INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

# C.C.I.R.

DOCUMENTS OF THE

# VIIth PLENARY ASSEMBLY

LONDON 1953

## VOLUME I

**RECOMMENDATIONS MADE BY THE COMMITTEE**
**REPORTS**
**RESOLUTIONS ADOPTED BY THE COMMITTEE**
**QUESTIONS TO BE STUDIED**
**STUDY PROGRAMMES**

INTERNATIONAL TELECOMMUNICATION UNION
GENEVA

# ADDENDUM No. 1

to

Volume I of the Documents

of the VIIth Plenary Assembly of the C.C.I.R.

London, 1953

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

The meeting of C.C.I.R. Study Group No. IX, which took place in Geneva from 10th to 22nd September 1954, proposed that three new Questions should be studied by the C.C.I.R.

In the absence of approval by a Plenary Assembly, the administrations of Members and Associate Members of the I.T.U. have been consulted by post and the approval of more than the necessary twelve has been obtained (See Art. 7, § 2 of the Buenos Aires Convention). These three Questions thus become officially C.C.I.R. Questions and the Director has allocated them to Study Group No. IX as Questions Nos. 113 (IX), 114 (IX) and 115 (IX). The text is given overleaf for insertion in Volume I. The necessary additions should be made in the middle of page 18 and at the bottom of page 382.

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*This opportunity is taken to draw attention to the following errata:*

| | |
|---|---|
| p. 8 | 1st para., 2nd line, for ' 373 ', read **272** |
| p. 157 | 1st line of para. 1 of Recommendation, for ' 71 ', read **125** |
| p. 216 | Last line, for ' 64 (VI) ', read **63 (VI)** |
| p. 302 | 1st footnote, for ' 45 (III) ', read **44 (III)** and for ' 46 (III) ', read **45 (III)** |
| p. 350 | Last line but four, for ' 111 ', read **135** |
| p. 359 | Under Question No. 66 (XI), for ' (Geneva, 1953) ', read **(Geneva, 1951).** |

# ADDENDUM No. 2

to

Volume I of the Documents

of the VIIth Plenary Assembly of the C.C.I.R.

London, 1953

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

(1) As notified in C.C.I.R. Administrative Circular No. AC/24 of 22nd February 1955, more than the necessary twelve Members and Associate Members of the I.T.U. have approved the adoption of the new Study Programme entitled "Tropospheric propagation across mountain ridges". By analogy with Art. 7, para. 2 of the Buenos Aires Convention this Study Programme thus becomes officially a C.C.I.R. Study Programme and the Director has allocated it to Study Group No. V as Study Programme No. 79 (V). The text is given overleaf for insertion in Volume I. The necessary additions should be made in the middle of page 20 and near the top of page 381.

(2) The XVIIth Plenary Assembly of the C.C.I.F. has submitted two new questions to the C.C.I.R. for study (also in accordance with Art. 7, para. 2 of the Buenos Aires Convention). These two questions thus become officially C.C.I.R. Questions and as Nos. 116 (IX) and 117 (XI) the Director has allocated them respectively to Study Group No. IX (General technical questions) and Study Group No. XI (Television). The text is given overleaf for insertion in Volume I. The necessary additions should be made in the middle of page 18, at the bottom of page 382 and near the top of page 384.

(3) C.C.I.R. Resolution No. 10 envisaged the extension to distances above 2000 km. of the C.C.I.R. propagation curves for frequencies below 300 kc/s. This work has now been completed in the C.C.I.R. Secretariat and the new curves have been sent to the I.F.R.B. The present opportunity is taken to make them generally available.

