematical analyses,

— transmitter analyses,

— receiver studies,

— propagation effects and relay considerations,

— field tests,

— subjective aspects.

More than twenty systems were considered. The Recommendation contains the specifications of two systems, the *pilot-tone* and *polar modulation* systems, which represent the preponderance of technical opinion for systems capable of transmitting high-quality stereophonic programmes. Further reference to Report 300-1 will explain in detail the various considerations involved in agreement on this Recommendation. Although it was impossible to agree on a single system, it is considered that the guidance given herein will enable Administrations to initiate a stereophonic service with confidence in the predicted results, and that confusion attendant to multiple standards may thereby be avoided.

3. Areas of work for continued study

The subject of the Reports retained will be studied during the current period, and should be related to existing Questions and Study Programmes.

There are 18 Questions and 10 Study Programmes for further study.

4. Observations related to work

4.1 During the XIth Plenary Assembly, the terms of reference of CMTT were amended by Opinion 19-1 to include the specifications of sound broadcasting signals to be transmitted over long distances. The Study Group unanimously elected Dr. J. Geluk of the Netherlands to act as its official liaison member to the CMTT on this aspect of its work. The CMTT adopted Question 5/CMTT outlining the work to receive attention during the current period 1966-1969.

4.2 During recent years, many new and developing countries have joined in the work of the C.C.I.R. Special consideration to their problems was given attention by the XIth Plenary Assembly. At the LF/MF African Broadcasting Conference of 1966 extensive reference was made to the work of Study Group X, particularly signal-to-interference and signal-to-noise ratios. It is hoped that other areas of our work will also be of value to such countries. Their participation and contributions to our programme of study are welcomed.

OPINION 15-1

USE OF THE 26 MHz BROADCASTING BAND

The C.C.I.R., (1953—1966)

CONSIDERING

(a) that it is important that long-distance broadcasting should use all frequency bands 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, at frequencies within the 26 MHz broadcasting band;

(c) that these frequencies are seldom 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;

IS UNANIMOUSLY OF THE OPINION

1. that Administrations should bring to the notice of broadcasting organizations the advantages of the 26 MHz band for long-distance broadcasting when ionospheric conditions are favourable;

2. that receiver manufacturers should be encouraged to extend the tuning range of their products to permit reception in the 26 MHz band.

OPINION 16

ORGANIZATIONS QUALIFIED TO TAKE ACTION ON QUESTIONS OF SOUND RECORDING

The C.C.I.R., (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;

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 17-1

RECORDING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

The C.C.I.R. (1963—1966)

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 294-1;
2. that the I.E.C. and the ISO should be invited to take these views into account.

OPINION 31

SOUND RECORDING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF BROADCASTING PROGRAMMES

The C.C.I.R., (1966)

CONSIDERING

(a) that specifications contained in the I.E.C. Publications relating to disc and tape recording and reproducing are intended for general application including broadcasting purposes;

(b) that extensive investigations have recently been concluded by various Administrations and organizations dealing with specifications exclusively for broadcasting purposes and covering disc, cartridge tape and reel-to-reel tape systems both monophonic and stereophonic;

(c) that these investigations might provide a basis for specifications of a more general nature;

IS UNANIMOUSLY OF THE OPINION

1. that the Director, C.C.I.R. should transmit the following documents of Study Group **X**, (1963-1966) to the Secretary General I.E.C.:

   Doc. X/17 (U.S.A.)—discs;

   Doc. X/18 (U.S.A.)—cartridge tape;

   Doc. X/29 (U.S.A.)—reel-to-reel tape;

   Doc. X/72 (O.I.R.T.)—reel-to-reel tape;

   Doc. X/136 (U.S.A.)—cartridge tape;

2. that the I.E.C. should be invited to take the views expressed in these documents into account in their future deliberations.

STUDY PROGRAMME 1A/X *

STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

The C.C.I.R. (1951—1953—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 wavelengths on the tape as possible, the absolute level of a recorded signal, independent 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 2A/X **

MEASUREMENT OF AUDIO-FREQUENCY NOISE FOR BROADCASTING AND IN SOUND RECORDING SYSTEMS

(Report 292-1)

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

CONSIDERING

that no methods exist for measuring noise in the audio-frequency 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).

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* This Study Programme, formerly Study Programme 161 (X), does not arise from any Question under study.

** This Study Programme, formerly Study Programme 162 (X), does not arise from any Question under study.

QUESTION 3/X *

MEASUREMENT OF THE CHARACTERISTICS OF SOUND SIGNALS RECORDED ON MAGNETIC TAPE

The C.C.I.R., (1965)

CONSIDERING

(a) that Report 79-1 calls for elimination of the concept of the ideal tape reproducing head and for definition in the future of only the state of magnetization of the tape, and for specification of measurement methods;

(b) that Study Programme 1A/X calls for further investigation of methods of absolute measurement of the characteristics of the signal recorded on a magnetic tape over as wide a range of wavelengths as possible;

(a) that no agreement concerning either measurement techniques of characteristics to be measured was reached at the Interim Meeting of Study Group X, Vienna, 1965;

UNANIMOUSLY DECIDES that the following question should be studied:

1. should the concept of the ideal head be abandoned for the measurement of signals recorded on magnetic tape, in view of the ease of utilization of this technique in laboratories possessing modest facilities;

2. what alternative measurement techniques can be substituted;

3. what correlation exists between measurements made using the ideal head concept and measurements made utilizing alternative methods;

4. what method of measurements is most suitable for measurement of a reference level recording at intermediate wavelengths (i.e., 0·25 mm-1·0 mm (0·01-0·04 in.));

5. what method of measurement is most suitable for measurement over a wide range of wavelengths to determine the recorded frequency characteristic;

6. what units of measurement should be used to express recorded signal levels on magnetic tape?

QUESTION 4/X **

DETERMINATION OF THE SUBJECTIVE LOUDNESS OF A BROADCASTING PROGRAMME

The C.C.I.R., (1965)

CONSIDERING

(a) that existing specifications and techniques for the determination of sound modulation levels in broadcasting are generally based on peak or quasi-peak programme levels;

(b) that neither true peak nor quasi-peak programme levels are necessarily indicative of subjective loudness;

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* Formerly Question 304(X).

** Formerly Question 300(X).

(c) that it may be advantageous to take subjective loudness into account in the determination of programme levels;

(d) that Report 292-1 has suggested the possibility of a study of the problem of the measurement and control of dynamic range of sound programmes;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the effects of amplitude, frequency range and other factors on loudness;
2. what techniques may be used to measure the subjective loudness of programme material in broadcasting;
3. what degree of accuracy is obtainable with each;
4. what characteristics should a meter possess to measure subjective loudness?

QUESTION 5/X *

STANDARDS FOR THE INTERNATIONAL EXCHANGE OF MONOCHROME TELEVISION PROGRAMMES

Film recording and reproducing

The C.C.I.R., (1965—1966)

CONSIDERING

(a) that films used for the international exchange of television programmes do not always match the reproducing characteristics of the telecine equipment at the film's destination;

(b) that reproducing characteristics differ in various telecine equipment;

(c) that a telecine characteristic should be defined for optimum reproduction of films intended for international exchange of television programmes;

(d) that further specifications concerning optimal density values and transfer characteristics of photographic films for television are desirable;

(e) that, to achieve comparable results, methods of density measurement should also be recommended;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the optimum telecine reproducing characteristics for use with television films;
2. to what extent can the various telecine reproducing characteristics be modified, to meet the optimum standard referred to in § 1;
3. if the modifications in § 2 are not practicable, what is the best compromise standard;
4. what methods of measurement and specification should be used for defining the density range of photographic films used for television programme exchange;
5. what should be the tolerances on the transfer characteristics within the recommended density range of a film image, as defined in Recommendation 265-1, § 2.4?

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* This Question replaces Question 303.

QUESTION 6/X

OPTICAL SOUND RECORDING AND REPRODUCING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES

The C.C.I.R., (1966)

CONSIDERING

(a) that, when films intended for the international exchange of television programmes have optical sound tracks, these sound tracks do not always reproduce satisfactorily in telecine equipment;

(b) that, although international standards exist for the location and dimensions of optical sound tracks, there do not appear to be national or international standards for their recording and reproduction characteristics;

(c) that compression of the sound signal is invariably used to obtain a satisfactory signal-to-noise ratio;

(d) that the signals reproduced from optical sound tracks have noticeably different characteristics from those originating from other programme sources;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the optimum optical sound recording characteristics for the two film gauges used for international programme exchange;

2. what are the preferred methods of measurement of the recording and reproducing characteristics;

3. what are the preferred types of optical sound tracks for international programme exchange;

4. what is the optimum compression characteristic consistent with satisfactory signal-to-noise ratio;

5. is it possible, by the use of volume expansion in telecine reproducing equipment, or by other means to reduce the difference between the sound quality obtained from optical tracks and that obtained from other programme sources?

QUESTION 7/X *

RECORDING OF TELEVISION SIGNALS ON MAGNETIC TAPE

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

CONSIDERING

that various types of equipment 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?

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* Formerly Question 266(X).

STUDY PROGRAMME 7A/X *

RECORDING OF TELEVISION SIGNALS ON MAGNETIC TAPE

The C.C.I.R., (1965)

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;

5. ways of specifying and measuring characteristics and parameters embodied in the standards of §§ 1 to 4 (e.g. signal-to-noise ratio, pre-emphasis or de-emphasis, etc.).

QUESTION 8/X **

AMPLITUDE-MODULATION SOUND BROADCASTING

Protection ratios

The C.C.I.R., (1959—1963—1966)

CONSIDERING

that there is a need for generally accepted values of audio-frequency and radio-frequency protection ratios for amplitude-modulation sound broadcasting;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what is the value of the radio-frequency 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;

* Formerly Study Programme 266B(X).

** This Question replaces Question 262.

2. what is the effect of limitation of the occupied bandwidth at the transmitter (for example, to less than ± 10 kHz), on these protection ratios (see Report 297-1);

Note 1. — 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.

Note 2. — Recommendation 413-1 gives the form in which these results should be presented.

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) (see Question 10/X);

4. what are the values of radio-frequency protection ratio, derived from the results of measurements carried out in accordance with §§ 1, 2 and 3, of the radio-frequency signal-to-interference ratio, between two broadcasting transmitters radiating different programmes, but operating on frequencies separated by 0 to 10 kHz, 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:

— 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 (see Recommendation 413-1)?

STUDY PROGRAMME 8A/X *

AMPLITUDE-MODULATION SOUND BROADCASTING

Radio-frequency protection ratios — objective two-signal methods of measurement

The C.C.I.R., (1963—1966)

CONSIDERING

(a) that subjective methods for determining the necessary radio-frequency 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 radio-frequency protection ratios;

UNANIMOUSLY DECIDES that the following studies should be carried out:

the objective two-signal methods of measurement that can be used to measure radio-frequency protection ratios.

QUESTION 9/X **

AMPLITUDE-MODULATION SOUND BROADCASTING

Broadcasting coverage

The C.C.I.R. (1965—1966)

UNANIMOUSLY DECIDES that the following question should be studied:

in what way does amplitude-modulation broadcasting coverage depend upon the choice of specific values of the various technical parameters concerned, e.g., radio-frequency protection ratios, carrier-frequency spacings, minimum fields to be protected, etc., for:

1. low and medium frequencies,

2. high frequencies?

QUESTION 10/X ***

AMPLITUDE-MODULATION SOUND BROADCASTING

Reception of the sky-wave signal

The C.C.I.R., (1959—1963)

CONSIDERING

that more information is desired concerning various propagation effects that lead to distortion of broadcasting signals;

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* This Study Programme replaces Study Programme 262A.

** Formerly Question 305(X).

*** Formerly Question 263(X).

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;

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 11/X

MF BROADCASTING

Reduction of sky-wave field strength

The C.C.I.R., (1966)

CONSIDERING

(a) that, under certain circumstances, a substantial reduction in the field strength of MF sky-wave is produced by transmitting an elliptically polarized wave in a manner referred to as orthogonal transmission;

(b) that this type of transmission is expected to reduce sky-wave interference and to extend the primary service area of broadcasting stations restricted by fading, due to such interference;

(c) that these improvements may be produced without altering the horizontal radiation pattern of the transmitting antenna;

(d) that more transmitter power than that at present employed at night is required to operate this system;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what improvement in reception can be obtained with orthogonal transmission, and to what extent does it depend on:

1.1 transmission frequency relative to the gyro-frequency;

1.2 magnetic dip between the mid-point of the path and the transmitter;

1.3 magnetic bearing of the path;

1.4 the distance;

2. what types of transmitting antennae can be used;

3. what is the effect of time of day, season and sunspot cycle?

QUESTION 12/X *

AMPLITUDE-MODULATION SOUND BROADCASTING

Compatible single-sideband transmission

The C.C.I.R., (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 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.

STUDY PROGRAMME 12A/X **

AMPLITUDE-MODULATION SOUND BROADCASTING SERVICES

Compatible single-sideband transmissions (CSSB)

The C.C.I.R. (1959—1963—1966)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the radio-frequency 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

* Formerly Question 205(X).

** Formerly Study Programme 205A(X).

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.

QUESTION 13/X *

LF AND MF BROADCASTING

High-efficiency transmitting antennae

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

CONSIDERING

(a) that there is a general tendency to increase the size of the service area of LF and MF 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?

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* Formerly Question 264(X).

QUESTION 14/X *

HF BROADCASTING

Directional antenna systems

(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?

Note. — The reasons which justify this Question are given in the Annex.

ANNEX

The characteristics of directional antenna systems, used in broadcasting, have been completely studied from theoretical aspects, and a number of experimental investigations have been undertaken by various bodies on the actual measured performance (see the Bibliography).

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 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.

BIBLIOGRAPHY

1. PAGE, H. The measured performance of horizontal dipole transmitting arrays. *J.I.E E.*, **92**, Part III, 18 (June, 1945).
2. DANDEMAN, E. K. *Radio Engineering*, Chapman & Hall, page 674.
3. HAYES, L. W. and MACLARTY, B. N. The Empire Service Broadcasting Station at Daventry. *J.I.E.E.*, **85**, 513 (September, 1939).
4. WELLS, N. Aerial characteristics. *J.I.E.E.*, **89**, Part III, 6 (June, 1942).
5. HACKE, J. E. Jr. and WAYNICK, A. H. *Restricted range sky wave transmission.* Elec. Eng. Dept., Pennsylvania State College, Pa., U.S.A.

* Formerly Question 23(X).

STUDY PROGRAMME 14A/X *

HF BROADCASTING

Directional antenna systems

(Recommendation 80)

The C.C.I.R., (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 15/X **

STEREOPHONIC BROADCASTING

The C.C.I.R., (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;

(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;

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* Formerly Study Programme 23A(X).

** Formerly Question 199(X).

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?

Note. — " Compatible " implies that, when a stereophonic programme is being broadcast, an ordinary receiver may continue to receive a satisfactory balanced, non-stereophonic programme.

STUDY PROGRAMME 15A/X *

STEREOPHONIC BROADCASTING

Standards for compatible systems in sound and television broadcasting

The C.C.I.R. (1959—1966)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the study of 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. the study of systems with particular regard to their feasibility and applicability to existing broadcast transmitters;

3. the study of 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. the study of systems with particular regard to:

4.1 coverage;

4.2 interference effects;

4.3 bandwidth involved and other matters concerned with channel utilization;

5. the carrying out of field tests of those systems that appear most satisfactory.

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* This Study Programme replaces Study Programme 199A.

STUDY PROGRAMME 15B/X

TOLERANCES FOR THE AUDIO-FREQUENCY PARAMETERS OF THE STEREOPHONIC TRANSMISSION CHAIN

The C.C.I.R., (1966)

CONSIDERING

(a) that the values given in the Tables of Report 293-1, although comparable on the whole, have not yet led to any general agreement;

(b) that the subjectively determined transmission tolerances, when monitored by a high-grade receiver, are not sufficient for ascertaining the conditions which must be ensured in the different parts of the transmission chain with regard to international exchange of programmes;

(c) that without such specifications, both the I.E.C. and the C.C.I.R. are unable to establish further recommendations, especially for stereophonic recording;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. determination of those sections of the stereophonic transmission chain—from the microphone output to the loudspeaker input—for which it is useful to specify tolerances for the parameters enumerated in the Tables in Report 293-1;
2. the tolerances that should be specified for these parameters under transmitter monitoring conditions;
3. taking into account their subjective nature, whether these tolerances should be subdivided into:
   — values to be aimed at;
   — values at present valid and attainable.

QUESTION 16/X *

TECHNIQUES FOR CHECKING THE ESSENTIAL CHARACTERISTICS OF FREQUENCY-MODULATION STEREOPHONIC BROADCASTING

The C.C.I.R., (1965)

CONSIDERING

(a) that incorrect modulation in frequency-modulation stereophonic broadcasting can result in objectionable crosstalk between channels A and B, and possibly between the stereophonic and supplementary communication multiplex channels. It can also produce objectionable distortion in stereophonic or in compatible monophonic reception;

(b) that ensuring correct stereophonic modulation involves the measurement of quantities which are not encountered in monophonic broadcasting (e.g. the relative polarity of the A and B audio-frequency signals and, in the case of the pilot-tone system, the phase of the pilot-tone);

UNANIMOUSLY DECIDES that the following question should be studied:

what techniques can be used to ensure that the transmitted signal conforms to the system specification?

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* Formerly Question 302(X).

STUDY PROGRAMME 16A/X

CHECKING STEREOPHONIC MODULATION CHARACTERISTICS: PARAMETERS AND METHODS

The C.C.I.R., (1966)

CONSIDERING

(a) that the problem of checking stereophonic transmissions requires thorough study, especially with regard to the parameters to be checked at the transmitter output;

(b) that it is also important to extend these studies to include studio and transmitter links;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. Checking of stereophonic transmissions

1.1 the parameters that it is essential or desirable to check during transmission, to ensure that the transmitter output signal conforms to the specifications for the stereophonic system used;

1.2 the parameters it would be useful to adjust during routine maintenance;

1.3 the most appropriate methods for these checks;

2. Checking of stereophonic links

2.1 the parameters it is essential or desirable to check during operation, to preserve stereophonic quality;

2.2 the parameters it would be useful to check during routine link maintenance;

2.3 the most appropriate methods for these checks.

QUESTION 17/X

SIMULTANEOUS TRANSMISSION OF TWO OR MORE SOUND PROGRAMMES IN FREQUENCY-MODULATION BROADCASTING

The C.C.I.R., (1966)

CONSIDERING

(a) that, in frequency-modulation broadcasting, it might be, for certain applications, desirable to be able to transmit two or more sound programmes simultaneously;

(b) that such transmissions may be particularly useful in areas where several languages are spoken;

(c) that two or more programmes might be transmitted most efficiently with a specially designed system;

(d) that compatibility is not a primary requirement;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what systems can be used with a single transmitter for the transmission of two or more compatible or non-compatible programmes in frequency-modulation broadcasting;

2. what types of frequency-modulation receivers should be used, to allow the listener to select each sound programme;

3. what specifications should be recommended for this purpose?

Note. — A transmission is said to be compatible if it can be received on an existing unmodified conventional receiver and gives a reception quality at least as satisfactory as that obtained with standard frequency-modulation broadcasting.

QUESTION 18/X *

SIMULTANEOUS TRANSMISSION OF TWO SOUND CHANNELS IN TELEVISION

The C.C.I.R., (1959—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;
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 crosstalk between the two sound channels can be obtained with such systems?

STUDY PROGRAMME 18A/X

SIMULTANEOUS TRANSMISSION OF TWO SOUND CHANNELS IN TELEVISION

Objective method of measurement of crosstalk

The C.C.I.R., (1966)

CONSIDERING

that the spectral distributicn of crosstalk depends upon the system in use:

UNANIMOUSLY DECIDES that the following study should be carried out:

the best objective method for measuring crosstalk, giving results comparable with subjective assessments.

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* Formerly Question 265(X).

QUESTION 19/X *

FREQUENCY-MODULATION BROADCASTING IN THE VHF BAND

Polarization of emissions

The C.C.I.R., (1965—1966)

CONSIDERING

that emissions from frequency-modulation broadcasting stations are usually transmitted with horizontal polarization;

UNANIMOUSLY DECIDES that the following question should be studied:

1. are there advantages, both in improving service and minimizing interference, in using for monophonic and stereophonic VHF sound broadcasting:

1.1 vertical polarization only;

1.2 emissions from the same location on the same frequency with both horizontal and vertical polarization;

2. what types of antennae can be used for transmission and reception?

QUESTION 20/X **

DIRECT BROADCASTING SERVICE FROM SATELLITES

Sound and television

The C.C.I.R., (1965—1966)

CONSIDERING

(a) Recommendation No. 5A of the Extraordinary Administrative Radio Conference, Geneva, 1963;

(b) that broadcasting from satellites will soon become possible because of technological progress;

(c) that the broadcasting services must take into account all the technical consequences of broadcasting from satellites and, in particular, of the possible sharing of frequency bands between the satellite and the terrestrial broadcasting services;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the optimum transmission characteristics for single and multiple broadcasting from satellites;

2. what are the frequency bands which are technically suitable for broadcasting from satellites;

3. are there any possibilities for sharing frequency bands between the satellite and terrestrial broadcasting services, and what, if any, are the practical conditions for such sharing;

4. what are the values of field strength necessary to provide a satisfactory satellite broadcasting service and to protect the terrestrial broadcasting service if sharing is envisaged?

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* Formerly Question 301(X).

** This Question, formerly Question 306(X) and identical with Question 5/XI, will be studied jointly by Study Groups X and XI, in connection with Question 12/IV. Contributions to the study of this Question should be brought to the attention of participants in the work of Study Group IV.

QUESTION 21/X

MAGNETIC SOUND RECORDING AND REPRODUCING STANDARDS FOR THE INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES ON FILM

Recording and reproducing characteristics for 16 SEPMAG and 16 COMMAG

The C.C.I.R., (1968)

CONSIDERING

(a) that Recommendation 265-1 specifies that for 16 COMMAG the recording and reproducing characteristics should be that standardized by the C.C.I.R. for magnetic tape for a speed of 19.05 cm/s except for the time constant which is 100 μs (see Recommendation 261-1);

(b) that this recommended standard has not been universally adopted;

(c) that the present multiplicity of standards for magnetic sound on 16 mm film recording and reproduction creates difficulties within broadcasting organizations;

DECIDES that the following question should be studied:

should a compromise between the I.S.O. and S.M.P.T.E. recording and reproducing characteristics, such as the 70 μs time constant specified in Recommendation 261-1, be adopted for both 16 COMMAG and 16 SEPMAG film?

QUESTION 22/X

RECORDING OF COLOUR TELEVISION SIGNALS ON FILM

The C.C.I.R., (1968)

CONSIDERING

(a) that colour films are a medium for the international exchange of colour television programmes, as stated in Report 406, § 6.8;

(b) that direct filming of programmes is not always possible for technical and economic reasons;

(c) that no simple, satisfactory system seems to be available in practice for recording colour television programmes on colour film;

DECIDES that the following question should be studied:

1. what system or systems are most satisfactory for producing colour films from a live colour television programme or from one recorded on magnetic tape;

2. what are the optimum recording characteristics which would meet the standards that may be adopted for films intended for the international exchange of colour programmes?

QUESTION 23/X

STANDARDS FOR THE INTERNATIONAL EXCHANGE OF COLOUR TELEVISION PROGRAMMES

Film recording and reproducing

The C.C.I.R., (1968)

CONSIDERING

that it is desirable to define:

(a) the colour balance for both 16-mm and 35-mm films;

(b) the conditions of projection for the assessment of both 16-mm and 35-mm colour films;

(c) the density range of the film and the telecine characteristics for optimum reproduction of colour films;

DECIDES that the following question should be studied:

1. at which colour temperature should films intended for television and used for international programme exchanges be balanced;

2. what are the optimum conditions of projection for assessment of colour films intended for television;

3. what are the suitable maximum and minimum densities of colour films intended for television;

4. what are the optimum telecine reproducing characteristics for use with colour television films;

5. to what extent can the various telecine reproducing characteristics be modified, to meet the optimum standard referred to in § 4?

QUESTION 24/X

METHODS OF SYNCHRONIZING VARIOUS RECORDING AND REPRODUCING SYSTEMS

The C.C.I.R., (1968)

CONSIDERING

(a) that Question 18/X concerns the simultaneous transmission of two sound channels in television;

(b) that present television tape recorders provide for only one sound channel of broadcast quality;

(c) that in other cases, also, it may be necessary to synchronize a number of audio and/or video signals with each other;

(d) that no single method or system is in general use which will meet all the different possible requirements for synchronization;

DECIDES that the following question should be studied:

1. what are the required capabilities of such methods of synchronizing;

2. what methods are applicable to the synchronization of the various types of recording and reproducing devices?

QUESTION 25/X*

LF, MF AND HF SOUND BROADCASTING SYSTEMS

(1968)

The C.C.I.R.,

CONSIDERING

(a) that any sound broadcasting system should specify the essential emission and reception characteristics taking into account the effects of propagation;

(b) that the system, or systems, chosen should permit efficient use of the frequency bands available, whilst maintaining reasonable receiver costs;

(c) that apart from the double-sideband amplitude-modulation system, other systems may be used;

(d) that sky-wave and/or ground-wave reception may be required;

DECIDES that the following question should be studied:

1. what sound broadcasting systems should be standardized;

2. what should be the characteristics of these systems with respect to:
   - the emission (type of modulation, audio-frequency bandwidth and necessary bandwidth of emission, dynamic compression, pre-emphasis, limiting, channel spacing, etc.);
   - reception (principle of demodulation, audio-frequency response, dynamic expansion, de-emphasis, intermediate frequency, etc.);

3. should a system differing from the present system be chosen, what are the consequences resulting from that choice during any transition period on:
   - existing receivers;
   - receivers constructed in conformity with the new system?

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* *Note by the Director, C.C.I.R.* — As a result of the adoption of this Question, with its associated Study Programmes, the XIIth Plenary Assembly of the C.C.I.R. will be requested to consider the deletion of Questions 8/X, 9/X, 10/X and 12/X and Study Programmes 8A/X and 12A/X.

STUDY PROGRAMME 25A/X

LF, MF AND HF SOUND BROADCASTING SYSTEMS

Radio-frequency protection ratios

The C.C.I.R., (1968)

DECIDES that the following studies should be carried out:

the determination of radio-frequency protection ratios under conditions which take account simultaneously of the following items, which may vary independently of each other:

1. **Fading** (see Study Programme (25D/X)):

1.1 wanted signal and unwanted signal stable*

1.2 wanted signal stable, and unwanted signal fluctuating*

1.3 wanted signal and unwanted signal fluctuating*

1.4 wanted signal fluctuating and unwanted signal stable;*

2. **Frequency separation** from 0 to 30 kHz between the wanted and unwanted carrier;

3. **Broadcasting programmes**

3.1 wanted and unwanted signals modulated with the same programme*

3.2 wanted and unwanted signals modulated with different programmes;*

4. **Class of emission** (the characteristics should be stated in each case)

4.1 double-sideband amplitude modulation:
- 4.1.1 with current-type receivers
- 4.1.2 with receivers with characteristics adapted to the defined double-sideband transmission;

4.2 single-sideband or vestigial-sideband, including compatible single-sideband modulation**
- 4.2.1 with current-type receivers
- 4.2.2 with receivers specially adapted to the system considered;

4.3 any other class of emission;

4.4 coexistence of two systems as follows:

Wanted emission	Unwanted emission
Double-sideband amplitude-modulation	Class of emission as under §§ 4.2 or 4.3
Class of emission as under §§ 4.2 or 4.3	Double-sideband amplitude-modulation

5. frequency band (LF, MF, HF);
6. minimum field-strength to be protected;
7. compression of dynamic range;
8. necessary bandwidth.

Note: Recommendation 413-1 gives the form in which the results should be presented.

* Tests should also be made with several unwanted signals.

** A transmission is said to be " compatible " if it can be received on an existing conventional receiver, without any modification whatsoever to the receiver, and then gives a quality of reception at least as satisfactory as that obtained at present in a double-sideband system.

STUDY PROGRAMME 25B/X

LF, MF AND HF SOUND BROADCASTING SYSTEMS

Objective two-signal methods of measurement of radio-frequency protection ratios

The C.C.I.R., (1968)

CONSIDERING

(a) that subjective methods for determining the necessary radio-frequency 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 radio-frequency protection ratios;

DECIDES that the following studies should be carried out:

the objective two-signal methods of measurement that can be used to measure radio-frequency protection ratios for various sound-broadcasting systems including double-sideband, vestigial-sideband, single-sideband and others.

STUDY PROGRAMME 25C/X

LF, MF AND HF SOUND BROADCASTING SYSTEMS

Minimum field-strength to be protected

The C.C.I.R., (1968)

DECIDES that the following studies should be carried out:

the minimum field strength to be protected in the LF, MF and HF broadcasting bands, taking account of:

— the characteristics of the system;

— whether ground-wave or sky-wave reception is envisaged;

— atmospheric noise;

— industrial noise.

STUDY PROGRAMME 25D/X

LF, MF AND HF SOUND BROADCASTING SYSTEMS

Reception of the sky-wave signal

The C.C.I.R., (1968)

DECIDES that the following studies should be carried out:

1. the nature of the distortion due to the effects of the ionosphere at distances beyond the ground-wave service area;
2. the degradation of the subjective quality of the sky-wave signal when received beyond the limit of the ground-wave service area, according to the system envisaged and as a function of distance and other possible factors, such as the geographical location of the transmitter, the frequency, the season of the year and the characteristics of the transmitting antenna;
3. the degree of distortion for a given percentage of time that would, after demodulation at the receiver, provide satisfactory sky-wave reception;
4. the reduction in distortion due to the effects of the ionosphere that can be secured by improvements in methods of detection, e.g. replacing the envelope detectors by other detection devices.

Note. — See also Question 11/X

STUDY PROGRAMME 25E/X

SOUND BROADCASTING SYSTEMS IN THE LF AND MF BANDS

Limitation of radiated power taking account of ionospheric cross-modulation

The C.C.I.R., (1968)

CONSIDERING that ionospheric cross-modulation can result from high-power radiation;

DECIDES that the following study should be carried out:

the maximum permissible radiated power in the LF and MF bands, as a function of the angle of elevation, to ensure that the effects of ionospheric cross-modulation are not disturbing.

Note. — See Questions 11/X and 13/X.

STUDY PROGRAMME 25F/X

SOUND BROADCASTING SYSTEMS IN THE LF, MF AND HF BANDS

Broadcasting coverage

The C.C.I.R., (1968)

DECIDES that the following studies should be carried out:

1. the dependence of ground-wave and sky-wave sound-broadcasting coverage on:
   - the characteristics of the system;
   - the radio-frequency protection ratios;
   - the channel spacing;
   - the minimum field-strength to be protected;
   - the radiated power;
   - the geographical distribution of the transmitters;
   - the use of directional transmitting antennae;
   - the use of groups of synchronized transmitters,

   for the LF, MF and HF bands;

2. methods for calculating the minimum number of channels required for the coverage in the LF and MF broadcasting bands, for each of the systems envisaged, taking into account the items listed under § 1 and the possibility of using computers.

Note 1. — The results of Study Programmes 24A/X, 24C/X, 24D/X and 24E/X and the propagation data worked out by Study Groups V and VI should be taken into account.

Note 2. — Attention is drawn to Resolution No. 5 of the African LF/MF Broadcasting Conference, Geneva, 1966, and to Resolution No. 614 of the Administrative Council of the I.T.U., Geneva, 1967, with particular respect to the problem of channel spacing.

LIST OF DOCUMENTS CONCERNING STUDY GROUP X
(Period 1963-1966)

No.	Submitted by	Title	Subject
X/1	E.B.U.	Signal-to-interference ratios in AM sound broadcasting	Q. 262
X/2	E.B.U.	An objective two-signal measuring method for determining the radio-frequency protection ratios for amplitude-modulated sound broadcasting	S.P. 262A
X/3	Federal Republic of Germany	Measurement of audio noise for broadcasting and in sound recording systems (Report 292)	S.P. 162
X/4	Federal Republic of Germany	Amplitude-modulation sound broadcasting—Protection ratios—Objective two-signal methods of measurements	Q. 262
X/5	Federal Republic of Germany	Amplitude-modulation sound broadcasting—Radio-frequency protection ratios—Objective two-signal method of measurements	S.P. 262A
X/6	Federal Republic of Germany	Standards of sound recording for the international exchange of programmes—Suitability of the tape-speed 3·75 in./s (9·525 cm/s) for the international exchange of programmes on magnetic tape	S.P. 161
X/7	Netherlands	Amplitude-modulation sound broadcasting services. (Compatible single-sideband (CSSB) transmissions)	S.P. 205A
X/8 (IV/16) (XI/3)	Canada	Draft Study Programme 241A(IV). Feasibility of direct sound and television broadcasting from satellites	Q. 241(IV)
X/9	E.B.U.	The influence of fading on the protection ratio and on the calculation of interference	Q. 262, § 3.1
X/10 and Corr. 1	Canada	Draft Recommendation. Recording standards for the international exchange of television programmes—Technical parameters of monochrome films and film recordings	Rec. 265
X/11	Canada	Draft Study Programme 66A(X). Reproducing standards for the international exchange of television programmes—Film recording	Q. 66
X/12	Canada	Draft Question. Measurement of modulation levels in frequency-modulation stereophonic broadcasting	Draft Q.
X/13	Canada	Draft Recommendation. Stereophonic broadcasting for frequency-modulation sound systems using a maximum frequency deviation of 75 kc/s	Q. 199 S.P. 199A
X/14	Sweden	Stereophonic broadcasting. Simultaneous transmission of two sound channels in television	Q. 199 S.P. 199A Q. 265
X/15	United Kingdom	Television recording	Q. 66
X/16	Netherlands	Stereophonic broadcasting. A single-sideband variant of the pilot-tone system of stereophonic broadcasting	S.P. 199A Rep. 300
X/17	United States of America	Stereophonic recording for broadcasting	Q. 200
X/18	United States of America	Standards of sound recording of the international exchange of programmes	S.P. 161

No.	Submitted by	Title	Subject
X/19	United Kingdom	Proposed modification to Recommendation 261. Standards of sound recording for the international exchange of programmes—Single track recording on magnetic tape	Rec. 261
X/20	United Kingdom	Stereophonic broadcasting—The effects on population coverage of introducing the pilot-tone system of stereophonic broadcasting into the United Kingdom VHF/FM service	Q. 199 S.P. 199A
X/21	United States of America	Low-and medium-frequency broadcasting—High-efficiency transmitting antennae	Q. 264
X/22	United States of America	Two separate programmes with the pilot-tone system	Q. 199 S.P. 199A
X/23	United States of America	Protection ratios for stereophonic broadcasting	Q. 199 S.P. 199A
X/24	United States of America	Television recording	Q. 266
X/25	United States of America	Recording of television signals on magnetic tapes	Q. 266
X/26	United States of America	Proposed modification to Study Programme 266A(X). Recording of television signals on magnetic tapes	S.P. 266A
X/27 and Corr. 1	United States of America	Recording standards for the international exchange of television programmes—Film recording	Q. 66 Rec. 265
X/28	Japan	Measurement of wow and flutter in recording equipment and in sound reproduction—Specification of an instrument for measuring the r.m.s. value of wow and flutter	S.P. 161
X/29	United States of America	Standards of sound recording for the international exchange of programmes (Reel-to-reel standards)	S.P. 161
X/30	Study Group X	Interim report by the Chairman—Broadcasting	
X/31	Federal Republic of Germany	Protection ratios in amplitude-modulation sound broadcasting—Interfering signal varying with time	Q. 262
X/32	Federal Republic of Germany	Amplitude-modulation sound-broadcasting services—Compatible single-sideband (CSSB) transmission—Laboratory tests on a CSSB transmission chain carried out according to the " Kahn " system	S.P. 205A
X/33	United States of America	Draft Question. Determination of subjective loudness	Draft Q.
X/34	United States of America	Polarization of frequency-modulation antennae in band 8	Draft Q.
X/35	France	Amplitude-modulation LF and MF broadcasting —Contribution to the assessment of protection ratios	Q. 262
X/36	France	Amplitude-modulation LF and MF broadcasting —Subjective assessment of stable interference	Q. 262
X/37	France	Contribution to the study of magnetic tape recording at low speeds	S.P. 161
X/38 (IV/82)	United States of America	Technical feasibility of direct broadcasting from earth satellites; sharing considerations for band 8 FM sound broadcasting	Q. 241(IV)

No.	Submitted by	Title	Subject
X/39	United Kingdom	Standards of sound recording for the international exchange of programmes	S.P. 161
X/40	United States of America	Polarization of FM antennae in band 8	
X/41	United States of America	Measurement of characteristics of signals recorded on magnetic tape	Rep. 79 S.P. 161
X/42	E.B.U.	Stereophonic broadcasting	
X/43	S. R. of Czechoslovakia	Compatible single-sideband (CSSB) transmission	Q. 205
X/44 (XI/47)	France	Colour television recording	Q. 266 Q. 118 (XI)
X/45	Federal Republic of Germany	Standards for stereophonic broadcasting	Q. 199 S.P. 199A
X/46	Japan	Simultaneous transmission of two sound channels in television	Q. 265
X/47	Italy	Television recording. Techniques of video film recording	Q. 66
X/48	Italy	Television recording—Interchangeability of magnetic tape recording video heads	Q. 66
X/49	Italy	High-frequency broadcasting — Directional antenna systems	Q. 23
X/50	C.C.I.R. Secretariat	List of documents issued (X/1 to X/50)	
X/51	C.C.I.R. Secretariat	Doc. IV/13 (Canada)—Time differences between the sound and vision components of a television signal	Q. 240 (IV) Q. 66 Q.270(CMTT) Rec. 265
X/52	O.I.R.T.	Technical Commission of the O.I.R.T., Prague, January, 1965, S.G. V—Some experiences with public stereophonic test-programme broadcasting	Q. 199
X/53	O.I.R.T.	Reduction of the service area of a VHF transmitter on transition from monophonic to stereophonic transmissions or in the case of two-programme transmissions using an AM sub-carrier procedure	S.P. 199A
X/54	O.I.R.T.	Stereo broadcasting—Reduction of the zone of coverage due to random and pulse interference	S.P. 199A
X/55	O.I.R.T.	On the usability of monophonic receivers for compatible reception of stereophonic broadcasts and of the main channel in the case of two-programme transmissions	S.P. 199A
X/56	O.I.R.T.	Studio-stereophonic engineering in Czechoslovakia	Q. 199
X/57	People's Republic of Poland	Simultaneous transmission of two sound channels in television	Q. 265
X/58	People's Republic of Poland	Single-sideband compatible transmissions—Measurement of dephasing in the AF and RF channels of high-power radio transmitters	S.P. 205A
X/59	U.S.S.R.	Standards of the quality indices of two-channel stereophonic broadcasting systems	Q. 199 S.P. 199A
X/60	U.S.S.R.	Proposed modification to Rec. 261, § 9.1—Standards of sound recording for the international exchange of programmes—Single-track recording on magnetic tape	Rec. 261 S.P. 161
X/61	U.S.S.R.	Sound transmission in television in two languages	Q. 265

No.	Submitted by	Title	Subject
X/62	United States of America	The pilot-tone system for countries using $\pm$ 50 kHz deviation	Q. 199 S.P. 199A
X/63	O.I.R.T.	Opinion of the O.I.R.T. on the choice of a system for stereophonic broadcasting	S.P. 199A
X/64	United Kingdom	Recording of monochrome television signals on magnetic tape sound channel characteristics	Rep. 295
X/65	United Kingdom	Measurement of programme level in sound broadcasting	Rep. 292
X/66 (XI/69)	C.C.I.R. Secretariat	Summary record of the opening session	
X/67	United Kingdom	Measurement of audio noise for broadcasting and in sound recording systems	S.P. 162
X/68	Federal Republic of Germany	Proposed modification to Rec. 409—Measurement of wow and flutter in recording equipment and in sound reproduction	Rec. 409
X/69	United States of America	The relay of stereophonic programmes by a space satellite using the pilot-tone system	Q. 199 S.P. 199A
X/70	O.I.R.T.	Radio transmission of two signals by means of a VHF transmitter using an AM sub-carrier	Rep. 300 Q. 199 S.P. 199A
X/71	O.I.R.T.	O.I.R.T. Reference tapes	S.P. 161 Rec. 261
X/72	O.I.R.T.	Magnetic tape recording for the international programme exchange	S.P. 161 Rec. 261
X/73	Study Group X	First report by Sub-Group X-B	
X/74	Study Group X	Summary record of the first meeting	
X/75	United Kingdom	Amplitude-modulation sound broadcasting services—Compatible single-sideband (CSSB) transmission	S.P. 205A
X/76	Sub-Group X-B	Recommendation—Signal-to-interference ratios in AM sound broadcasting—Definitions	Q. 262
X/77	Sub-Group X-A	Draft Report—Measurement of audio noise for broadcasting and in sound-recording systems	S.P. 162
X/78	Sub-Group X-A	Draft Study Programme—Determination of the subjective loudness of a programme	
X/79	Working Party X-B-2	Report of Working Party X-B-2	
X/80	Sub-Group X-A	Draft Recommendation—Standards of sound recording for the international exchange of programmes—Single-track recording on magnetic tape	
X/81 and Rev. 1	Sub-Group X-A	Question 200 (X)—Stereophonic recording for broadcasting	
X/82	Sub-Group X-C	Draft Question—Equipment for monitoring frequency-modulation stereophonic broadcasting	
X/83	Study Group X	Amendment to Question 205(X)—Compatible single-sideband (CSSB) transmission for amplitude-modulation sound broadcasting services	
X/84	Study Group X	Amendments to Report 299—Compatible single-sideband transmission (CSSB) for amplitude-modulation sound broadcasting service	
X/85	Study Group X	Draft Report—Low- and medium-frequency broadcasting—High efficiency transmitting antennae	Q. 264

No.	Submitted by	Title	Subject
X/86	Study Group X	Supplement to Report 32—High frequency broadcasting directional antenna systems	
X/87	Sub-Group X-A	Proposed Revision of Rec. 264 (2nd edition)—International exchange of television programmes on film	
X/88	Sub-Group X-A	Answers to Question 66(X)—Television recording	
X/89	Working Party X-A-2	Proposed revision to Rec. 265—Standards for the international exchange of monochrome television programmes on film	
X/90 (XI/88)	Joint Sub-Group X-B/ XI-B	Transmission of Docs. IV/107 and IV/108 of Monte-Carlo 1965—Feasibility of direct sound and television broadcasting from satellites	Q. 241 (IV)
X/91	Sub-Group X-C	Draft Question—FM Broadcasting in the VHF band—Polarization of emissions	
X/92	Sub-Group X-C	Draft Question—Equipment for monitoring frequency-modulation stereophonic broadcasting	
X/93 (XI/95)	Joint Sub-Group X-B/ XI-B	Draft Question—Direct broadcasting service from satellites (sound and television)	
X/94 (XI/101)	Study Groups X and XI	Report of the Joint Sub-Group X-B/XI-B	
X/95	Sub-Group X-A	Draft Report—Standards for the international exchange of monochrome television programmes on film	Rec. 265
X/96	Sub-Group X-A	Draft Study Programme—Standards for the international exchange of monochrome television programmes—Film recording and reproducing	
X/97	Sub-Group X-A	Proposed modification to Rec. 407—Sound recording for the international exchange of programmes	
X/98	Sub-Group X-A	Opinion—Recording standards for the international exchange of programmes	
X/99	Sub-Group X-A	Proposed revision of Annex III, Report 295	
X/100	C.C.I.R. Secretariat	List of documents issued (X/51 to X/100)	
X/101	Sub-Group X-A	Proposed modification to Study Programme 266A(X)—Recording of television signals on magnetic tapes	
X/102 and Rev. 1	Sub-Group X-C	Stereophonic systems for VHF frequency-modulation broadcasting	Draft Rec.
X/103	Sub-Group X-A	Measurement of programme level in sound broadcasting	Rep. 292
X/104	Sub-Group X-A	Proposed modification to Rec. 409—Measurement of wow and flutter in recording equipment and in sound reproduction	
X/105	Sub-Group X-A	Draft amendment to Recommendation 408	
X/106	Sub-Group X-A	Draft Question—Measurement of characteristics of signals recorded on magnetic tape	
X/107	Sub-Group X-C	Draft Report—Simultaneous transmission of two sound channels in television	Q. 265
X/108	Sub-Group X-B	Amplitude-modulation sound broadcasting—AF wanted-to-interfering signal ratios; objective two-signal methods of measurement	Draft Rep.