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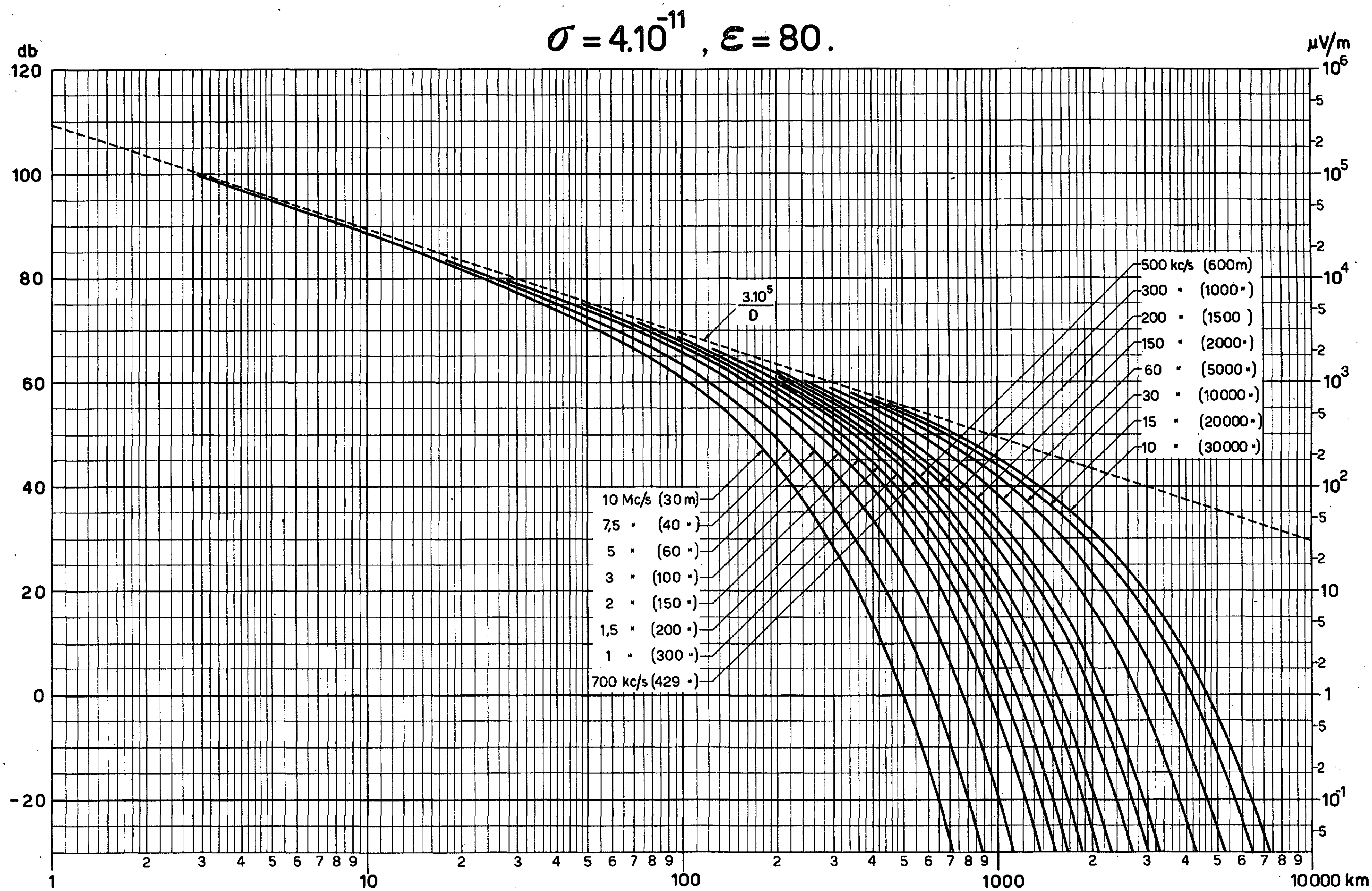
*This opportunity is taken to draw attention to the following errata:*

p. 156 under the title of Recommendation No. 124, for '(Question No. 56)', read '(Question No. **57**)';