No.	Submitted by	Title	Subject
X/109	Sub-Group X-C	Draft Report—Audio-frequency parameters for the stereophonic reproduction of sound	S.P. 199A
X/110	Sub-Group X-B	Proposed revision of Report 298—Protection ratios for amplitude-modulation sound broadcasting	
X/111	Sub-Group X-B	Draft Recommendation—Amplitude-modulation sound broadcasting—RF protection ratio curve	Q. 262
X/112	Sub-Group X-B	Draft Question—Amplitude-modulation sound broadcasting—Optimum use of the LF and MF broadcasting bands	
X/113	Study Group X	Second report by Sub-Group X-B—(Long-, medium- and short-wave broadcasting)	
X/114	Sub-Group X-C	Draft Report—Stereophonic broadcasting	Q. 199 S.P. 199A
X/115	Study Group X	Summary record of the second meeting	
X/116	Study Group X	Summary record of the third meeting	
X/117 (XI/119)	Study Groups X & XI	Summary record of the joint closing meeting	
X/118 (XI/120)	C.C.I.R. Secretariat	List of participants S.G. X & XI	
X/119	C.C.I.R. Secretariat	List of documents issued (X/101 to X/119)	
X/120	C.C.I.R. Secretariat	Comments by the Administration of the United Kingdom on Question 303 (X)	Q. 303
X/121	United Kingdom	Low- and medium-frequency broadcasting—High-efficiency transmitting antennae	Q. 264
X/122	United Kingdom	Measurement of the characteristics of sound signals recorded on magnetic tape	Q. 304
X/123	United Kingdom	Measurement of audio noise for broadcasting and in sound recording systems	Draft Rep.
X/124	United Kingdom	High- frequency broadcasting—Directional antenna systems	S.P. 23A
X/125 (IV/205)	United States of America	Technical feasibility of direct broadcasting from earth satellites—Sharing considerations for AM broadcasting in band 7	Q. 241 (IV) Q. 306
X/126	Federal Republic of Germany	Standards for the international exchange of monochrome television programmes—Film recording and reproducing	Q. 303
X/127	Federal Republic of Germany	Determination of the subjective loudness of a broadcasting programme	Q. 300
X/128	Australia	Study Programme—Sound-reproducing standards for the international exchange of television programmes—Film recording	Q. 66
X/129	Sweden	Swedish comments to the texts relating to the work of Study Group X	Draft Rep.
X/130	Canada	Subjective loudness and measurement of the subjective loudness of sounds	Q. 300
X/131	United States of America	Proposed revision of Recommendation 261—Specification and measurement of characteristics of signals recorded on magnetic tape	Rec. 261

No.	Submitted by	Title	Subject
X/132	E.B.U.	Proposed modifications to Draft Recommendation E.2.c(X)—Amplitude-modulation sound broadcasting—Curve of radio-frequency protection ratio	Draft Rec.
X/133	E.B.U.	Objective measuring method filter circuit for obtaining the signal corresponding to the standardized " coloured " noise	S.P. 262A Draft Rep.
X/134	E.B.U.	MF broadcasting coverage	Q. 305
X/135	Switzerland	Comments on Draft Recommendation E.2.b (X) —Stereophonic systems for VHF frequency-modulation broadcasting	Draft Rec.
X/136	United States of America	A description of the broadcast cartridge tape system in the U.S.A.	S.P. 161
X/137	United States of America	Determination of the subjective loudness of a broadcasting programme	Q. 300
X/138	I.F.R.B.	Amplitude-modulation sound broadcasting. Radio-frequency protection ratio curve	Draft Rec.
X/139	E.B.U.	Recording of monochrome television signals on magnetic tape	Q. 266 Draft Rep.
X/140	E.B.U.	Recommendations concerning the production and the reproduction of monochrome films intended for television	Q. 303
X/141	E.B.U.	Use of 35 COMMAG film for international exchange of television programmes	Draft Rec.
X/142	Chairman S.G. X	Report by the Chairman of Study Group X	
X/143	Japan	Simultaneous transmission of two sound channels in television	Draft S.P.
X/144	Japan	Proposed modifications to Draft Report E.2.i (X) —Simultaneous transmission of two sound channels in television	Draft Rep.
X/145 (IV/188)	O.I.R.T.	Computation of protection field strength and interference of sky waves in the 150-1500 kc/s frequency range at distances from 300 to 3000 km	Draft Rec. Draft Rep. Q. 262, 263
X/146	United States of America	A phase monitor for the pilot-tone system of stereophonic broadcasting	Q. 302
X/147	O.I.R.T.	Considerations on a draft Recommendation for tolerances in stereophonic broadcasting	S.P. 199A Draft Rep.
X/148	France	Amplitude-modulation sound broadcasting—MF broadcasting coverage	Q. 305
X/149	L. M. Ericsson	Techniques for checking the essential characteristics of frequency-modulation stereophonic broadcasting	Q. 302
X/150	C.C.I.R. Secretariat	List of documents issued (X/121-X/150)	
X/151	Italy	Draft amendment to Question 301(X)—FM broadcasting in the VHF band—Polarization of emissions	Q. 301
X/152	Italy	Draft amendment to Draft Report E.2.d(X)—High-frequency broadcasting—Directional antenna systems	Q. 23
X/153	Italy	Measurement of characteristics of sound signals recorded on magnetic tape	Q. 304

No.	Submitted by	Title	Subject
X/154	O.I.R.T.	Determination of subjective programme level in sound broadcasting	Q. 300 Rep. 293
X/155	O.I.R.T.	Measurement of audio noise for broadcasting and in sound-recording systems	S.P. 162
X/156	Study Group X	Summary record of the first meeting	
X/157	Italy	Standardization of the texts of C.C.I.R. Study Group X to bring them into line with the definitions given in Draft Recommendation E.2.a (X)	Draft Rec.
X/158	Italy	LF/MF sound broadcasting—RF protection ratio for emissions on the same frequency	Q. 262
X/159 and Rev. 1	E.B.U.	Draft Recommendation—LF/MF sound broadcasting—RF protection ratio	
X/160	E.B.U.	RF protection-ratio curves	Q. 262
X/161	France	Contribution to the study of possible interference on the intermediate-frequency of sound broadcast receivers	Q. 305
X/162	U.S.S.R.	Basic results of tests with polar-modulation stereophonic broadcasting systems	Q. 199
X/163	U.S.S.R.	Some stereophonic detector circuits for polar-modulation stereophonic broadcasting systems	Q. 199
X/164	Working Group X-B	Broadcasting on long, medium and short waves	
X/165	United States of America	Draft Question—Simultaneous transmission of two or more sound channels in FM broadcasting	
X/166	Working Group X-B	Amendments to Draft Report E.2.j (X)—Amplitude-modulation sound broadcasting	
X/167 and Rev. 1	Study Group X	Amendment to Draft Question 305 (X)—Amplitude-modulation sound broadcasting—Broadcasting coverage	
X/168	Working Group X-B	Draft Recommendation—Amplitude-modulation sound broadcasting—RF protection-ratio curves	Q. 262
X/169 (III/130)	Ad Hoc Committee X/III	Consideration of Doc. III/43 (Rev. 1), Draft Report C.t (III) and Doc. III/86 (Rev. 1), Draft Report C.aa (III)	
X/170	Working Group X-A	Draft Question 303(X) (revised)—Standards for the international exchange of monochrome television programmes—Film recording and reproducing	
X/171	Working Group X-A	Proposed modifications to Draft Report E.1.k (X) (revised)—Standards for the international exchange of monochrome television programmes on film	Draft Rec.
X/172	Study Group X	Proposed revision of Draft Recommendation E.1.c(X)—Standards for the international exchange of monochrome television programmes on film	
X/173	Working Group X-C	Draft amendment to Question 301(X)—FM broadcasting in the VHF band—Polarization of emissions	

No.	Submitted by	Title	Subject
X/174	Working Group X-C	Amendment to Draft Recommendation E.2.b (X)—Stereophonic systems for VHF frequency-modulation sound broadcasting	
X/175	Working Group X-C	Draft Study Programme 265—Simultaneous transmission of two sound channels in television—An effective method of objective measurement of crosstalk for comparing systems for the simultaneous transmission of two sound channels in television	Q. 265
X/176, Rev. 1 and 2	Working Group X-C	Draft Question—Simultaneous transmission of two or more sound channels in FM broadcasting	
X/177	Study Group X	Revision of Draft Recommendation E.1.a(X)—Standards of sound recording for the international exchange of programmes	
X/178	Study Group X	Revision of Draft Recommendation E.1.d(X)—Sound recording for the international exchange of programmes	
X/179	Study Group X	Revision of Draft Opinion E.1.l(X)—Sound-recording standards for the international exchange of broadcasting programmes	
X/180	Study Group X	Draft Report—Measurement of characteristics of sound signals recorded on magnetic tape	Q. 304
X/181	Study Group X	Draft Question—Optical sound-reproducing standards for the international exchange of television programmes	
X/182	Study Group X	Proposed revision of Draft Recommendation E.1.b(X)—International exchange of monochrome television programmes on film	
X/183	Study Group X	Revision of Draft Recommendation E.1.e(X)—Standards of sound recording for the international exchange of programmes	
X/184	Working Group X-B	Draft Report — High-frequency broadcasting directional antenna systems	Q. 23 S.P. 23A
X/185	Working Group X-B	Draft Report—Low- and medium-frequency broadcasting—High efficiency transmitting antennae	Q. 264
X/186	Working Group X-B	Draft Recommendation—LF/MF sound broadcasting—RF protection ratio	Q. 262
X/187	Working Group X-C	Amendment to Report E.2.g (X)—Stereophonic broadcasting	Q. 199 S.P. 199A
X/188	Working Group X-C	Draft Study Programme—Audio-frequency parameters for individual sections of the stereo transmission chain	Q. 199, § 3
X/189	Working Group X-C	Draft Study Programme—Techniques for checking the characteristics of stereophonic modulations: parameters and methods	Q. 302
X/190 (IV/293) (XI/186)	Ad Hoc Joint Study Group IV/X/XI	First report of the ad hoc Joint Study Group IV/X/XI—Satellite broadcasting	
X/191	Working Group X-B	Second report by Working Group X-B—LF, MF and HF broadcasting	
X/192	Working Group X-C	Amendments to Draft Report E.1.h (X)	
X/193	Working Group X-C	Amendment to Study Programme 199A (X)	
X/194	Working Group X-C	Draft Study Programme—Audio-frequency parameters for individual sections of the stereo transmission chain	Q. 199, § 3

No.	Submitted by	Title	Subject
X/195	Working Group X-C	Draft Report—Techniques for checking the essential characteristics of frequency-modulation stereophonic characteristics	Q. 302
X/196	Working Group X-B	Modifications of Opinion 15	
X/197	Working Group X-B	Draft Report—Amplitude-modulation sound broadcasting—MF broadcasting coverage	Q. 305
X/198	Working Group X-A	Note to the Chairman of Study Group X—Determination of subjective loudness of a broadcasting programme	Q. 300
X/199	Working Group X-A	Revision of Draft Study Programme 266B (X)—Recording of television signals on magnetic tape	
X/200	C.C.I.R. Secretariat	List of documents issued (X/151 to X/224)	
X/201	Working Group X-A	Report E.1.i(X) (revised)—Recording of monochrome signals on magnetic tape	Q. 266
X/202	Working Group X-A	Revision of Draft Recommendation E.1.f (X)—Measurement of wow and flutter in recording equipment and in sound reproduction	
X/203	Working Group X-A	Revision of Draft Report E.1.g (X)—Measurement of programme level in sound broadcasting	
X/204	Working Group X-A	Revision of Draft Report E.1.j (X)—Measurement of audio noise for broadcasting and in sound-recording systems	S.P. 162
X/205	Working Group X-B	Modifications of Recommendation 413	
X/206	Working Group X-B	Standardization of the texts of C.C.I.R. Study Group X to bring them into line with the definitions given in Draft Recommendation E.2.a (X)	
X/207	Working Group X-B	Revision of Draft Report E.2.e (X)—Protection ratios	
X/208	C.C.I.R. Secretariat	Submission of Doc. VI/165—The absorption of medium-frequency skywaves by close coupling to the extraordinary mode	
X/209 (IV/295) (XI/187)	Joint Study Group IV/X/XI	Draft revision of Question 306 (X/XI)—Direct broadcasting-service from satellites—Sound and television	
X/210 (IV/319) (XI/194)	Joint Study Group IV/X/XI	Draft Question—Feasibility of direct sound and television broadcasting from satellites	
X/211 (IV/320) (XI/195)	Joint Working Group IV/X/XI	Draft Study Programme—World-wide standard for television broadcasting from satellites	
X/212 (IV/321) (XI/196)	Joint Working Group IV/X/XI	Draft Study Programme—Composite 625-line signal for television broadcasting from satellites	
X/213	Working Group X-B	Opinion 18	
X/214	Working Group X-B	Recommendation 205	
X/215	Working Group X-B	Draft Question—The absorption of medium-frequency sky-wave by close coupling to the extraordinary mode	

No.	Submitted by	Title	Subject
X/216 (IX/292) (CMTT/ 80)	Joint Ad Hoc Working Party, S.G. IX/X/CMTT	Report by the Chairman	
X/217 (IV/257 and Rev. 1) (XI/188), Add. 1 and Corr. 1	Joint Working Group IV/X/XI	Proposed modification to Draft Report L.3.a (IV) Feasibility of direct sound and television broadcasting from satellites	Q. 283 (IV) Q. 306 (X/XI) Rec. No. 5A, (EARC, 1963)
X/218	Working Group X-B	Third report—Low-, medium- and high-frequency broadcasting	
X/219 (IV/332) (XI/215)	Joint Study Group IV/X/XI	Second report—Broadcasting from satellites	
X/220	Study Group X	Summary record of the second meeting	
X/221	Study Group X	Summary record of the third meeting	
X/222	Study Group X	Summary record of the fourth meeting	
X/223	Study Group X	Summary record of the fifth meeting	
X/224	Study Group X	Status of texts	

LIST OF DOCUMENTS OF THE XIth PLENARY ASSEMBLY ESTABLISHED BY STUDY GROUP X

No.	Title	Final text
X/1001 and Add. 1	Amplitude-modulation sound broadcasting	Rep. 399
X/1002	Amplitude-modulation sound broadcasting—RF protection-ratio curves	Rec. 449
X/1003	High-frequency broadcasting—Directional antenna systems	Rep. 321-1
X/1004	Low- and medium-frequency broadcasting—High-efficiency transmitting antennae	Rep. 401
X/1005	Optical sound-recording and reproducing standards for the international exchange of television programmes	Q. 6/X
X/1006	International exchange of monochrome television programmes on film	Rec. 264-1
X/1007	LF/MF sound broadcasting—RF protection ratio	Rec. 448
X/1008	Tolerances for the audio-frequency parameters of the stereophonic transmission chain	S.P. 15B/X
X/1009	Checking stereophonic modulation; characteristics, parameters and methods	S.P. 16A/X
X/1010	Amplitude-modulation sound broadcasting—Broadcasting coverage	Q. 9/X
X/1011	Standards for the international exchange of monochrome television programmes on film	Rep. 294-1
X/1012	Measurement of characteristics of sound signals recorded on magnetic tape	Rep. 79-1
X/1013	Measurement of audio noise in broadcasting and in sound-recording systems	Rep. 398
X/1014	Measurement of programme level in sound broadcasting	Rep. 292-1
X/1015	Measurement of wow and flutter in recording equipment and in sound reproduction	Rec. 409-1
X/1016	Sound-recording standards for the international exchange of broadcasting programmes	Op. 31
X/1017 and Add. 1	Recording of monochrome television signals on magnetic tape	Rep. 295-1
X/1018	Standards of sound recording for the international exchange of programmes—Single-track recording on magnetic tape	Rec. 261-1
X/1019	Sound recording for the international exchange of programmes	Rec. 407-1
X/1020	Standards of sound recording for the international exchange of programmes—Two-track stereophonic recording on magnetic tape	Rec. 408-1
X/1021	Standards for the international exchange of monochrome television programmes—Film recording and reproducing	Q. 5/X
X/1022	Compatible single-sideband transmission (CSSB) for amplitude-modulation sound-broadcasting services	Rep. 299-1
X/1023	Audio-frequency parameters for the stereophonic reproduction of sound	Rep. 293-1
X/1024	Frequency-modulation stereophonic broadcasting—Techniques for checking the essential modulation characteristics	Rep. 402
X/1025	Stereophonic broadcasting	Rep. 300-1
X/1026	Simultaneous transmission of two or more sound programmes in FM broadcasting	Q. 17/X
X/1027	Simultaneous transmission of two sound channels in television—Objective method of measurement of crosstalk	S.P. 18A/X
X/1028	Protection ratios for amplitude-modulation sound broadcasting	Rep. 298-1

No.	Title	Final text
X/1029	Amplitude-modulation sound broadcasting—MF broadcasting coverage	Rep. 400
X/1030	Stereophonic systems for VHF frequency-modulation broadcasting	Rec. 450
X/1031	High-frequency broadcasting—Use of synchronized transmitters	Rec. 205-1
X/1032	FM broadcasting in the VHF band—Polarization of emissions	Q. 19/X
X/1033	Use of the 26-Mc/s broadcasting band	Op. 15-1
X/1034	Medium-frequency broadcasting reduction of sky-wave field strength	Q. 11/X
X/1035	Presentation of the results of measurements of RF protection ratios for amplitude-modulation sound broadcasting	Rec. 413-1
X/1036	Standards for the international exchange of monochrome television programmes on film	Rec. 265-1
X/1037	Signal-to-interference ratios in a.m. sound-broadcasting definitions	Rec. 447
X/1038	Stereophonic broadcasting—Standards for compatible systems in sound and television broadcasting	S.P. 15A/X
X/1039 (XI/1023)	Direct broadcasting service from satellites	Q. 20/X
X/1040	Simultaneous transmission of two sound channels in television	Rep. 403
X/1041	High-frequency broadcasting—Bandwidth of emissions	Rep. 297-1
X/1042	Amplitude-modulation sound broadcasting—RF protection ratios—Objective two-signal methods of measurements	S.P. 8A/X
X/1043	High-frequency broadcasting—Conditions for satisfactory reception	Rec. 411-1
X/1044	High-frequency broadcasting—Effects of closer spacing between carriers	Rec. 262-1
X/1045	Amplitude-modulation sound-broadcasting protection ratios	Q. 8/X
X/1046	Amplitude-modulation sound-broadcasting services—Compatible single-side-band (CSSB) transmissions	S.P. 12A/X
X/1047	Deletion of Opinion 18	Op. 18
X/1048	List of documents issued (X/1001 to X/1048)	

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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. General

The terms of reference of Study Group XI include matters pertaining to television. The following are the main problems under consideration:

— television standards,

— ratio of the wanted-to-unwanted signal in television,

— assessment of the quality of television pictures.

In connection with the above, the Study Group is occupied with many other problems, such as the transmission of television signals over long distances, exchange of television programmes, the minimum field strength to be protected when television frequency plans are being drawn up, standards conversion, insertion of special signals in the field-blanking interval, stereoscopic television, and so on.

2. Television standards

2.1 At its Interim Meeting, Vienna, 1965, Study Group XI revised Report 308 (Characteristics of black-and-white television systems), and this Report was adopted, with a few amendments, by the XIth Plenary Assembly. Report 308-1 contains Tables showing, in detail, the characteristics of the various kinds of monochrome television systems in use.

2.2 Between the Xth and XIth Plenary Assemblies of the C.C.I.R., the most important question on the Study Group's agenda was that of colour television standards in bands IV and V. Progress had been made in the study of this matter at the Interim Meeting, Moscow, 1958, where all the European countries had stated their intention of adopting a channel spacing of 8 MHz, so as to ensure uniform channel distribution and hence a more rational use of the spectrum. Many countries with networks operating television in bands I and III with standards other than 625-lines have adopted this standard for bands IV and V. All the countries which have adopted 625-lines as a standard have also adopted 4·43 MHz as the colour sub-carrier frequency.

Not all the countries represented at the XIth Plenary Assembly were ready for the adoption of a common standard. It was considered that investigations should be pursued.

Despite these studies, Study Group XI was unable, either at the Interim Meeting, Vienna, 1965, or at the XIth Plenary Assembly, Oslo, 1966, to issue a Recommendation urging the European countries to adopt a single common standard.

It was only able to approve Report 407 (Characteristics of colour-television systems), which reproduces, for information purposes, the standards of the various colour-television systems, either in use or under consideration at the time the XIth Plenary Assembly met.

Report 406 gives a brief analysis of the behaviour of three-colour television systems (NTSC 625-line, PAL and SECAM III) from the standpoint of the technical factors mentioned in Question 118 (XI).

2.3 Report 312 (Stereoscopic television), which describes, in particular, experimental methods used in the United States and the Soviet Union, was slightly amended.

2.4 As regards television transmission, the Plenary Assembly adopted various texts on long-distance television transmission. In this field, Study Group XI is cooperating with the CMTT (Joint Study Group for Television Transmissions).

2.5 On the question of the international exchange of television programmes, the Study Group produced a revised text for Report 310 on standardization of the video signal for the 625-line system.

2.6 The problem of the conversion of television signals from one standard to another was considered in Vienna. On the basis of the Vienna document, the Plenary Assembly prepared and adopted a Report describing the present position of the question.

2.7 With regard to the insertion of special signals in the field-blanking interval, the XIth Plenary Assembly amended the Recommendation specifying the characteristics of a special signal to be inserted in such intervals for the international transmission of television signals.

3. Ratio of the wanted-to-unwanted signal in television

3.1 For monochrome television, the XIth Plenary Assembly slightly modified Recommendation 418, which gives the protection ratios to be used for planning purposes. It also made some slight changes in Recommendation 417, on the minimum field strength to be protected in planning a television service.

4. Assessment of the quality of television pictures

The Plenary Assembly adopted an amended version of Report 313. It also adopted Report 405, prepared in Vienna, which summarizes the main characteristics of the various methods of assessing the quality of a television picture.

5. Conclusions

It will be seen that the Study Group has to find solutions for many problems. Recommendations, Reports, etc., have been adopted, but many questions remain outstanding, amongst them the numerous problems posed by the introduction of colour television.

QUESTION 1/XI *

COLOUR TELEVISION STANDARDS

The C.C.I.R., (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 (see Note);

— frequency planning;

— international exchange of programmes;

— scope for development;

— the differences between bands I and III, as compared with bands IV and V.

Note. — 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.

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* Formerly Question 118(XI).

STUDY PROGRAMME 1A/XI *

STANDARDS FOR VIDEO COLOUR TELEVISION SIGNALS

The C.C.I.R. (1965)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the preferred colorimetric parameters for representing the television picture;
2. the gamma pre-correction;
3. the scanning standards that can be recommended, e.g. sequential (field, line, dot), simultaneous or mixed;
4. comparison of the various methods of coding and decoding the colour picture information;
5. the minimum acceptable bandwidths for the signal components, corresponding to these parameters.

STUDY PROGRAMME 1B/XI **

STANDARDS FOR RADIATED COLOUR TELEVISION SIGNALS

The C.C.I.R. (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 1(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 1C/XI ***

CONSTITUTION OF A SYSTEM OF STEREOSCOPIC TELEVISION

The C.C.I.R., (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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* Formerly Study Programme 118A(XI).

** Formerly Study Programme 118B(XI).

*** Formerly Study Programme 118C(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 2/XI *

EXCHANGE OF TELEVISION PROGRAMMES

The C.C.I.R., (1966)

CONSIDERING

(a) that it is desirable to exchange television programmes between countries;

(b) that a variety of television standards is in use;

(c) that the number of scanning standards used throughout the world tends to be reduced to two, namely the 525 lines, 60 fields per second standard and the 625 lines, 50 fields per second one, the line frequencies of which are very near;

UNANIMOUSLY 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.

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* Formerly Question 307(XI).

QUESTION 3/XI *

ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

The C.C.I.R., (1951—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 3A/XI **

SUBJECTIVE ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

The C.C.I.R., (1963—1966)

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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* Formerly Question 152(XI).

** This Study Programme replaces Study Programme 152A.

— 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;

3. on the use of the methods described in §§ 1 and 2 during international transmissions.

QUESTION 4/XI *

RATIO OF THE WANTED-TO-UNWANTED SIGNAL IN TELEVISION

The C.C.I.R., (1955—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 1. — 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.

Note 2. — See Recommendation 418-1 for monochrome television and Report 306 for colour television.

Note 3. — See Report 307 for protection against radionavigation transmitters.

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* Formerly Question 267(XI).

STUDY PROGRAMME 4A/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., (1959—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 (see Recommendation 418-1);

(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.

Note. — See Report 306 for information on protection ratios for colour television, when the carrier frequency differences between wanted and unwanted signals are small.

QUESTION 5/XI **

DIRECT BROADCASTING SERVICE FROM SATELLITES

(Sound and Television)

The C.C.I.R., (1965—1966)

CONSIDERING

(a) Recommendation No. 5A of the Extraordinary Administrative Radio Conference, Geneva, 1963;

(b) that broadcasting from satellites will soon become possible because of technological progress;

(c) that the broadcasting services must take into account all the technical consequences of broadcasting from satellites and, in particular, of the possible sharing of frequency bands between the satellite and the terrestrial broadcasting services;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what are the optimum transmission characteristics for single and multiple broadcasting from satellites;

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* Formerly Study Programme 267A(XI).

** This Question, which replaces Question 308 and is identical with Question 20/X, will be studied jointly by Study Group X and Study Group XI, in connection with Question 12/IV. Contributions to the study of this Question should be brought to the attention of participants in the work of Study Group IV.

2. what are the frequency bands which are technically suitable for broadcasting from satellites;

3. are there any possibilities for sharing frequency bands between the satellite and terrestrial broadcasting services, and what, if any, are the practical conditions for such sharing;

4. what are the values of field strength necessary to provide a satisfactory satellite broadcasting service and to protect the terrestrial broadcasting service if sharing is envisaged?

STUDY PROGRAMME 5A/XI

WORLD-WIDE STANDARD FOR TELEVISION BROADCASTING FROM SATELLITES

The C.C.I.R., (1966)

CONSIDERING

(a) that the line-of-sight propagation from satellites presents the possibilities of exploiting bands not at present used for television broadcasting;

(b) that, with the use of a new band, a new transmission standard may be desirable;

(c) that use of the wide coverage possibilities of television broadcasting from artificial satellites is simplest if a single standard is used within the coverage area;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. determination of the frequency bands technically suitable for this service;

2. determination of the values of the parameters controlling picture and sound quality (resolution, permissible contrast range and brightness, etc.) and, if different from existing standards, the reason for the differences;

3. establishment of a basic transmission system, including the method of modulation which could provide high-quality monochrome and colour reception, and also acceptable monochrome reception with low-cost receivers;

4. the possibility of transmitting the colour information within the video spectrum of the luminance signal;

5. the number of sound channels which could be provided and the manner in which they could be transmitted.

STUDY PROGRAMME 5B/XI

COMPOSITE 625-LINE SIGNAL FOR TELEVISION BROADCASTING FROM SATELLITES

The C.C.I.R., (1966)

CONSIDERING

(a) that television broadcasting from satellites is inherently a wide area service;

(b) that transmitting on existing television standards in bands currently used may be a method of instituting such a service;

(c) that there are numerous variations between existing standards, especially in the 625-line systems;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the possibility that satisfactory results can be obtained on receivers built to existing standards' without change, or with a minimum number of changes when receiving a composite 625-line transmission, composed of one vision signal plus two, three or more sound signals;
2. the possibility of accomplishing any necessary changes by adapters (introduced, for example, between the picture tube and its connecting socket);
3. the increases in receiver complexity that would be incurred if dual standard receivers were to be developed for reception of an existing standard and the composite signal.

QUESTION 6/XI

GHOST IMAGES IN TELEVISION

The C.C.I.R., (1966)

CONSIDERING

(a) that it is often necessary to locate a television transmitting antenna in the vicinity of other antenna structures;

(b) that this can result in undesirable ghost images in the received picture;

UNANIMOUSLY DECIDES that the following question should be studied:

1. what factors must be considered to ensure satisfactory ghost-free operation;
2. how can these factors be evaluated?

STUDY PROGRAMME 6A/XI

GHOST IMAGES IN TELEVISION

The C.C.I.R. (1966)

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. the ratio of direct-to-delayed reflected signal required for satisfactory television service, taking into account:
   - polarity of the ghost images;
   - displacement of ghost images from wanted images;

   the method of calculation to be used to determine the ratio and displacement of the direct and reflected signals which result from antenna structures in the vicinity of television radiators, taking into account factors such as radiation, polarization, etc.

QUESTION 7/XI *

RECOMMENDED CHARACTERISTICS FOR TELEVISION ANTENNAE FOR DOMESTIC USE

The C.C.I.R., (1965)

CONSIDERING

(a) that the antenna and its associated components are important elements of the transmission chain;

(b) that their characteristics have an influence on the performance of receivers;

(c) that this problem does not appear to have been sufficiently studied;

UNANIMOUSLY DECIDES that the following question should be studied:

what are the recommended characteristics for antennae for both individual and collective domestic use?

QUESTION 8/XI

ATTENUATED SIDEBAND CHARACTERISTICS FOR VESTIGIAL-SIDEBAND TELEVISION TRANSMISSION

The C.C.I.R., (1966)

CONSIDERING

(a) that vestigial-sideband transmission of television signals is accepted practice in broadcasting;

* Formerly Question 309(XI),

(b) that frequency planning is assisted by a knowledge of the unwanted out-of-band energy radiated on the vestigial-sideband side of the vision carrier;

(c) that the data contained in §§ 8 and 9 of Recommendation 212 are insufficient for frequency planning purposes and for the economical establishment of transmitters;

UNANIMOUSLY DECIDES that the following question should be studied:

what are the limits that should be specified for radiation outside the nominal width of the vestigial-sideband and what are the circumstances to which these limits apply?

STUDY PROGRAMME 8A/XI

ATTENUATED SIDEBAND CHARACTERISTICS FOR VESTIGIAL-SIDEBAND TELEVISION TRANSMISSION IN BANDS IV AND V

The C.C.I.R., (1966)

CONSIDERING

(a) that the degree of attenuation of the unwanted sideband given in Recommendation 212 imposes a requirement that is difficult to meet in the design of an economical transmitter for use in bands IV and V;

(b) that this degree of attenuation could be relaxed without giving rise to interference between television services using adjacent channels in these bands;

UNANIMOUSLY DECIDES that the following study should be carried out:

the attenuation characteristic of the vestigial-sideband which satisfies, in the most economical way, the requirements of frequency planning for both monochrome and colour television transmissions in bands IV and V.

STUDY PROGRAMME 8B/XI

ATTENUATED SIDEBAND CHARACTERISTICS FOR VESTIGIAL-SIDEBAND TELEVISION TRANSMISSION AT LOW POWERS

The C.C.I.R., (1966)

CONSIDERING

that to obtain a vestigial-sideband characteristic requires filtering, the cost of such filters being an appreciable part of the cost of low-power transmitters;

UNANIMOUSLY DECIDES that the following study should be carried out:

the circumstances in which relaxation of the attenuation of the unwanted energy radiated on the vestigial-sideband side of the vision carrier can be allowed in the case of low-power television transmitters.

STUDY PROGRAMME 9A/XI*

DISTORTION OF TELEVISION SIGNALS DUE TO THE USE OF VESTIGIAL-SIDEBAND TRANSMISSION

The C.C.I.R., (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.

STUDY PROGRAMME 10A/XI **

CONVERSION OF A TELEVISION SIGNAL FROM ONE STANDARD TO ANOTHER

The C.C.I.R. (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.

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* This Study Programme, formerly Study Programme 110(XI), does not arise from any Question at present under study.

** This Study Programme, formerly Study Programme 36(XI), does not arise from any Question at present under study.

STUDY PROGRAMME 11A/XI *

REDUCTION OF THE CHANNEL CAPACITY REQUIRED FOR A TELEVISION SIGNAL

The C.C.I.R., (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 12A/XI **

INSERTION OF SPECTRAL SIGNALS IN THE FIELD-BLANKING INTERVAL OF A TELEVISION SIGNAL

The C.C.I.R., (1962—1963—1966)

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, formerly Study Programme 119(XI), does not arise from any Question at present under study.

** This Study Programme, which replaces Study Programme 177, does not arise from any Question at present under study. It is identical with Study Programme 6A/CMTT.

(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 and for the transmission of information on the operation of international networks;

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. whether special signals can 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. the purposes for which such signals should be used internationally;

3. the points at which these signals should be inserted in the international television connection and, possibly, removed again;

4. the provisions to be made to avoid confusion between signals for national and international use;

5. the forms of special signal to be recommended for international use;

6. the position in the field-blanking interval of signals for measuring the characteristics of television networks;

7. the position in the field-blanking interval of signals associated with control functions and the transmission of operational information;

8. the best system of encoding for the signals referred to in § 7.

QUESTION 13/XI *

SPECIFICATIONS FOR LOW-COST TELEVISION RECEIVERS

(1968)

The C.C.I.R.

CONSIDERING

(a) Resolution 163 (VIII) adopted by the Economic Commission for Africa at its Eighth Session, Lagos, 13–25 February 1967;

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

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

(d) that general agreement on the performance of suitable television 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;

DECIDES that the following question should be studied:

to draw up performance specifications for one or more types of television receiver, suitable for production in large quantities at the lowest possible cost, the receivers to meet the requirements applying to the countries mentioned in § *(b)*.

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* This Question also concerns Study Group II, the Chairman of which should be kept informed of the results obtained by Study Group XI as they become available.

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LIST OF DOCUMENTS CONCERNING STUDY GROUP XI
(Period 1963-1966)

Doc.	Origin	Title	Reference
XI/1	C.C.I.R.	Report by Study Group XI, Colour Sub-Group	
XI/2	Federal Republic of Germany	Distortion of television signals due to the use of vestigial-sideband transmission—Recent investigations into the improvement of the transmission performance of the vestigial-sideband system for television by the introduction of quadrature correction	Q. 118 S.P. 110
XI/3 (IV/16) (X/8)	Canada	Draft Study Programme 241A(IV)—Feasibility of direct sound and television broadcasting from satellites	Draft S.P. 241A (IV) Q. 241 (IV)
XI/4 (CMTT/7) and Add. 1	Canada	Use of test and reference signals in the vertical blanking-interval on Canadian television networks	S.P. 177 S.P. 121A (CMTT)
XI/5	Switzerland	Television standards	Rec. 212 Rep. 309
XI/6	Switzerland	Gamma characteristics of the radiated signal in colour television	New S.P.
XI/7	Switzerland	World-wide standards for television	New Q.
XI/8	Canada	Draft Question. Ghost images in television	Draft Q.
XI/9	Canada	Draft Study Programme. Ghost images in television	Draft S.P. Draft Q.
XI/10	Canada	Draft Study Programme. Lower sideband characteristics for vestigial-sideband television transmission at lower powers	Draft S.P.
XI/11 (IV/13) (CMTT/1)	Canada	Time differences between the sound and vision components of a television signal	Q. 240 (IV) Q. 66 (X) Q.270(CMTT) Rec. 265
XI/12	United States of America	Relationship of aural to visual received powers—New York City UHF television project	Rep. 308
XI/13 and Corr. 1	United States of America	A study of UHF multicasting—New York City UHF-television project	
XI/14 (V/2)	United States of America	Relative effectiveness of indoor and roof-top television reception—New York City UHF television project	S.P. 189 (V)
XI/15 (V/3)	United States of America	Comparison of channel 31 measurements with C.C.I.R. propagation curves—New York City UHF television project	S.P. 189 (V)
XI/16	United Kingdom	Subjective assessment of the quality of television pictures	S.P. 152A Rep. 313
XI/17	United Kingdom	Proposed modification to Recommendation 212—Television standards—Suppression of unwanted sidebands	Rec. 212
XI/18	United Kingdom	Resolving power and differential sensitivity of the human eye	Q. 153

Doc.	Origin	Title	Reference
XI/19	United Kingdom	Conversion of a television signal from one standard to another—The B.B.C. line-store standards converters	S.P. 36 Rep. 311
XI/20	Japan	Colour television system with separate luminance	Q. 118 S.P. 118A
XI/21 (CMTT/8)	Japan	A method for the automatic monitoring of television	S.P. 121A (CMTT) §§ 1, 3
XI/22	O.I.R.T.	Study of the possibility of eliminating luminance-signal-delay at the receiving end	S.P. 118A
XI/23	O.I.R.T.	Distortion of television signals due to the use of vestigial-sideband transmission	S.P. 110
XI/24 (CMTT/9)	O.I.R.T.	Requirements for the transmission of monochrome television signals over long distances	Rec. 421 Q.121 (CMTT)
XI/25	O.I.R.T.	The effect on television signal quality of broadening of vestigial sideband	S.P. 110
XI/26	O.I.R.T.	Investigation of compatibility of the SECAM colour television system	Rep. 309
XI/27 (CMTT/11)	O.I.R.T.	Some parameters of a system for automatic remote supervision of the fundamental qualitative indices of television circuits	S.P. 121A (CMTT)
XI/28	O.I.R.T.	Distortion of TV signals due to the use of vestigial-sideband transmission	S.P. 110
XI/29	United States of America	Comparison of the receivers for NTSC, PAL and SECAM colour TV systems	Q. 118 S.P. 118A S.P. 118B
XI/30 (V/4)	United States of America	Height gain measurements for antennae 3·0 and 9·1 m above ground—New York City VHF —television project	
XI/31 and Corr. 1	Federal Republic of Germany	Subjective assessment of the quality of television pictures—Viewing conditions for the assessment of the quality of television pictures	S.P. 152A
XI/32 and Add. 1	Study Group XI	Interim report by the Chairman, Study Group XI —Television	
XI/33	E.B.U.	Colour television standards—Report of the E.B.U. ad-hoc Group on colour television	Q. 118 S.P. 118A S.P. 118B
XI/34	United States of America	Influence of clutter on the ratio of picture and sound terminal voltage	Rep. 308
XI/35	United States of America	The need for receiver colour controls in any system of colour television	Q. 118, 152, 153 S.P. 118B 152A
XI/36	United States of America	United States practice for the insertion of special signals in the field-blanking interval of a television signal	S.P. 177
XI/37 (IV/83)	United States of America	Technical feasibility of direct broadcasting from earth satellites. Sharing considerations for bands 8 and 9 television broadcasting	Q. 241 (IV)
XI/38	E.B.U.	Colour television standards	Q. 118 S.P. 118A S.P. 118B
XI/39	United Kingdom	Controllability of NTSC receivers	Q. 118

Doc.	Origin	Title	Reference
XI/40	United States of America	Comments on C.C.I.R. Doc. 33 (2nd Rev.), London 1964 Report of XI, Study Group Colour Sub-Group	
XI/41	United Kingdom	Colour television	Q. 118
XI/42	Czechoslovak S.R.	Frequency and transient responses of a radio-frequency television channel	R. 266 S.P. 110
XI/43	United Kingdom	Proposed sub-carrier pilot for NTSC—Type colour television	Q. 118
XI/44	People's Republic of Poland	Comparative assessment of the compatibility of the NTSC and SECAM III systems	S.P. 118B
XI/45	E.B.U.	Comparative tests of the transmission of colour TV pictures over long international circuits	Q. 118
XI/46	France	Some results of comparative measurements on the SECAM, PAL and NTSC colour television systems	Q. 118
XI/47 (X/44)	France	Colour television recording	Q. 266 (X) Q. 118
XI/48	France	Exchange of colour programmes between countries with different standards	Q. 118
XI/49	United Kingdom	Choice of subcarrier line and field frequencies for a dual-standard colour TV system	Q. 118 Q. 120
XI/50	C.C.I.R. Secretariat	List of documents issued (XI/1 to XI/50)	
XI/51	Switzerland	Tests of colour reception with domestic receivers	Q. 118
XI/52	Italy	Standards for radiated colour-television signals—Investigation on the manual tuning of domestic monochrome and colour television receivers	S.P. 118B
XI/53	Italy	Compatibility of NTSC, SECAM III and PAL emissions using domestic receivers	Q. 118
XI/54	Italy	Colour picture of NTSC, SECAM III and PAL emissions using domestic receivers	Q. 118
XI/55	People's Republic of Poland	Comparison of NTSC and SECAM III systems	S.P. 118B
XI/56	People's Republic of Poland	Behaviour of the NTSC and SECAM III colour television systems under the simultaneous influence of various distortions and disturbances	S.P. 118B
XI/57	Federal Republic of Germany	Colour television standards—Behaviour of the SECAM III colour television system in the presence of statistically distributed noise	Q. 118
XI/58	France	Experiments in colour television broadcasting with the SECAM system	Q. 118
XI/59	France	Compatibility of the NTSC, SECAM and PAL colour television systems on commercial receivers	Q. 118
XI/60 (CMTT/17)	U.S.S.R.	Monitoring of some characteristics of television chains by transmission of discrete values of the pilot signal	S.P. 177, 121A (CMTT)
XI/61	U.S.S.R.	Automatic documentary recording of the video signal waveform	Q. 152 Rep. 313 S.P. 121A (CMTT)

Doc.	Origin	Title	Reference
XI/62 (CMTT/18)	U.S.S.R.	Measurement of signal-to-r.m.s. noise ratio by means of an oscillograph	Q.166(CMTT), S.P. 152A, 166A (CMTT) Rep. 313
XI/63	U.S.S.R.	Automatic measurement of the quality of television signals during transmission of the monochrome television programme	Q. 152
XI/64	U.S.S.R.	Television picture conversion standards	Q. 153 S.P. 119
XI/65	U.S.S.R.	Design of recording circuits in stereoscopic colour television	S.P. 118C
XI/66	U.S.S.R.	Encoder in stereoscopic colour television	S.P. 118C
XI/67	United Kingdom	The behaviour of the SECAM system in the presence of distortions encountered on existing long-distance transmission circuits	Q. 118
XI/68	Japan	Transmission of colour television signals over long distances	Q.121 (CMTT) Rep. 316 Rec. 421
XI/69 (X/66)	C.C.I.R. Secretariat	Summary record of the opening sessions	
XI/70	United Kingdom	Colour television standards—Comments on Doc. XI/33	Q. 118 S.P. 118A and 118B
XI/71	Study Group XI	Summary record of the first meeting	
XI/72	United Kingdom	Compatibility of NTSC, SECAM III and PAL colour television systems	Q. 118
XI/73	O.I.R.T.	Changes to be introduced in Rec. 15 of the O.I.R.T.	Rep. 310
XI/74	O.I.R.T.	Recommendation 38 of the O.I.R.T.—Basic parameters of test signals inserted into the field-blanking interval	Rep. 314 S.P. 177
XI/75	United Kingdom	Statement by the United Kingdom delegation	
XI/76 and Corr. 1	Study Group XI	Note by the Chairman, Study Group XI—Transmission of a letter from the Argentine Republic	
XI/77	France	Outline of reply to Doc. XI/40 submitted by the United States of America	Doc. 33 (Rev. 2), London, 1964
XI/78 and Corr. 1	Italy	Example of a PAL colour television receiver	
XI/79	Federal Republic of Germany	Statement as regards the choice of a colour television system	
XI/80	Netherlands	Statement by the Netherlands delegation	
XI/81	People's Republic of Poland	Statement regarding the choice of a colour television system	
XI/82	U.S.S.R.	Statement on the choice of a single-colour television system	
XI/83 (CMTT/14)	United States of America	Automatic remote monitoring of the fundamental qualitative parameters of television chains	S.P. 121A (CMTT)
XI/84	People's Republic of Bulgaria	Statement by the Administration of the People's Republic of Bulgaria regarding the choice of a colour television system	
XI/85	Italy	Statement of the Italian delegation	
XI/86	Working Group XI-B	Draft Study Programme—Lower sideband characteristics for vestigial-sideband television transmission at lower powers	
XI/87	Japan	Statement by the Japanese delegation	

Doc.	Origin	Title	Reference
XI/88 (X/90)	Joint Working Group X-B/XI-B	Submission of Docs. IV/107 and IV/108, Monte-Carlo, 1965—Feasibility of direct sound and television broadcasting from satellites	
XI/89	Australia	Use of special signals in the field-blanking interval by Australian television stations and networks	S.P. 177
XI/90	Australia	Television reflections for masts and towers	Draft Q. and S.P. (Docs. XI/8 and XI/9)
XI/91	Working Group XI-B	Draft revision, Report 311, § 4	
XI/92	Spain	Statement by the Spanish Delegation on the choice of a colour television system	
XI/93	France	Letter to Chairman of Study Group XI	
XI/94	France	Note on the comments made on the SECAM system	
XI/95 (X/93)	Joint Working Groups X-B/XI-B	Draft Question—Direct broadcasting service from satellites (sound and television)	
XI/96	United States of America	Statement by the United States Delegation regarding the choice of a colour television system	
XI/97	Working Group XI-C	Draft Report—Subjective assessment of the quality of television pictures	S.P. 152
XI/98	Working Group XI-C	Proposed amendment to Report 314	
XI/99 and Rev. 1	Working Group XI-C	Proposed amendment to Report 313	
XI/100	C.C.I.R. Secretariat	List of documents issued (XI/51 to XI/100)	
XI/101 (X/94)	Study Groups X and XI	Report of the Joint Sub-Group X-B/XI-B (Satellite broadcasting)	
XI/102	Working Group XI-C	Proposal for deletion of Question 153 (XI)	
XI/103	Working Group XI-C	Report by the Chairman	
XI/104	Working Group XI-A	Draft Question—Recommended characteristics for television antennae for domestic use	
XI/105	Working Group XI-B	Draft revision—Bibliography, Report 315	
XI/106	Working Group XI-A-1	Draft amendment to Report 312—Constitution of a system of stereoscopic television	
XI/107	Working Group XI-A-1	Draft comment on Document XI/24 (CMTT/9)	
XI/108	Working Group XI-A-1	Draft amendment to Study Programme 118A (XI) —Standards for video colour television signals	
XI/109	Working Group XI-A-1	Draft amendment to Question 120(XI)—Exchange of television programmes	
XI/110	Working Group XI-B	Draft Report—Distortion of television signals due to the use of vestigial-sideband transmission	S.P. 110
XI/111	Working Group XI-B	Draft Report to the Chairman of Study Group XI	
XI/112	People's Republic of Poland	Remarks concerning Doc. XI/96	
XI/113	Working Group XI-A-1	Draft revision of Report 308—Characteristics of monochrome television systems	

Doc.	Origin	Title	Reference
XI/114	Working Party XI-A-1	Report of Working Party XI-A-1 to the Chairman of Sub-Group XI-A	
XI/115	United Kingdom	Proposals for the revision of the table of parameters given in Report 310	Rep. 310
XI/116 and Corr. 1	Working Party XI-A	Report by the Chairman	
XI/117	Working Party XI-A-2	Draft Report of Study Group XI on colour television	
XI/118	Study Group XI	Summary record of the second meeting	
XI/119 (X/117)	Study Groups X and XI	Summary record of the joint closing meeting	
XI/120 (X/118)	Study Groups X and XI	List of participants, Study Groups X and XI	
XI/121	C.C.I.R. Secretariat	List of documents issued (XI/101 to XI/121)	
XI/122 (II/30)	O.I.R.T.	Required selectivity of television receivers with establishment of protection ratios adopted for network planning	Q. 229 (II) S.P. 185 (II) Q. 267 (IX)
XI/123	Australia	Reduction of the channel capacity required for a television signal	S.P. 119 Rep. 315
XI/124	C.C.I.R. Secretariat	Doc. II/12 (U.S.S.R.)—Definition of basic parameters for radio reception systems Doc. II/25 (Italy)—Television community systems	Q. 228 & 309 S.P. 185 (II) Rec. 239 & 230 Q. 309
XI/125	C.C.I.R. Secretariat	Doc. CMTT/49 (Rev. 1)—Proposed amendments to Recommendation 420	Rec. 420
XI/126	C.C.I.R. Secretariat	Doc. CMTT/39—Proposed amendments to Study Programme 177 (XI)	S.P. 177
XI/127	Australia	Statistics of television frame differences	Rep. 315 S.P. 119
XI/128	United States of America	Characteristics of the U.S.A. colour television system	Q. 118
XI/129	United States of America	Characteristics of monochrome television systems —Proposed modification to Report 308	Rep. 308
XI/130	United Kingdom	Proposed modification to Draft Report E.4.e (XI) —Insertion of special signals in the field-blanking interval of a television signal	S.P. 177 Draft Rep.
XI/131	United Kingdom	Proposed modification to Recommendation 418—CW interference to monochrome television reception standard I	Rec. 418
XI/132	United Kingdom	Proposed modification to Draft Report E.4.b (XI) —Standards conversion by field-stores	Draft Rep.
XI/133	United Kingdom	Subjective assessment of the quality of television pictures	S.P. 152A Draft Rep.
XI/134 (IV/206)	United States of America	A study of possible zonal television signal standards for television broadcasting from satellites	Q. 241 (IV) Q. 306
XI/135 (IV/207)	United States of America	Draft Study Programme—World-wide standard for television broadcasting from satellites	Draft S.P.
XI/136 (IV/208)	United States of America	Draft Study Programme—Composite 625-line signal for television broadcasting from satellites	Draft S.P.
XI/137 (II/57)	Italy	Television community systems	Rec. 239 and 330

Doc.	Origin	Title	Reference
XI/138	Federal Republic of Germany	Characteristics of monochrome television systems	Rep. 308
XI/139	Federal Republic of Germany	Exchange of television programmes—Proposal for the basic characteristics of a uniform European black-and-white television system for the exchange of programmes	Q. 120 Rep. 310
XI/140	Japan	Subjective assessment of the quality of television pictures	S.P. 152A
XI/141	Japan	Television standards converter using a delay-line system	Q. 307 S.P. 36
XI/142	Federal Republic of Germany	Distortion of television signals due to the use of vestigial-sideband transmission—Subjective assessment of picture quality with vestigial sideband, when pre-correcting the linear (group-delay) and non-linear (quadrature) errors at the transmitter	S.P. 110
XI/143	Federal Republic of Germany	Colour television standards—Central correction of the phase error in PAL colour television signals	Q. 118
XI/144	Canada	Lower sideband characteristics for television transmission at lower powers	Q. 308
XI/145	United States of America	Subjective assessment of the quality of television pictures	Draft Rep.
XI/146 (CMTT/60)	O.I.R.T.	Mask for test signal No. 2	Draft Rec. (CMTT) Q.121 (CMTT)
XI/147 (CMTT/61)	O.I.R.T.	Additional information obtained by means of pulse-and-bar test signals	Draft Rec. (CMTT) Q.121 (CMTT)
XI/148	Chairman, Study Group XI	Report by the Chairman, Study Group XI	
XI/149	O.I.R.T.	Subjective assessment of the quality of television pictures in the international exchange of programmes	Q. 152 S.P. 152A
XI/150	C.C.I.R. Secretariat	List of documents issued (XI/122-XI/150)	
XI/151	Japan	Characteristics of monochrome television systems	Draft Rep. E.4.a
XI/152	Japan	Colour television system in Japan	Q. 118
XI/153	C.C.I.R. Secretariat	Amendments to the report of the E.B.U. ad hoc Group on colour television	Q. 118
XI/154	P. R. of Poland	Use of monochrome television equipment now in operation in Poland for colour television	Q. 118
XI/155	The Netherlands	Colour television standards—Correction in transmitters for group delay errors	Q. 118
XI/156	Czechoslovak S.R.	Experimental assessment of the DST-II colour television transmission characteristics	Q. 118
XI/157	Czechoslovak S.R.	DST-II colour television system	Q. 118
XI/158	E.B.U.	Characteristics of monochrome television systems	Rep. 308
XI/159 (CMTT/66)	E.B.U.	Monitoring signals for insertion in the field-blanking interval of a 625-line television signal	Rep. 314 S.P. 177

Doc.	Origin	Title	Reference
XI/160	Italy	Video characteristics of a 625-line monochrome television system proposed for the international exchange of programmes	Rep. 310
XI/161 (CMTT/67)	Italy	Automatic monitoring of the performance of television circuits	S.P. 177 and 121A (CMTT)
XI/162 and Corr. 1	Belgium	Choice of the parameters for one single system of colour television for 625-line systems	Q. 118 S.P. 118A and 118B
XI/163	E.B.U.	Colour television standards in the European area—Resolution concerning the introduction of colour television in Europe	Q. 118 S.P. 118A and 118B
XI/164 and Corr. 1	France and U.S.S.R.	Specifications of the SECAM III colour television system	S.P. 118A
XI/165 and Corr. 1	France and U.S.S.R.	Results of comparative tests of the NTSC and SECAM systems	S.P. 118A
XI/166 (IV/251) (CMTT/68)	France and U.S.S.R.	Experimental transmission between Moscow and Paris of SECAM III colour television system signals via the satellite Molnya-I	Q. 235 (IV) S.P. 117 (IV) Q· 121 (CMTT
XI/167 and Add. 1	Switzerland	Contribution to the theoretical study of the problem of colour television multipath reception	Q. 118 S.P. 118A
XI/168	Australia	Proposed revision of Recommendation 417—Minimum field strength for which protection may be sought in planning a television service	Rec. 417
XI/169	France and U.S.S.R.	SECAM IV colour television system	S.P. 118A
XI/170	United States of America	Selection of a world-wide NTSC colour television system	Q. 118
XI/171	Spain	Note of the Spanish delegation on adoption of a colour television system	
XI/172	Study Group XI	Colour television statement by United Kingdom	
XI/173	Switzerland	Value of the ratio of effective radiated powers of vision and sound for standard G	Rec. 418 Rep. 306 and 308 Q. 118 and 267
XI/174	Chairman, S.G. XI	Specifications of the PAL-system	
XI/175	Italy	Preliminary tests on SECAM IV colour television system	Q. 118
XI/176 (CMTT/72)	France	Transmission of coded data in digital form on lines 16 and 329 of a video signal	S.P. 177
XI/177	C.C.I.R. Secretariat	Communication by the People's Republic of Albania on colour television	
XI/178	Working Group XI-B	Linear precorrection of L-system television transmitters	
XI/179	Denmark	625-line colour television	Q. 118
XI/180 and Corr. 1	Sub-Group XI-A-1	Proposed modification to Draft Report E.4.j (XI) —Colour television	
XI/181	France and U.S.S.R.	Comments on Doc. XI/170 dated 28 June 1966 entitled: " Selection of a world-wide NTSC colour television system "	Q. 118
XI/182	Working Group XI-C	Draft Report E.4.f (XI)	

Doc.	Origin	Title	Reference
XI/183	Working Partv XI-C	Study Programme 152A (XI)	
XI/184	Working Party XI-C	Draft Report E.4.d (XI)	
XI/185	Working Party XI-C	Draft Report—Subjective assessment of the quality of television pictures	S.P. 152A
XI/186 (IV/293) (X/190)	Ad hoc Joint Study Group IV/X/XI	First report—Satellite broadcasting	
XI/187 (IV/295) (X/209)	Joint Study Group IV/X/XI	Draft revision of Question 306 (X/XI)—Direct broadcasting-service from satellites—Sound and television	
XI/188 (IV/257 Rev. 1) (X/217) Add. 1, and Corr. 1	Joint Working Group IV/X/XI	Proposed modification to Draft Report L.3.a (IV) —Feasibility of direct sound and television broadcasting from satellites	Q. 283 (IV) Q. 306 (X/XI) Rec. No. 5A (EARC)
XI/189	Working Party XI-C	Report by the Chairman	
XI/190	Sub-Group XI-A-1	Proposed modification to Draft Report E.4.b (XI) —Field-store standards conversion by use of delay lines	
XI/191	Study Group XI	Summary record of the first meeting	
XI/192	Sub-Group XI-A-1	Draft Question—Ghost images in television	
XI/193	Sub-Group XI-A-1	Draft Study Programme—Ghost images in television	
XI/194 (IV/319) (X/210)	Joint Study Group IV/X/XI	Draft Question—Feasibility of direct sound and television broadcasting from satellites	
XI/195 (IV/320) (X/211)	Joint Working Party IV/X/XI	Draft Study Programme—World-wide standard for television broadcasting from satellites	
XI/196 (IV/321) (X/212)	Joint Working Party IV/X/XI	Draft Study Programme—Composite 625-line signal for television broadcasting from satellites	
XI/197	Sub-Group XI-A-1	Draft Report—Attenuated sideband characteristics for vestigial-sideband television transmission	Q. 308 (XI) S.P. 308A (XI) and 308B (XI)
XI/198	Sub-Group XI-A-1	Draft Study Programme 308B (XI)—Attenuated sideband characteristics for vestigial-sideband television transmission in bands IV and V	
XI/199	Sub-Group XI-A-1	Draft Study Programme 308A (XI)—Attenuated sideband characteristics for vestigial-sideband television transmission at lower powers	
XI/200	C.C.I.R. Secretariat	List of documents issued (XI/151 to XI/200)	
XI/201	Sub-Group XI-A-1	Draft Report—Video characteristics of a 625-line monochrome television system proposed for the international exchange of programmes	Q. 307
XI/202	Sub-Group XI-A-1	Proposed modification of Draft Question 308 (XI) —Attenuated sideband characteristics for vestigial-sideband television transmission	
XI/203	Working Party XI-B	Draft modifications to Draft Report E.4.g (XI)—Distortion of television signals due to the use of vestigial-sideband transmission	S.P. 110

Doc.	Origin	Title	Reference
XI/204	Working Party XI-B	Draft amendment to Recommendation 418	
XI/205	Working Party XI-B	Draft Report—Television service area boundaries in rural districts containing a low population density	Rec. 417
XI/206	Working Party XI-B	Draft amendments to Recommendation 417	
XI/207 (CMTT/83)	Working Party XI-B	Draft modifications to Draft Report E.4.e (XI)—Insertion of special signals in the field-blanking interval of a television signal	
XI/208 (CMTT/84)	Working Party XI-B	Draft modifications to Study Programme 177 (XI)—Insertion of special signals in the field-blanking interval of a television signal	
XI/209 (CMTT/85)	Working Party XI-B	Draft modification to Recommendation 420—Insertion of special signals in the field-blanking interval of a 625-line television signal	
XI/210	Working Party XI-B	Report to the Chairman of Study Group XI	
XI/211 and Add. 1	Sub-Group XI-A-1	Draft Report—Characteristics of monochrome television systems—Amendments to the text of Report 308	
XI/212	Sub-Group XI-A-1	Report of Sub-Group XI-A-1 to the Chairman of Working Group XI-A	
XI/213 (CMTT/88)	CMTT	Note from the Chairman of the CMTT to the Chairman of Study Group XI	
XI/214	Sub-Group XI-A-2	Report	
XI/215 (IV/332) (X/219)	Joint Study Group IV/X/XI	Second report—Broadcasting from satellites	
XI/216	Chairman, S.G. XI	Letter from the head of the Italian Delegation received by the Chairman of Study Group XI	
XI/217	United States of America	Characteristics of NTSC colour television for system " N "	Q. 118
XI/218	France	Specifications of the SECAM III colour television system—Standard M	S.P. 118A
XI/219	France	Specifications of the SECAM III colour television system—Standard N	S.P. 118A
XI/220	Study Group XI	Summary record of the second meeting	
XI/221	Study Group XI	Summary record of the third meeting	
XI/222	Study Group XI	Summary record of the fourth meeting	
XI/223	Study Group XI	Summary record of the fifth meeting	
XI/224	Study Group XI	Summary record of the sixth meeting	
XI/225	Working Party XI-A	Summary record of the first meeting	
XI/226	Working Party XI-A	Summary record of the second meeting	
XI/227	Working Party XI-A	Summary record of the third meeting	
XI/228	Working Party XI-A	Summary record of the fourth meeting	
XI/229	Study Group XI	Status of texts	
XI/230	C.C.I.R. Secretariat	List of documents issued (XI/201 to XI/230)	

LIST OF DOCUMENTS OF THE XIth PLENARY ASSEMBLY ESTABLISHED BY STUDY GROUP XI

Doc.	Title	Final No.
XI/1001	Subjective assessment of the quality of television pictures	S.P. 3A/XI
XI/1002	Colour television	Rep. 406
XI/1003	Assessment of the quality of television pictures	Rep. 313-1
XI/1004	The present position of standards conversion	Rep. 311-1
XI/1005	Subjective assessment of the quality of television pictures	Rep. 405
XI/1006	Video characteristics of a 625-line monochrome television system proposed for the international exchange of programmes	Rep. 310-1
XI/1007	Distortion of television signals due to the use of vestigial-sideband transmission	Rep. 404
XI/1008	Characteristics of monochrome television systems	Rep. 308-1
XI/1009	Attenuated sideband characteristics for vestigial-sideband television transmission	Rep. 408
XI/1010	Television service area boundaries in rural districts containing a low population density	Rep. 409
XI/1011	Insertion of special signals in the field-blanking interval of a television signal	Rep. 314-1
XI/1012	Ghost images in television	Q. 6/XI
XI/1013	Ghost images in television	S.P. 6A/XI
XI/1014	Attenuated sideband characteristics for vestigial-sideband television transmission in bands IV and V	S.P. 8A/XI
XI/1015	Attenuated sideband characteristics for vestigial-sideband television transmission at low powers	S.P. 8B/XI
XI/1016	Attenuated sideband characteristics for vestigial-sideband television transmission	Q. 8/XI
XI/1017	Ratio of the wanted-to-unwanted signal in monochrome television	Rec. 418-1
XI/1018	Minimum field strengths for which protection may be sought in planning a television service	Rec. 417-1
XI/1019 (CMTT/ 1010)	Insertion of special signals in the field-blanking interval of a television signal	S.P. 12A/XI
XI/1020	Insertion of special signals in the field-blanking interval of a 625-line television signal	Rec. 420-1
XI/1021	World-wide standard for television broadcasting from satellites	S.P. 5A/XI
XI/1022	Composite 625-line signal for television broadcasting from satellites	S.P. 5B/XI
XI/1023 (X/1039)	Direct broadcasting service from satellites	Q. 5/XI
XI/1024	Characteristics of colour television systems	Rep. 407
XI/1025	Reduction of the channel capacity required for a television signal	Rep. 315-1
XI/1026	List of documents issued (XI/1001 to XI/1026)	

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QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO STUDY GROUP XII (TROPICAL BROADCASTING); RESOLUTION 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. CHAMAN-LAL (India)

Vice-Chairman : Mr. C. NOGBOU (Ivory Coast)

INTRODUCTION BY THE CHAIRMAN, STUDY GROUP XII

Introduction

1. In recognition of the problems associated with broadcasting in the tropics, the C.C.I.R. 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 tropical regions as compared with propagation in 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.

In the middle of 1963, after the Xth Plenary Assembly, Mr. A. C. Ramchandani (India), Chairman of Study Group XII, retired. The Vice-Chairman, Mr. N. V. Gadadhar of India, took over the Chairmanship as provided for in No. 691 of the General Regulations annexed to the Geneva Convention, 1959. Subsequently, in September 1963, Mr. Gadadhar was appointed Senior Counsellor in the C.C.I.R. Secretariat. As no Vice-Chairman was available to take over, Mr. Gadadhar continued to hold the Chairmanship.

No Interim Meetings of Study Group XII could be held between the Xth and XIth Plenary Assemblies, since no contributions were received from any of the participating countries. Four documents were, however, received for consideration at the final meeting of Study Group XII.

At the first meeting of Study Group XII during the XIth Plenary Assembly, Oslo, 1966, Mr. Chaman Lal (India) was elected Chairman of the Study Group. At the second meeting of the Study Group, Mr. C. Nogbou (Ivory Coast) was elected Vice-Chairman. In this and subsequent meetings, Study Group XII discussed the four documents and adopted them. During these discussions, considerable interest was shown by new and developing countries in tropical broadcasting. As a result it was decided that Study Group XII should prepare a Manual of Tropical Broadcasting which would be issued by the C.C.I.R. Secretariat for the benefit of the new and developing countries who are interested in tropical broadcasting. It was resolved (Resolution 32) to set up an International Working Party to undertake the preparation of this manual.

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 strength produced by tropical broadcast transmitters:*

This study arises from Question 2/XII. The assessment of field strengths is particularly useful in planning 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 305-1. 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 Report 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. The A.I.R. method has also been extended for calculating the sky-wave field strength in a tropical region for two-hop propagation. Nomograms have also been produced for the prediction of E-layer cut-off frequency.

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 1/XII, and Study Programmes 1B/XII and 1C/XII. The studies aim at the determination of the minimum permissible protection ratios 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 for tropical broadcasting in the presence of 1A, A2 and A3 emissions, with carrier-frequency separation up to 10 kHz. 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 301-1 gives some typical designs of antennae and their electrical characteristics. The Annex to Report 301-1 describes experimental results obtained with a new type of antenna for tropical broadcasting. Studies for improved designs are continuing under Question 3/XII.

2.4 *Assessment of fading allowances for tropical broadcasting:*

The results of studies under Question 4/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:*

Report 303-1 gives the minimum signal required for satisfactory listening, during the various seasons and at different times of the day for some locations in India. The Annex to Report 303-1 provides extended noise data for Trivandrum (India) and tentative data for Vishakhapatnam (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 C.R.P.L., 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 worldwide noise data is being revised. It has been suggested, however, that the data contained in this Report should be used with some caution in predicting noise conditions in tropical countries.

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 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. 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 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.

2.7 *Manual of tropical broadcasting:*

By Resolution 32, the XIth Plenary Assembly resolved to set up International Working Party XII/1 to prepare a Manual of Tropical Broadcasting containing all technical information on tropical broadcasting systems. The Manual will be useful to a large number of new and developing countries located in the tropical zone.

QUESTION 1/XII *

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

The C.C.I.R., (1948—1951—1953—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 kHz and to what minimum value of the wanted field should this ratio be maintained?

Note 1. — The reasons justifying this Question will be found in the Annex.

Note 2. — Practical consideration of the frequency separation of adjacent channels requires the use of an audio-frequency cut-off of 5 kHz in the measurement, in preference to 6·4 kHz, appropriate corrections being applied, if considered necessary, to correspond to an audio-frequency cut-off of 6·4 kHz.

ANNEX

1. The permissible frequency tolerances for broadcasting stations would permit variations in frequency of broadcasting stations up to about 250 Hz until 1953 and up to about 150 Hz after that date. The corresponding tolerances for fixed stations would allow maximum frequency changes of about 500 Hz and 150 Hz respectively. The tolerances permitted to mobile stations would be initially about 2500 Hz and later about 1000 Hz. 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 kHz, then the maximum frequency spacing between a fixed or mobile station and a broadcasting station would be 5 kHz. 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 1953 fixed stations in these bands should have maintained the same frequency tolerances as broadcasting stations, as specified in Appendix 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

* Formerly Question 102(XII).

of mobile stations using class of emission A3 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 Hz.

4. In Doc. 110, 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, 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 kHz, 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 Hz 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 5 kHz may have to be accepted.

STUDY PROGRAMME 1A/XII *

SHORT-DISTANCE HIGH-FREQUENCY BROADCASTING IN THE TROPICAL ZONE (TROPICAL BROADCASTING)

(Question 27 — Recommendation 215)

The C.C.I.R., (1951—1956—1963)

CONSIDERING

(a) that few data exist on the determination of the power required for a given grade of tropical broadcasting service (defined in the Annex);

* Formerly Study Programme 102A(XII).

(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 MHz, 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 ;*

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STUDY PROGRAMME 1B/XII *

INTERFERENCE IN THE FREQUENCY BANDS USED FOR TROPICAL BROADCASTING

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

CONSIDERING

(a) that the limited data available on the measured field-strength of tropical broadcasting transmitters operating in the bands 2300 kHz to 5060 kHz, and in the high-frequency broadcasting bands above 5060 kHz normally used for tropical broadcasting, are insufficient to arrive at the minimum signal to be protected, as required in Question 1/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 kHz to 5060 kHz and in the high-frequency broadcasting bands above 5060 kHz:

— 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 shall be carried out simultaneously with experimental observation of signal-to-noise ratios.

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* Formerly Study Programme 102B(XII).

STUDY PROGRAMME 1C/XII *

INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

(Recommendation 216)

The C.C.I.R., (1953—1956—1959)

CONSIDERING

(a) that Recommendation 216 does not provide a final answer to § 6, Question 1/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 1/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 kHz (the characteristics of the filter employed should be given);

1.3 measurements should also be carried out for cut-off frequencies of 6, 7, 8 and 9 kHz;

1.4 measurements should be carried out for carrier frequencies separated by 0, 1, 2, ... 10 kHz;

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, should relate (taking into account the nature, intensity and distribution of noise levels in different parts of the tropical zone).

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* Formerly Study Programme 102C(XII).

QUESTION 2/XII *

BEST METHOD FOR CALCULATING THE FIELD STRENGTH PRODUCED BY A TROPICAL BROADCASTING TRANSMITTER

(Report 305-1)

The C.C.I.R., (1951—1956—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 (defined in the Annex to Study Programme 1A/XII);

(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 few 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 4000 km, by a transmitter situated in the " tropical zone " (as defined in Appendix 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 kHz, 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?

* Formerly Question 154(XII).

QUESTION 3/XII *

DESIGN OF TRANSMITTING ANTENNAE FOR TROPICAL BROADCASTING

(Report 301-1)

The C.C.I.R., (1951—1953—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?

* Formerly Question 156(XII).

QUESTION 4/XII *

FADING ALLOWANCES FOR TROPICAL BROADCASTING

(Report 301-1)

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

CONSIDERING

(a) that Recommendation 340 and Study Programme 1A/III concern 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;

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 5/XII **

DETERMINATION OF THE EFFECTS OF ATMOSPHERIC NOISE ON THE GRADE OF RECEPTION IN THE TROPICAL ZONE

The C.C.I.R., (1951—1956—1963)

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?

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* Formerly Question 157(XII).

** Formerly Question 268(XII).

STUDY PROGRAMME 6A/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 owing 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;

(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)*. 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, UNESCO.

RESOLUTION 32

MANUAL OF TROPICAL BROADCASTING

The C.C.I.R., (1966)

CONSIDERING

(a) that a very large number of new and developing countries are located in the tropical zone defined in Radio Regulations, numbers 135 and 136, and the ever-growing importance of tropical broadcasting to these new and developing countries and their Administrations;

* This Study Programme, formerly Study Programme 170(XII), 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.

(b) the ever-increasing difficulties encountered by Administrations in collecting the information for the establishment and operation of tropical broadcasting services;

UNANIMOUSLY RESOLVES

1. that an international working party should be set up by Study Group XII to prepare a Manual of Tropical Broadcasting containing detailed information on subjects specified in the Annex;

2. that the specialized Secretariat of the C.C.I.R. should publish the Manual after appropriate editing as soon as the final draft is received from the International Working Party.

ANNEX

1. *Introduction.*

2. *Purpose of tropical broadcasting.*

3. *Design considerations in respect of power, frequency, antenna characteristics and estimated service area.*

4. *Siting of tropical broadcasting stations :*

4.1 Specifications of equipment;

4.2 Planning and layout of installations;

4.3 Building layout including air conditioning;

4.3.1 Power supply and other installations;

4.4 Installation and testing of equipment;

4.5 Installation of antenna and its tuning;

4.6 Testing of complete installation.

5. *Receiving centres for re-broadcasting :*

5.1 Siting;

5.2 Building layout;

5.2.1 Power supply,

5.2.2 Monitoring and relaying receivers,

5.2.3 Special purpose diversity receivers.

6. *Types of antenna and their layout.*

7. *Measurement of frequency :*

7.1 Standards;

7.2 Methods;

7.3 Precision of measurement;

7.4 Measuring equipment.

8. *Measurement of field strength.*

9. *Preparation of seasonal frequency schedules taking into account propagation and noise level data :*

9.1 Ionospheric measurements.

10. *Organization of operation :*

10.1 Examples of organization;

10.2 Preparation of forms.

11. *Staff :*

11.1 Recruitment;

11.2 Training.

12. *Co-operation on research and other problems between countries using tropical broadcasting.*

13. *Low-cost receivers for tropical broadcasting.*

14. *Bibliography.*

STUDY PROGRAMME 7A/XII *

USE OF SINGLE-SIDEBAND RECEPTION FOR MINIMIZING FADING EFFECTS FOR REBROADCAST APPLICATIONS WITHIN TROPICAL ZONES

(1968)

The C.C.I.R.,

CONSIDERING

(a) that the quality of HF broadcasts within tropical zones suffers greatly from the ill-effects of selective fading and peculiar types of " surge " ** and " flutter " fading;

(b) that development of techniques to minimize the ill-effects of these types of fading will improve the quality of rebroadcast services within the tropics;

(c) that results of these studies will also be of interest to Study Groups II, III, VI and X;

DECIDES that the following studies should be carried out:

1. the extent to which the use of single-sideband reception can improve the quality of HF broadcasts for rebroadcast applications within tropical zones by way of:
   — reduction in selective fading,
   — reduction in " surge " and " flutter " fading;

2. determination of the preferred characteristics of such a system of single-sideband reception for rebroadcast applications.

* This Study Programme does not arise from any Question under study.

** As compared with " flutter fading ", " surge fading " is a slower but deeper form of fading accompanied by severe distortion. This peculiar type of fading gives the impression of the signal being received in powerful " surges ".

LIST OF DOCUMENTS CONCERNING STUDY GROUP XII

(Period 1963-1966)

Doc.	Origin	Title	Reference
XII/1 (V/110)	New Zealand	Draft Question—Propagation data required for MF broadcasting systems	
XII/2 and Add. 1	Chairman, Study Group XII	Report by the Chairman, Study Group XII—Tropical broadcasting	
XII/3	India	Best method for calculating the field-strength produced by a tropical broadcasting transmitter	Q. 154 Rep. 305
XII/4 and Corr. 1	India	An experimental antenna for tropical broadcasting	Q. 156 Rep. 301
XII/5	India	Determination of atmospheric radio noise in India for tropical broadcasting	Rec. 215 S.P. 102A Q. 268 Draft Res. Rep. 303
XII/6	Study Group XII	Summary record of the first meeting	
XII/7	Study Group XII	Summary record of the second meeting	
XII/8	Study Group XII	Draft Resolution—Manual of tropical broadcasting	
XII/9	Study Group XII	Summary record of the third meeting	
XII/10	Study Group XII	Status of the texts	
XII/11	C.C.I.R. Secretariat	List of documents issued (XII/1 to XII/11)	

LIST OF DOCUMENTS OF THE XIth PLENARY ASSEMBLY ESTABLISHED BY STUDY GROUP XII

Doc.	Title	Final No.
XII/1001	An experimental antenna for tropical broadcasting	Rep. 301-1
XII/1002	Determination of atmospheric radio noise in India for tropical broadcasting	Rep. 303-1
XII/1003	Best method for calculating the field-strength produced by a tropical broadcasting transmitter—Extension of the method developed by All India Radio for calculating the sky-wave field-strength in a tropical region for two-hop propagation	Rep. 305-1
XII/1004	Manual of tropical broadcasting	Res. 32
XII/1005	List of documents issued (XII/1001-XII/1005)	

QUESTIONS AND STUDY PROGRAMMES ASSIGNED TO THE CMTT (C.C.I.R./C.C.I.T.T. JOINT STUDY GROUP FOR TELEVISION TRANSMISSIONS); OPINIONS AND RESOLUTIONS OF INTEREST TO THIS STUDY GROUP

CMTT

(C.C.I.R./C.C.I.T.T. Joint Study Group for Television Transmissions)

(Opinion: 19-1)

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 sound and television broadcasting signals over long distances.

Chairman : Professor Y. Angel (France)
Vice-Chairman : Mr. R. H. Franklin (United Kingdom)

INTRODUCTION BY THE CHAIRMAN CMTT

1. General

The CMTT was set up under an opinion adopted by the VIIIth Plenary Assembly of the C.C.I.R. (Warsaw, 1956). Its original terms of reference were to consider all matters relating to long-distance television transmission.

At the request of the XIth Plenary Assembly, Oslo, 1966, (see Opinion 19-1), these terms of reference were extended to include sound-broadcasting transmissions (stereophonic and monophonic), as shown above.

The Study Group is administered by the C.C.I.R. and works with the same methods as the C.C.I.R. Study Groups. It is in close co-operation with the relevant C.C.I.T.T. Study Groups, but more especially with Study Groups IV, IX, X and XI of the C.C.I.R.

2. Work already done

Up to the XIth Plenary Assembly, the questions studied by the CMTT related to the following matters:

2.1 Transmission standards on the 2500 km hypothetical reference circuit;

2.2 Transmission standards over distances beyond 2500 km;

2.3 Definition of a hypothetical reference circuit applicable to verv long circuits;

2.4 Insertion of signals in the field-blanking interval;

2.5 Automatic remote monitoring of transmission grading;

2.6 Tolerance applicable to the difference in transmission time for pictures and the corresponding sound.

Between 1963 and 1966, the CMTT met twice:

— in Geneva, for an interim meeting, in July, 1965;

— in Oslo, in July, 1966 (before the XIth Plenary Assembly of the C.C.I.R.);

and made contributions on all the points listed above, except § 2.3, for which no contributions were received:

Recommendation 421-1 concerning §§ 2.1 and 2.2;

Recommendation 451 concerning §§ 2.1 and 2.2;

Recommendation 420-1 concerning § 2.4;

Recommendation 316-1 concerning § 2.1;

Report 410 concerning §§ 2.1 and 2.2;

Report 411 concerning § 2.5;

Report 412 concerning § 2.6;

Report 314-1 concerning § 2.4.

Note. — Recommendation 420-1 was drawn up in cooperation with Study Group XI.

3. Future work

3.1 A good deal of work still remains to be done in connection with the questions listed in § 2 above, especially as regards the effects of colour television on transmission standards. The CMTT will attempt to draw up standardized specifications as far as this can be done, despite the variety of television systems in use, in accordance with the new Study Programme 1B/CMTT.

3.2 By virtue of the extension of its terms of reference (Opinion 19-1), the CMTT will have to consider problems of sound transmission, so as to be able to answer Question 5/CMTT.

OPINION 19-1

TRANSMISSION OF SOUND AND TELEVISION BROADCASTING SIGNALS OVER LONG DISTANCES

The C.C.I.R., (1956—1963—1966)

CONSIDERING

(a) Opinion 19 (Geneva, 1963);

(b) the progress of recent developments in sound broadcasting and the problems involved in the long-distance transmission of sound signals;

IS UNANIMOUSLY OF THE OPINION that the terms of reference of the CMTT should be:

" 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 sound and television broadcasting signals over long distances ".

QUESTION 1/CMTT *

TRANSMISSION OF MONOCHROME AND COLOUR TELEVISION SIGNALS OVER LONG DISTANCES

The C.C.I.R., (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);

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?

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* Formerly Question 121(CMTT).

STUDY PROGRAMME 1A/CMTT *

AUTOMATIC REMOTE MONITORING OF THE FUNDAMENTAL QUALITATIVE PARAMETERS OF TELEVISION CHAINS

The C.C.I.R., (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 Hertz (see Doc. 256, Geneva, 1963);

(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 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.

STUDY PROGRAMME 1B/CMTT

PERFORMANCE REQUIREMENTS FOR INTERNATIONAL TELEVISION CIRCUITS

The C.C.I.R., (1966)

CONSIDERING

(a) that Question 1/CMTT, § 1, has not been fully answered;

(b) that Recommendations 421-1 and 451 quote different values and tolerances for television transmission circuits for different television standards;

(c) that it is often necessary for an international television circuit to carry, at different times, signals conforming to one of a number of the standards covered by Recommendations 421-1 and 451;

(d) that it may be possible to define and build economically transmission circuits that are capable of carrying the majority of internationally established television systems;

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* Formerly Study Programme 121A(CMTT).

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. unified testing methods that can be recommended for television circuits intended for the transmission of signals conforming to the majority of television standards;

2. determination of unified performance objectives for the hypothetical reference circuit, permitting satisfactory transmission of signals conforming to the majority of television standards.

QUESTION 2/CMTT *

DEFINITION OF HYPOTHETICAL REFERENCE CIRCUITS FOR TELEVISION

For application to real circuits longer than 2500 km

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

CONSIDERING

(b) 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 3/CMTT **

STANDARDS OF TRANSMISSION QUALITY FOR TELEVISION CIRCUITS SUBSTANTIALLY LONGER THAN 2500 km

The C.C.I.R., (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?

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* Formerly Question 269(CMTT).

** Formerly Question 222(CMTT).

QUESTION 4/CMTT *

TIME DIFFERENCES BETWEEN THE SOUND AND VISION COMPONENTS OF A TELEVISION SIGNAL

The C.C.I.R., (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 265-1, § 3.3.2).

QUESTION 5/CMTT

TRANSMISSION OF SOUND-PROGRAMME SIGNALS OVER LONG DISTANCES

The C.C.I.R., (1966)

CONSIDERING

(a) that the use of radio-relay systems for television, carrying sound-programme signals (whether accompanying a television signal or not) has become common practice;

(b) that Study Group IX is studying the transmission by radio-relay systems of one or more sound modulation channels with or without an accompanying television signal;

(c) that Recommendation 402 and Reports 289 and 290 on these subjects have already been published;

(d) that so far as the quality of the sound-modulation channel is concerned, these texts are based on the C.C.I.T.T. standards for international sound-programme circuits;

(e) that the C.C.I.T.T. is also studying ways and means of complying with these standards for a 2500-km hypothetical reference circuit on a cable system or over radio-relay links for telephony;

(f) that new forms of radio broadcasting, in particular stereophonic radio broadcasting, have come into being since these standards were established;

(g) that, as implied in Study Programme 2C/IX, the C.C.I.T.T. standards for transmissions by cable cannot always be readily applied to radio-relay systems;

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* Formerly Question 270(CMTT).

STUDY PROGRAMME 4A/CMTT

COORDINATION OF THE TRANSMISSION OF SOUND AND VIDEO SIGNALS

(1967)

The C.C.I.T.T.,

CONSIDERING

that the CMTT is studying the maximum permissible difference between the propagation times of the sound and video signals,

REQUESTS THE C.C.I.R. to carry out the following studies:

1. the authority which shall be responsible for making the necessary corrections in case the stipulated limits are exceeded;

2. when such corrections are made by the Administration responsible for the programme circuit, the additional distortion that can be tolerated.

STUDY PROGRAMME 5A/CMTT

CIRCUITS FOR HIGH QUALITY MONOPHONIC PROGRAMME TRANSMISSIONS

(1967)

The C.C.I.T.T.,

REQUESTS THE C.C.I.R. to carry out the following studies:

1. the necessity for a study of Recommendations concerning circuits for monophonic programme transmissions of higher quality than those of type A circuits (Recommendation J.21);

2. determination of the general characteristics of such circuits (hypothetical reference link *, frequency band effectively transmitted, attenuation distortion, phase distortion, noise, intelligible crosstalk, variation of the relative level with time, non-linear distortion, error on frequency reconstitution, etc.).

Note 1. — The Recommendation issued by the C.C.I.F. on this subject is reproduced below.

Note 2. — Some Administrations have already received requests for setting up high-quality national circuits. Study Group XV considers that a study of this question is essential if incompatible technical solutions are not to create greater difficulties for international standardization in the future.

Note. 3 — A reply to this Study Programme should enable C.C.I.T.T. Study Group XV to study a new question.

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* The attention of the CMTT is drawn to the figure on page 353 of Volume III of the C.C.I.T.T. Blue Book, which can be compared with the first figure in Recommendation J.61 (C.C.I.R. Recommendation 421, Geneva 1963) for the purpose of drafting appropriate definitions. The definition of the hypothetical reference circuit in Recommendation J.21 (Blue Book, Volume III, page 359) will probably have to be revised.

ANNEX

C.C.I.F. RECOMMENDATION ON HIGH-QUALITY CIRCUITS FOR PROGRAMME TRANSMISSIONS

(Issued by the XIVth Plenary Assembly, Montreux, 1946, as Annex 10 to the General Telephone Switching Programme, 1947-1952, under the title " Provisional essential clauses, etc." Re-issued, with some amendments, as background information in the Yellow Book, Volume III (Paris, 1949) and Volume III bis (Florence, 1951). Deleted by the XVIIth Plenary Assembly (Geneva, 1954). The text reproduced below has been taken from Volume III bis of the C.C.I.F. Yellow Book (Florence, 1951)).

HIGH-QUALITY CIRCUITS FOR PROGRAMME TRANSMISSIONS

1. *Provisional general characteristics (supplied as background information)*

The International Telephone Consultative Committee considers that circuits used to relay programme transmissions should not be equipped for a specific type of modulation but that it is desirable for some circuits to be capable of providing very high-quality transmission. Although amplitude-modulation broadcasting transmitters do not make full use of the qualities of such circuits, no pre-suppositions can be made regarding the quality that will be required in future whether for frequency-modulation or pulse-modulation transmitters, or for other programme distribution systems.

If broadcasting organizations consider in future that the " normal circuits for programme transmission " defined above are not of sufficiently good quality in certain cases, the clauses outlined below could be taken as a guide for the preparation of specifications for " high-quality circuits for programme transmissions ".

These clauses apply in principle to a circuit of 1000 kilometres used permanently for programme transmissions. They may be amended and amplified in due course as a result of the studies under way on direct transmission circuits and on carrier systems.

2. *Frequency band effectively transmitted and attenuation distortion*

The frequency band effectively transmitted defined above (see the section " Frequency band effectively transmitted " of the recommendation entitled " 1. Circuits for old-type programme transmissions ") * should extend from 30 to 15 000 Hz.

The curve representing the variations in overall circuit loss as a function of the frequency should lie within the unshaded area of Fig. 1. The slope of this curve should not exceed 0·7 neper (or 6 dB) per octave in the 10 000–15 000 Hz frequency band.

3. *Maximum peak power*

At a point of relative level N, the maximum peak power which can be transmitted is equal to 32. exp $(2\ N)$ mW for a line having a nominal impedance of 600 ohms.

If the 30–15 000 Hz frequency band is transmitted direct to line, the repeaters must be able to provide a peak power of 100 mW in a line of 600 ohm nominal impedance, the non-linear distortion conditions outlined below remaining satisfied.

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* *Note by the C.C.I.T.T. Secretariat :* Now C.C.I.T.T. Recommendation J.41, paragraph *(a)* (Blue Book, Volume III page 370).

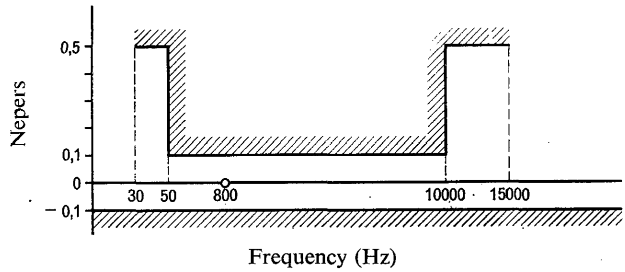

FIGURE 1

Permissible limits for the variation, as a function of the frequency in relation to its nominal value of 800 Hz, of the overall loss of a high-quality circuit for programme transmissions

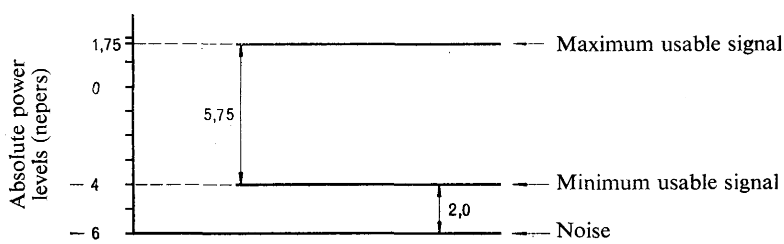

FIGURE 2

4. *Non-linear distortion*

The harmonic ratio of the circuit for the various frequencies should not be less than the figures shown in the following table.

Frequency (Hz)	Minimum harmonic ratio (nepers)
50 to 100	3·5
100 to 7 500	4·6
7 500 to 15 000	3·5

The measurements should be effected with a sine-wave current; the power calculated from the r.m.s. voltage and current and applied to the origin of the circuit (point of zero relative level) for the measurement concerned should be 16 mW for a line impedance of 600 ohms. The conditions to be observed between 30 and 50 Hz will be laid down in due course.

5. *Transients*

The phase distortion index (or difference between the group delays for the frequency under consideration and for the frequency corresponding to the minimum group delay) should not exceed the values:

$t_{15\,000} - t_{min}$ . . . less than 8 ms
$t_{100} - t_{min}$ . . . less than 20 ms
$t_{50} - t_{min}$ . . . less than 50 ms

6. *Circuit noise*

In the 50–15 000 Hz frequency band, the absolute r.m.s. noise voltage level, measured at the end of the circuit without a weighting network, and referred to a zero relative level, should not be more than −6 nepers.

Note. — Since the maximum usable power of 32 mW corresponds to an absolute power level of 1·75 nepers, if we assume a " dynamic range " of 5·75 nepers during the programme transmission, the minimum usable signal will have an absolute power level of −4 nepers; hence, the signal-to-noise ratio will be 2 nepers (see Fig. 2) for the nominal levels indicated above. If account is taken of the variation of overall circuit loss with time specified below (which may reach 0·2 neper), the signal-to-noise ratio may be reduced to 1·8 nepers in the most unfavourable conditions.

7. *Crosstalk*

The near-end or far-end crosstalk attenuation for speech between two high-quality wideband circuits for programme transmissions, or between a circuit of this type and any other circuit used to relay programme transmissions, or between such a circuit and a telephone circuit, should be at least 78 dB (or 9 nepers) on cable lines and at least 61 dB (or 7 nepers) on open-wire lines. The maximum power applied to the input should be reduced accordingly if it is necessary to use lines with a lower crosstalk attenuation than the values quoted above for wide-band programme transmission relays.

8. *Variation of the overall circuit loss with time*

While meeting the conditions laid down above for the attenuation distortion, the overall circuit loss should not vary by more than +0·20 or −0·10 neper during one and the same day.

9. *Lines*

High-quality circuits for programme transmissions can be established in wideband cables either with a special pair of screened conductors for sound broadcasting, or by using all or part of a 12-channel carrier group.

STUDY PROGRAMME 5B/CMTT

CIRCUITS FOR STEREOPHONIC PROGRAMME TRANSMISSIONS

(1967)

The CMTT has embarked upon the study of circuit and sound modulation signal parameters to be recommended for the transmission of stereophonic broadcasting, it therefore appears necessary for C.C.I.T.T. Study Group XV to study recommendations relative to the specification of the relevant circuit equipment.

The CMTT should inform C.C.I.T.T. Study Group XV of the overall characteristics these circuits should possess, to enable the Study Group to examine this question properly.

Note 1. — Special study should be given to the following points (the list is not exhaustive):

— hypothetical reference link *, frequency band effectively transmitted, attenuation distortion, phase distortion, noise, intelligible crosstalk, variation of the relative level with time, non-linear distortion.

Are there any operating reasons for preferring one of the transmission methods mentioned below:

— methods making use of two separate channels: either for the transmission of signals *A* and *B* respectively, or for the transmission of signals *M* and *S*;

— methods using a single wideband channel for the transmission of either signals *A* and *B* or signals *S* and *M*. For the transmission of signals *S* and *M*, is it desirable that they be transmitted in a form identical with the signal modulating the broadcasting transmitter;

— if the composite stereo signal is transmitted, what is the tolerable error in the reconstitution of the frequencies;

— if signals *A* and *B* are transmitted on a pair of channels constituting the stereophonic circuit, how far can the characteristics of the two channels be different and what is the crosstalk attenuation required between channels *A* and *B*?

Note 2. — C.C.I.R. Report 293-1 defines the general characteristics between the microphone and the listener, but does not specify what parts of the overall tolerances can be allocated to the programme circuit.

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* The attention of the CMTT is drawn to the figure on page 353 of Volume III of the C.C.I.T.T. Blue Book, which can be compared with the first figure in Recommendation J.61 (C.C.I.R. Recommendation 421, Geneva 1963) for the purpose of drafting appropriate definitions. The definition of the hypothetical reference circuit in Recommendation J.21 (Blue Book, Volume III, page 359) will probably have to be revised.

STUDY PROGRAMME 5C/CMTT

REVISION OF RECOMMENDATION J.21

(1967)

Should the recommendations for type A programme circuits (Recommendation J.21) be amplified?

Note. — For example, is a clause on the error in the reconstitution of the frequencies desirable? For information the Annex below indicates the conditions applying at present to carrier systems designed for telephone transmission. In circuits for programme transmissions, there may be supplementary equipment which will introduce additional errors. Study Group XV hopes that the relevant tolerances may be as wide as possible.

ANNEX

REPLY BY STUDY GROUP XV (NOVEMBER 1966) TO QUESTION 12/XV — ERROR ON THE RECONSTITUTED FREQUENCY

Part (a)

Study Group XV based its discussion on the contribution submitted by the Administration of the Federal Republic of Germany (COM XV — No. 74, pp. 19-29) completed by the Annex below *. The contribution shows that, if the clauses of Recommendation G.225 are strictly applied in all systems used to set up a chain of 12 four-wire circuits which corresponds to the world-wide hypothetical reference chain, the standard deviation of the error on the frequency at the end of the chain will be approximately 1·1 Hz, from which we can deduce the probability of any values being exceeded.

These calculations show that about 10% of the total frequency errors of the model connection under consideration are caused by the channel modulating-demodulating equipment, 3% by the group modulating-demodulating equipment, and 87% by the supergroup and supermastergroup modulating-demodulating equipment.

The very small contribution of 3% which is made to the total error by the group modulating-demodulating equipment raises the question whether Recommendation G.225 could not be amended by a small reduction in the accuracy of the group carrier frequencies. Since the group carrier frequencies in systems having a larger number of channels in most cases have (by the central supply of carrier frequencies) the high degree of accuracy of supergroup carriers or mastergroup or supermastergroup carriers, it is easy to understand that a request be made to reduce the accuracy in smaller stations, which have no supergroup carrier supply. Such stations are to be expected in international connections only at the extremities, but they may be present in considerable numbers in national networks. For these small stations, a reduction of the required group carrier frequencies of $\pm 10^{-7}$ to $\pm 10^{-6}$ would represent a considerable relief, since the group carriers could then be taken from the same base oscillator as the channel carriers.

If, for example, 10^{-6} is specified in the model connection for the accuracy of the group carriers in the two 60-channel terminal systems, no appreciable increase in the frequency error ensues.

It is therefore proposed that a Note be added to Recommendation G.225. These considerations show that the calculation results would not be significantly different in practice if a small number of the chain circuits were established on comparable open-wire carrier systems, in which the frequency stability is less good.

* Not reproduced in the text intended for the CMTT.

These conclusions are based on a theoretical study. It is for Study Group IV to indicate whether the frequency deviations observed on the network confirm these calculations.

Part (b)

Study Group XV has assumed that an error on the frequency of not more than 2 or 3 Hz (which, according to the reply to Part *(a)*, is the probable value) will have no adverse effects on the speech transmission, signalling, or data or facsimile transmission.

There therefore seems to be no need to make Recommendation G.225 any stricter. A slight relaxation of standards could even be accepted, as proposed under *(a)*. However, the text of the Recommendation does need to be made clearer, and Study Group XV proposes (subject to the agreement of the competent Study Groups) that § *(a)* be amended to read:

" *(a) Accuracy of the virtual carrier frequencies on an international circuit or on a chain of circuits*

As the channels of any international telephone circuit .... modulating and demodulating processes.

To attain this objective, the C.C.I.T.T. recommends that the channel and group carrier frequencies of the various stages should have the following accuracies:

Virtual channel carrier frequencies in a group:	$\pm 10^{-6}$
Group and supergroup carrier frequencies:	$\pm 10^{-7}$
Mastergroup and supermastergroup carrier frequencies;	
— for the 12 MHz system:	$\pm 5 \times 10^{-8}$
— for the 60 MHz system (in the band above 12 MHz):	$\pm 10^{-8}$ *

Experience shows ** that, if a proper check is kept on the operation of oscillators designed to these specifications, the difference between the frequency applied at the origin of a telephone channel and the reconstituted frequency at the other end hardly ever exceeds 2 Hz if the channel has the same composition as the 2500 km hypothetical reference circuit for the system concerned.

Calculations indicate that, if these recommendations are followed, in the world-wide hypothetical reference connection defined in Recommendation G.101 C, § *(c)* ***, there is about 1% probability that the frequency difference between the beginning and the end of the connection will exceed 3 Hz and less than 0·1% probability that it will exceed 4 Hz.

Note 1. — In small stations, i.e. in stations which do not need supergroup carrier frequencies, the accuracy of the group carrier may be $\pm 10^{-6}$, which is the same as for channel carrier frequencies.

Note 2. — The modulating frequencies appropriate to $(n + n)$ systems should have the accuracies recommended in the relevant recommendations:

Recommendation G.311 for 12-channel open-wire systems;

Recommendation G.351 for 3-channel open-wire systems;

Recommendations G.324 and G.327 for (12 + 12) cable systems."

* According to the reply to Question 20/XV.

** Text proposed, subject to the agreement of Study Group IV.

*** In fact, the connection considered for these calculations comprised 16 (instead of 12) modulator-demodulator pairs to allow for the possibility that submarine cables with equipment in conformity with Recommendation G.235 might form part of the connection. No allowance was made, however, for the effects of Doppler frequency-shift due to inclusion of a non-stationary satellite in the connection; values for this shift are given in C.C.I.R. Report 214-1 (Oslo 1966 — provisionally C.C.I.T.T. COM XV — No. 89/COM XVI — No. 49)

This reply is to be transmitted to C.C.I.T.T. Study Group XVI.

— C.C.I.T.T. Study Group IV is asked to indicate whether the theoretical values are attainable in practice and whether reference should be made to the Recommendations on oscillator maintenance in Volume IV.

— The Joint LTG Working Party is asked to ascertain from the competent Study Groups whether these values are acceptable for data and facsimile transmission and to take them into account when revising Recommendation H.13 with reference to voice-frequency telegraphy.

Provided these Study Groups agree to the new text of Recommendation G.225, the study of this Question in its present form is now completed. When the CMTT indicates the permissible frequency difference in the transmission of monophonic and stereophonic broadcast signals, it will be necessary either to reconsider Recommendation G.225 or to prepare a recommendation on the synchronization of frequencies between the ends of circuits used for sound programme transmissions (see reply to Question 8/XV).

STUDY PROGRAMME 5D/CMTT

CHARACTERISTICS OF SIGNALS SENT OVER MONOPHONIC PROGRAMME CIRCUITS

(1967)

The C.C.I.T.T.

REQUESTS the C.C.I.R. to carry out the following studi:se

1. Determination of the characteristics of the test signals used by broadcasting authorities on programme circuits; any new types of test signals to be expected;

Note. — The level of these test signals should be kept as low as possible to avoid overloading the amplifiers of the carrier system.

2. The mean power (representative of usual broadcast programmes) of the signal applied at a point of zero relative level of a programme circuit, and the distribution of the " instantaneous " power levels corresponding to that mean power;

Note. — In practice, the " instantaneous " values may be mean powers measured over a short period (e.g. milliseconds). The type of measuring instrument should be stated.

3. The influence on these values of any differences between methods and/or apparatus used for volume control (see C.C.I.R. Report 292-1).

Note. — Information already assembled is given in Annex 53 of the Blue Book, Volume III, page 547, and in the Annex below.

ANNEX

SIGNAL POWER ON A PROGRAMME CIRCUIT

(Note by the Administration of the Federal Republic of Germany)

In investigating the useful level of the programme circuit, we shall have to compare the properties of telephone and programme signals, due allowance being made for statistical evidence. Not only must we bear in mind the r.m.s. signal voltage is a mean over a long period; short peak values will also have to be considered.

If there are two programme circuits, we must recollect that they may sometimes carry the same monophonic programme, in which event the power is increased by 3 dB and the peak voltages by 6 dB (synchronous transmission, load as with double-sideband transmission without carrier).

Statistically speaking, a group carries a different load if programme circuits are set up rather than telephone channels. Hence we must ensure that the load imposed by the programme circuits is properly matched to the average load of a supergroup.

If there are twelve telephone channels, the mean power over a long period will be 12×32 μW $= 384$ μW. During 1% of the time the power will rise to 2·5 mW, as is readily seen from Fig. 6 of the paper by Holbrook and Dixon [1].

In the supergroup, the mean power over a long period is 60×32 μW $= 1 \cdot 92$ mW. Reference to [1] shows that this increases to about 6 mW for 1% of the time.

Detailed measurements made in the Federal Republic of Germany show that the mean power over a long period [2] in a programme circuit is about 330 μW. If pre-emphasis, as recommended by the C.C.I.T.T. (Recommendation J.21) is used, this figure becomes 510 μW, while the compandor at present employed by the Federal German Administration becomes 930 μW. But if the mean is taken over one second [3], the maxima are found to be 2·5 mW, 8 mW, or 2·5 mW, provided of course that the level of the original signal is adjusted by means of a peak indicator as recommended by the C.C.I.T.T., that is to say, that the peaks shown by the indicator, calibrated in r.m.s. sine-wave voltages, are at + 9 dBm0. In fact, however, power levels may be very different, because:

— amplitude distribution during dynamic peaks is similar to a normal Gaussian distribution, whereas, with a long-term observation normalized with respect to a much lower r.m.s. value, voltage peaks will occur relatively more often;

— spectral distribution during such programme passages falls by about 3 dB per octave instead of by about 6 dB, as is the case during a long-term observation;

— the compandor reduces power above the level, which remains unaffected by the compressor.

The above figures show how useful is the C.C.I.T.T. Recommendation that the relative level on the programme circuit should be equal to that on the telephone circuit. The same holds good when two programme circuits are set up within a group (with no pre-emphasis or compandor). A new kind of compandor (see Annex 1 to the reply to Question 7/XV) makes it possible to operate two programme circuits in a group, using compandors, without an inadmissible increase in the load of the channels, averaged over a long period. With the new compandor, the load per channel is less than with the compandor hitherto employed.

This is confirmed by observation of the short-term peaks. An oscillograph will show (this conclusion appears in an unpublished monograph of the Hamburg Institute for Broadcasting Technique) that the equivalent peak power for a programme signal is not + 9 dBm0, as shown by the peak indicator, but some 6 dB more. Only at this level will the probability of exceeding the figure be so small that it can be compared with the 10^{-5} which, for the C.C.I.T.T. represents the basis of the permissible peak power in carrier systems. The amplifiers of audio programme circuits in the Federal Republic of Germany have a margin of at least 6 dB over the peak power of + 17 dBm0 recommended by the C.C.I.T.T. In many cases this margin is + 9 dB, even though non-linear disturbance of other channels is unlikely.

Measurements made in the Federal Republic of Germany show, that with one programme circuit we must expect peaks corresponding to an equivalent peak power of + 15 dBm0. With two programme circuits, we must expect + 21 dBm0, and with a programme circuit with pre-emphasis, some 20 dBm0. According to the C.C.I.T.T., the peak power equivalent to the sum of the telephone signals is + 19 dBm0 in a group, and + 20·8 dBm0 in a supergroup.

In the light of the above, it would be inadvisable, we feel, to allow any increase in the level of the programme circuit over the figure recommended by the C.C.I.T.T. The low noise level required in the programme circuit cannot be obtained with sufficient reliability without the use of a compandor. An additional virtue of the compandor is that it keeps down crosstalk.

Note. — The margin of ± 2 dB laid down in Recommendation J.13 should be complied with only for audio amplifiers, as mentioned in Recommendations J.13 and J.42 (peak power: + 17 dBm0 instead of + 15 dBm0). With carrier transmission, Recommendation G.223 (Volume III of the Blue Book, page 84, § 6.3) leaves planners free to decide on the margin for variations in level. This point need not be discussed here, when Recommendation G.223 is considered separately.

BIBLIOGRAPHY

1. HOLBROOK, B. D. and DIXON, J. T. Load rating theory for multi-channel amplifiers. *B.S.T.J.*, 624-644 (1939).

2. FISCHER, G. and RASCH, J. Die bei Fernsprech- und Rundfunkübertragung auftretenden elektrischen Leistungen unter Berücksichtigung von Preemphasis und Kompander (Electrical powers occurring in telephone and programme transmission, allowance being made for pre-emphasis and compandors). *NTZ*, 18, **4**, 205 to 209 (1965).

3. VON GUTTENBERG, W. and HOCHRATH, H. Untersuchungen über die Geräuschverminderung mittels Pre- und Deemphasis bei Rundfunkübertragung (Inquiries into noise reduction by pre-emphasis and de-emphasis in programme transmission). *NTZ*, 12, **9**, 467 to 474 (1959).

STUDY PROGRAMME 5E/CMTT

COMPANDORS FOR PROGRAMME CIRCUITS

(1967)

In uncompandored circuits the noise level is unaffected by the level of the signal transmitted, but when compandors are used, the action of the expander causes the noise level at the output of the circuit to vary as a function of the signal level (i.e. the noise is expanded).

To determine the limit of noise power to be tolerated on the transmission path alone, it is necessary to know the amount of " expanded noise " which can be accepted. This information is required from the broadcasting authorities and it is proposed that they be asked to study the matter.

It would be possible for such a study to be made independently of any other distortions to which programme material might be subjected during transmission. A noise source could be modulated by an expander which is controlled from a compressor actuated by a replica of the programme signal and the resultant noise added to the programme signal and the subjective effect assessed. This would enable incidental distortions of the programme material to be avoided.

STUDY PROGRAMME 5F/CMTT

NOISE FROM THE POWER SUPPLY

(1967)

The C.C.I.T.T.,

CONSIDERING

that signals transmitted by carrier systems are sometimes modulated by interfering signals from power supply sources at the frequency of the mains;

REQUESTS the C.C.I.R. to carry out the following study:

the maximum permissible limit that should be recommended for the r.m.s. level of this most intense unwanted side component, if this noise is characterized by the r.m.s. level of the most intense unwanted side component observed at the end of the hypothetical reference programme circuit, when a sine wave of 1·55 V r.m.s. is applied at the origin of this circuit, i.e. at a point of relative voltage level + 0·7 neper (+ 6 dB).

Note. — The Annex indicates the noise considered tolerable for the other types of transmission.

ANNEX I

REPLY BY STUDY GROUP XV (NOVEMBER 1966) TO QUESTION 37/XV — LIMITS FOR MAINS HARMONICS IN BEARER CIRCUITS FOR FREQUENCY-MODULATED VF TELEGRAPHY OR FACSIMILE

1. Reply by the Joint Working Party LTG (Use of lines for telegraphy) approved by Study Group XV

1.1 The Working Party first discussed whether three points *(a)*, *(b)* and *(c)* under this Question should be studied separately by Study Groups or Working Parties specially concerned and concluded that the Joint Working Party LTG shall study all of them and send its study results to the relevant C.C.I.T.T. Study Groups such as IV, IX, XII, XIV, XV, Sp. A and Sp. C.

1.2 After examination of various contributions indicated above or given orally in the course of the discussion it became evident that, for the ratio of a telegraph carrier to the strongest unwanted side component of this carrier, measured at the end of a telegraph circuit, values between 43 and 45 dB were proposed by four Administrations. The A.T. and T. delegate proposed a value of 30 dB.

As a result of its studies to subdivide this overall limit to individual sources of hum modulation the Federal Republic of Germany proposed in Contribution GM/ITG — No. 10 an admissible value of 58 dB for the degree of hum phase-modulation of the highest carrier frequency produced in any carrier generating equipment.

The A.T. and T. uses as an overall objective for interfering hum-modulation a ratio of 30 dB between the desired signal and the most significant, interfering frequency-modulation hum-modulation sibedand. That value will provide satisfactory performance for A.T. and T. voice, voice-band data, and 150 word/minute multi-channel voice-frequency (carrier) telegraphy services. For the latter, a 30 dB ratio may be expected to provide between 5% and 10% overall telegraph distortion. Starting with the overall objective of 30 dB, an objective value of 36 dB was allocated statistically by the A.T. and T. to each of the several transmitting-receiving multiplex terminal pairs of equipment in a 4000 mile long, complex connection. However, transmitting-receiving pairs of vacuum tube multiplex terminal equipment (LMX-1) provide a performance of 50 dB in the highest frequency carrier channel. Modifications are being made to all A.T. and T. modern transistorized terminals (LMX-Z), by the addition of d.c. to d.c. converters to all the battery feeds to carrier supplies, to achieve at least that same ratio of 50 dB, per transmitting-receiving terminal pairs, between the desired signal and the most significant hum-modulation sideband in the highest frequency carrier channel.

1.3 The Working Party drew the following conclusions from the study of these contributions:

1.3.1 As to the maximum admissible level of the strongest unwanted side component when a sine-wave signal is applied at the level 0 dBm0, a limit of −45 dBm0 (−52 dNm0) could be acceptable for circuits for FM and AM-VF telegraphy, facsimile transmission, speech, telephone signalling and data transmission when a sinusoidal signal with level 0dBm0 is transmitted over the circuit.

As to the sound-programme circuits, there is no information to specify and limit at this time.

1.3.2 The main causes of the interference due to power sources are:

1.3.2.1 residual ripples at the terminals of d.c. supply which are directly transmitted to equipment through the power-fed circuits;

1.3.2.2 the a.c. to the dependent power-fed stations in some systems, which interferes through the power separating filter or through the iron tapes of coaxial pairs;

1.3.2.3 the induction voltages in the d.c. supply line to power-fed dependent stations, in some systems;

1.3.2.4 the unwanted amplitude and phase modulations of the various carriers, due to the cause listed in § 1.3.2.1 and increased in the frequency-multiplying equipment.

1.3.3 The Working Party considers that it is very difficult to attempt to specify the performance of individual items in terms that will ensure that a derived circuit will meet a specific limit, e.g. −45 dBm0 (−52 dNm0).

As mentioned in § 1.2 above, values of 58 dB and 50 dB were suggested by some delegates. The Working Party however could not reach the conclusion and decided to leave this question for further study.

2. Comments by Study Group XV

Study Group XV is interested mainly in § *(c)* of this Question and notes that, according to the Working Party's reply, the value −50 dBm0 might be replaced by a less stringent requirement, such as −45 dBm0.

In view of C.C.I.T.T. Recommendations H.11 and H.13 which advise that, so far as possible, VF telegraph circuits should consist of a telephone channel set up on one group link, excluding channels 1 and 12 of the group, Study Group XV invites Administrations to submit for its next meeting contributions which examine the distribution of the above-mentioned overall objective among the various equipments, assuming that the objective should be met on a circuit 830 km long, which is established on one group link and consists of one-third of the hypothetical reference circuit.

At a later stage it will be necessary to study the provisions to be adopted for a world-wide telephone connection.

The permissible interference in the case of programme transmissions forms the subject of Study Programme 5F/CMTT.

3. Studies to be effected by C.C.I.T.T. Study Group XV

Taking into consideration Study Programmes 5A/CMTT and 5B/CMTT which have been submitted to the CMTT, Study Group XV thinks it would be useful to study the characteristics to be recommended for lines and equipment for:

— high-quality monophonic programme transmissions;

— stereophonic programme transmissions.

Administrations are requested to submit contributions making clear what these characteristics are, for the next meeting of Study Group XV so that sufficiently detailed questions may be proposed to the C.C.I.T.T. Plenary Assembly.

QUESTION 4-1/CMTT

DIFFERENCES IN TRANSMISSION TIME BETWEEN THE SOUND AND VISION COMPONENTS OF A TELEVISION SIGNAL

(1963, 1966, 1968)

The C.C.I.R.,

CONSIDERING

(a) that the time of transmission of television signals over a terrestrial or a communication-satellite system is not generally 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;

DECIDES that the following question should be studied:

1. what differences in transmission time can be accepted between the sound and vision components of a television signal (see Note);
2. what methods may be used to ensure that the acceptable differences in transmission time are not exceeded?

Note. — A similar problem exists in connection with sound and picture recording on the same base (see Draft Recommendation E.1.a(X)*, § 3.2.2) .

STUDY PROGRAMME 4-1A/CMTT

TRANSMISSION OF SOUND AND VISION SIGNALS BY TIME-DIVISION MULTIPLEX

(1968)

The C.C.I.R.,

CONSIDERING

(a) that if the sound and vision components of a television signal are transmitted over different routes or by different methods there may be an error of timing between the signals at the receiving end;

(b) that one method of minimizing this problem would be to transmit both signals over the same circuit by multiplexing;

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* Intended to replace Recommendation 265-1.

(c) that the study of systems of frequency multiplexing is associated with Draft Question F.5.h(IX)* and Question 18/X and certain information related to these systems is contained in Recommendation 402 and Draft Reports F.5.d(IX)** and E.2.g(X)***;

DECIDES that the following studies should be carried out:

1. techniques which can be used to enable a sound signal to be transmitted in time-division multiplex with the vision signal;
2. standards of performance that can be obtained by the use of these techniques;
3. special problems or requirements that might be introduced if these techniques were to be adopted for the international transmission of sound and vision signals.

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* Intended to replace Question 3/IX.

** Intended to replace Report 289.

*** Intended to replace Report 403.

UNANIMOUSLY DECIDES that the following question should be studied:

1. which are the parameters of the circuit and sound modulation signal that are to be considered, and what must be their values and tolerances if such transmission is to be satisfactory for the purpose of monophonic or stereophonic radio programmes;

2. what methods of measurement and maintenance may be recommended?

STUDY PROGRAMME 6A/CMTT *

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

The C.C.I.R., (1962—1963—1966)

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;

(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 and for the transmission of information on the operation of international networks;

UNANIMOUSLY 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 should 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. what should be the position in the field-blanking interval of signals for measuring the characteristics of television networks;

7. what should be the position in the field-blanking interval of signals associated with control functions and the transmission of operational information;

8. what would be the best system of encoding for the signals referred to in § 7?

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* This Study Programme, which replaces Study Programme 177 and does not arise from any Question under study, is identical with Study Programme 12A/XI.

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LIST OF DOCUMENTS CONCERNING THE CMTT

(Period 1963-1966)

Doc.	Origin	Title	Reference
CMTT/1 and Corr. 1 (IV/13) (XI/11)	Canada	Time differences between the sound and vision components of a television signal	Q. 240 (IV) Q. 66 (X) Q. 270 Rec. 265
CMTT/2 (IX/18)	New Zealand	Draft Question—Radio-relay systems for television and telephony—Limiting parameters for the design of routes for high-capacity radio-relay systems carrying colour television and telephony	
CMTT/3	Canada	Statistical expression of service tolerances for the transmission of television signals over long distances	Q. 222
CMTT/4	Canada	Proposed modifications to Recommendation 421 —Requirements for the transmission of monochrome television signals over long distances	Rec. 421
CMTT/5	Canada	Single value of the signal-to-noise ratio for different television systems	S.P. 166A
CMTT/6	France	Draft Study Programme—Use of special signals in the field-blanking interval for source identification and network operation	
CMTT/7 and Add. 1 (XI/4)	Canada	Use of test and reference signals in the vertical blanking interval on Canadian television networks	S.P. 177 (XI) S.P. 121A
CMTT/8 (XI/21)	Japan	A method for the automatic monitoring of television chains	S.P. 121A §§ 1, 3
CMTT/9 (XI/24)	O.I.R.T.	Requirements for the transmission of monochrome television signals over long distances	Rec. 421 Q. 121
CMTT/10	O.I.R.T.	Standards of transmission quality independent of the length of the circuit	Q. 222
CMTT/11 (XI/27)	O.I.R.T.	Some parameters of a system for automatic remote supervision of the fundamental qualitative indices of television circuits	S.P. 121A
CMTT/12	United States of America	Time differences between the sound and vision components of a television signal	Q. 270
CMTT/13	United States of America	Transmission of monochrome and colour television signals over long distances	Q. 121
CMTT/14 (XI/83)	United States of America	Automatic remote monitoring of the fundamental (qualitative) parameters of television chains	S.P. 121A
CMTT/15	United States of America	Single value of the signal-to-noise ratio for different television systems	S.P. 166A
CMTT/16	Japan	Transmission of colour television signal over long distances	Q. 121 Rep. 316 Rec. 421
CMTT/17 (XI/60)	U.S.S.R.	Monitoring of some characteristics of television chains by transmission of discrete values of the pilot signal	S.P. 177 (XI) 121A
CMTT/18 (XI/62)	U.S.S.R.	Measurement of signal-to-r.m.s. noise ratio by means of an oscillograph	Q. 166 S.P. 152A (XI), 166A Rep. 313 (XI)

Doc.	Origin	Title	Reference
CMTT/19	C.C.I.R. Secretariat	Submission of Doc. XI/36—U.S. practice for the insertion of special signals in the field-blanking interval of a television signal	S.P. 177 (XI)
CMTT/20	C.C.I.R. Secretariat	Submission of Doc. XI/61—Automatic documentary recording of the vidoe signal waveform	Q. 152 (XI) Rep. 313 (XI) S.P. 121A
CMTT/21	C.C.I.R. Secretariat	Submission of Doc. XI/74—Text of Rec. No. 38 (O.I.R.T.)	Rep. 314 S.P. 177 (XI)
CMTT/22	Study Group XI	Comment on Doc. XI/24 (CMTT/9) addressed to the CMTT	
CMTT/23 and Add. 1	C.C.I.R. Secretariat	Submission of Doc. IX/80—Radio-relay systems for television	Q. 261 (IX) 121
CMTT/24	C.C.I.R. Secretariat	Submission of Doc. IX/139 (Rev. 1)—Tropospheric-scatter radio-relay systems	
CMTT/25	C.C.I.R. Secretariat	Submission of Doc. XI/63—Automatic measurement of the quality of television signals during transmission of the monochrome television programme	Q. 152 (XI)
CMTT/26	C.C.I.R. Secretariat	Submission of Doc. XI/89—Use of special signals in the field-blanking interval by Australian television stations and networks	S.P. 177 (XI)
CMTT/27	Chairman of the CMTT	Interim Report—CCIR/CCITT Joint Commission for television transmission	
CMTT/28	United Kingdom	Requirements for the transmission of colour television signals over long distances	Q. 121
CMTT/29	E.B.U.	Monitoring signals for insertion in the field-blanking interval of a 625-line television signal	Rep. 314 S.P. 177 (XI)
CMTT/30	E.B.U.	Report on the behaviour of some long television circuits in Europe during a demonstration of the possibilities of transmitting television programmes in colour	
CMTT/31	Federal Republic of Germany	Insertion of special signals in the field-blanking interval of a 625-line television signal	Rec. 420 S.P. 121A
CMTT/32	Federal Republic of Germany	Transmission of monochrome and colour television signals over long distances—Assessment of the short-time waveform distortion for the modulated sub-carrier	Rep. 316 Q. 121
CMTT/33	Federal Republic of Germany	Transmission of monochrome and colour television signals over long distances—Performance measurements on television circuits	Rep. 316 Q. 121
CMTT/34	United States of America	Differential gain and phase measurements on long-distance TV transmission circuits	Rep. 316 Q. 121
CMTT/35	Italy	Automatic remote monitoring of the fundamental qualitative parameters of television chains—Design of recording equipment	S.P. 121A
CMTT/36	Japan	Requirements for the transmission of 525-line NTSC colour television signals	Q. 121
CMTT/37	CMTT	Summary record of the first meeting	
CMTT/38	C.C.I.R. Secretariat	Submission of Draft Question 296(IX)—Radio-relay systems for television	
CMTT/39	Working Group CMTT-C	Draft—Proposed amendment to Study Programme 177(XI)	

Doc.	Origin	Title	Reference
CMTT/40	Sub-Group CMTT-B	Draft Report—Time differences between the sound and vision components of a television signal	Q. 270
CMTT/41	Sub-Group CMTT-B	Draft—Note from the Chairman of the CMTT to the Chairman of CCIR Study Group IX	
CMTT/42	Sub-Group CMTT-B	Draft—Note from the Chairman of the CMTT to the Chairman of Study Group IV	Q. 222
CMTT/43	Sub-Group CMTT-C	Draft Report—Automatic remote monitoring of the fundamental qualitative parameters of television chains	S.P. 121A
CMTT/44	Working Party CMTT-A	Note from the Chairman to the Chairman, CMTT	
CMTT/45	Sub-Group CMTT-A	Proposed amendments to Recommendation 421	
CMTT/46	Sub-Group CMTT-A	Proposed modifications to Recommendation 421 —Requirements for the transmission of monochrome television signals over long distances	
CMTT/47	Sub-Group CMTT-A	Proposed modifications to Report 316—Characteristics of international television circuits	Q. 121
CMTT/48	Sub-Group CMTT-A	Proposed modifications to Annex V of Recommendation 421	
CMTT/49 and Rev. 1	Chairman of CMTT	Note to the Chairman, C.C.I.R. Study Group XI —Insertion of special signals in the field-blanking interval of a 625-line television signal—Proposed amendments to Recommendation 420	
CMTT/50	C.C.I.R. Secretariat	List of documents issued (CMTT/1 to CMTT/53)	
CMTT/51	CMTT	Summary record of the second meeting	
CMTT/52	CMTT	Summary record of the third and fourth meetings	
CMTT/53	C.C.I.R. Secretariat	List of participants	
CMTT/54 and Add. 1	United Kingdom	Developments in test-line monitoring systems	S.P. 121A
CMTT/55	United States of America	A comparison of random noise requirements for NTSC colour and monochrome television transmission	Q. 121
CMTT/56	United States of America	Differential gain and differential phase requirements in 525-line NTSC colour television	Q. 121
CMTT/57	United Kingdom	Transmission of monochrome and colour television signals over long distances	Q. 121
CMTT/58	Japan	Proposed modifications to Draft Recommendation E.4.k (CMTT)—Requirements for the transmission of television signals over long distances	Q. 121 Draft Rec.
CMTT/59 (IV/219)	Japan	System for the transmission of television signals using a positive synchronizing signal and non-linear pre-emphasis	S.P. 235D (IV) Q. 121
CMTT/60 (XI/146)	O.I.R.T.	Mask for test signal No. 2	Draft Rec. Q. 121
CMTT/61 (XI/147)	O.I.R.T.	Additional information obtained by means of pulse-and-bar test signals	Draft Rec. Q. 121
CMTT/62	O.I.R.T.	Nominal value of waveform return loss at video inputs and outputs	Q. 121

Doc.	Origin	Title	Reference
CMTT/63	O.I.R.T.	Requirements for the transmission of monochrome and colour television signals over long distances	Q. 121 Draft Rep. E.4.1 Draft Rec.
CMTT/64 and Corr. 1	Chairman, CMTT	Report by the Chairman, CMTT—C.C.I.R./C.C.I.T.T. Joint Commission for television transmissions	
CMTT/65	Japan	Desirable routine maintenance practices on long-distance television transmission circuits—Requirement for the transmission of colour television signals over long distances	Q. 121
CMTT/66 (XI/159)	E.B.U.	Monitoring signals for insertion in the field-blanking interval of a 625-line television signal	Rep. 314 S.P. 177 (XI)
CMTT/67 (XI/161)	Italy	Automatic monitoring of the performance of television circuits	S.P. 177 (XI) and 121A
CMTT/68 (IV/251) (XI/166)	France and U.S.S.R.	Experimental transmission between Moscow and Paris of SECAM III colour television system signals via the satellite Molnya-I	Q. 235 (IV) S.P. 117 (IV) Q. 121
CMTT/69	C.C.I.R. Secretariat	Submission of Doc. IX/243—Radio-relay systems for the transmission of sound-broadcasting signals	
CMTT/70, Revs. 1, 2	CMTT	Draft Opinion—Transmission of sound broadcasting and television signals over long distances	
CMTT/71 (IX/252)	CMTT	Draft Question—Long-distance transmission of sound radio broadcasts	
CMTT/72 (XI/176)	France	Transmission of coded data in digital form on lines 16 and 329 of a video signal	S.P. 177 (XI)
CMTT/73	C.C.I.R. Secretariat	Submission of Doc. IX/80—Radio-relay systems for television—Proposed pre-emphasis characteristic for the transmission of 625-line colour television signals	Q. 261 (IX) and 121
CMTT/74 and Corr. 1	Working Party CMTT-D	Draft Report—Single signal-to-noise ratio value for all television systems	
CMTT/75 and Rev. 1	CMTT	Summary record of the first meeting	
CMTT/76	Working Party CMTT-B	Report by the Chairman	
CMTT/77	Working Party CMTT-C	Report from the Chairman to the Chairman of C.M.T.T.—Television circuits substantially longer than 2500 km	Q. 222 and 269
CMTT/78	CMTT	Summary record of the second meeting	
CMTT/79	CMTT	Performance requirements for international television circuits	S.P. 121B
CMTT/80 (IX/292) (X/216)	Joint *ad hoc* Working Party (S.G. IX/X/CMTT)	Report by the Chairman—Transmission of sound modulation channel	
CMTT/81	CMTT	Draft Recommendation—Requirements for the transmission of television signals over long distances (System I only)	
CMTT/82	CMTT	Recommendation—Requirements for the transmission of monochrome television signals over long distances (System I excepted)	
CMTT/83 (XI/207)	Working Party XI-B	Draft modifications to Draft Report E.4.e (XI)—Insertion of special signals in the field-blanking interval of a television signal	

Doc.	Origin	Title	Reference
CMTT/84 (XI/208)	Working Group XI-B	Draft modifications to Study Programme 177 (XI) —Insertion of special signals in the field-blanking interval of a television signal	
CMTT/85 (XI/209)	Working Group XI-B	Draft modification to Recommendation 420—Insertion of special signals in the field-blanking interval of a 625-line television signal	
CMTT/86	CMTT	Draft Question	
CMTT/87	CMTT	Draft Report—Requirements for the transmission of television signals over long distances	Q. 121
CMTT/88 (XI/213)	CMTT	Note from the Chairman of the CMTT to the Chairman of Study Group XI	
CMTT/89	CMTT	Summary record of the third meeting	
CMTT/90	CMTT	Summary record of the fourth meeting	
CMTT/91	CMTT	Summary record of the fifth meeting	
CMTT/92	CMTT	Status of texts	
CMTT/93	C.C.I.R. Secretariat	List of documents issued (CMTT/54 to CMTT/93)	

LIST OF DOCUMENTS OF THE XIth PLENARY ASSEMBLY ESTABLISHED BY THE CMTT

Doc.	Title	Final No.
CMTT/1001	Time differences between the sound and vision components of a television signal	Rep. 412
CMTT/1002	Single signal-to-noise ratio value for all television systems	Rep. 410
CMTT/1003	Performance requirements for international television circuits	S.P. 1B/CMTT
CMTT/1004	Automatic remote monitoring of the performance of television chains	Rep. 411
CMTT/1005	Requirements for the transmission of television signals over long distances	Rep. 316-1
CMTT/1006	Long-distance transmission of sound radio broadcasts	Q. 5/CMTT
CMTT/1007	Requirements for the transmission of television signals over long distances (System I only)	Rec. 451
CMTT/1008	Transmission of sound and television broadcasting signals over long distances	Op. 19-1
CMTT/1009	Requirements for the transmission of television signals over long distances (System I excepted)	Rec. 421-1
CMTT/1010 (XI/1019)	Insertion of special signals in the field-blanking interval of a television signal	S.P. 6A/CMTT
CMTT/1011	List of documents issued (CMTT/1001 to CMTT/1011)	