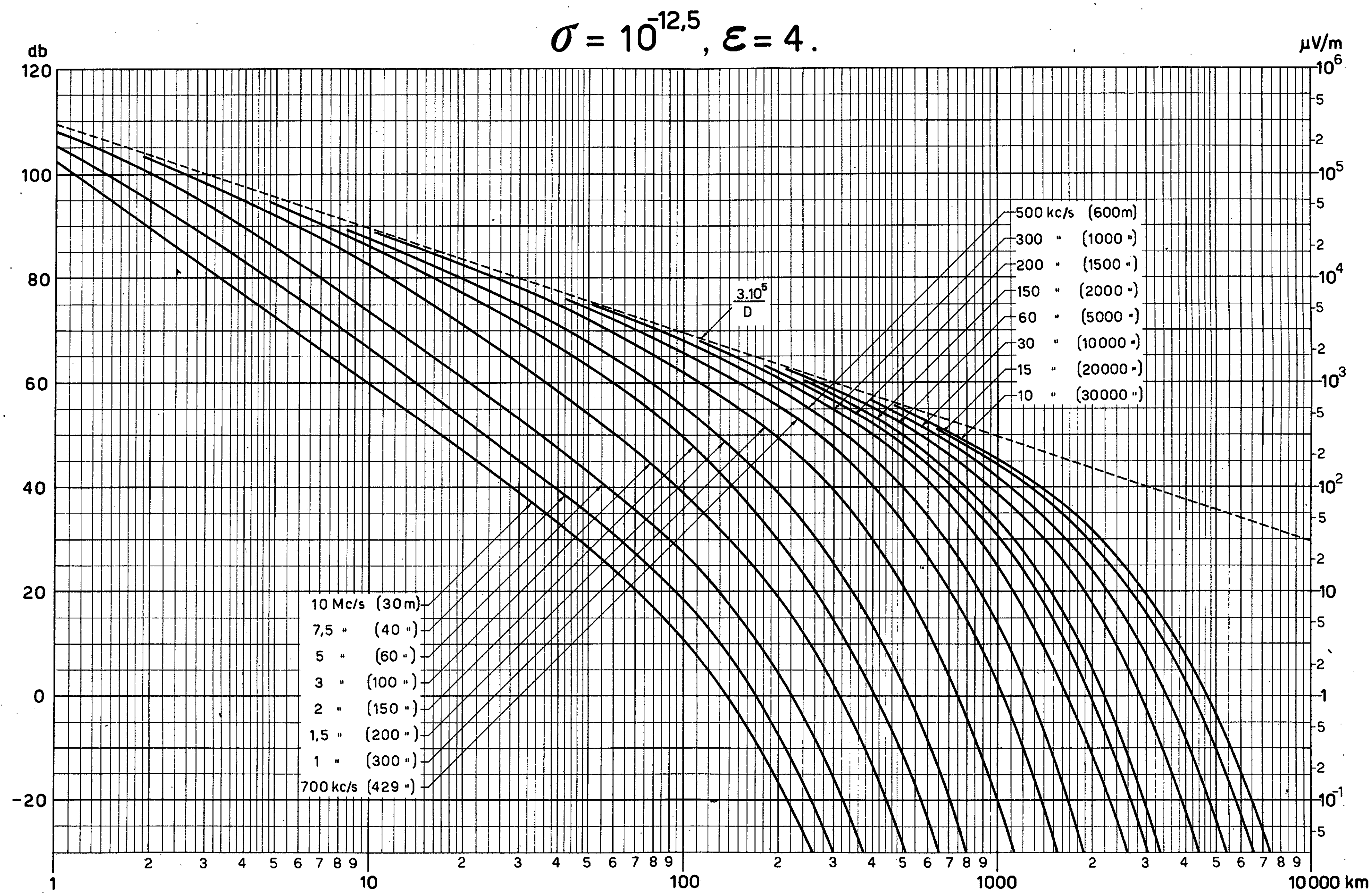
p. 280 footnote—the third word—for 'Recommendation', read '**Resolution**';

p. 307 under the title of Question No. 43 (III) *, delete '(Study Group No. III)';

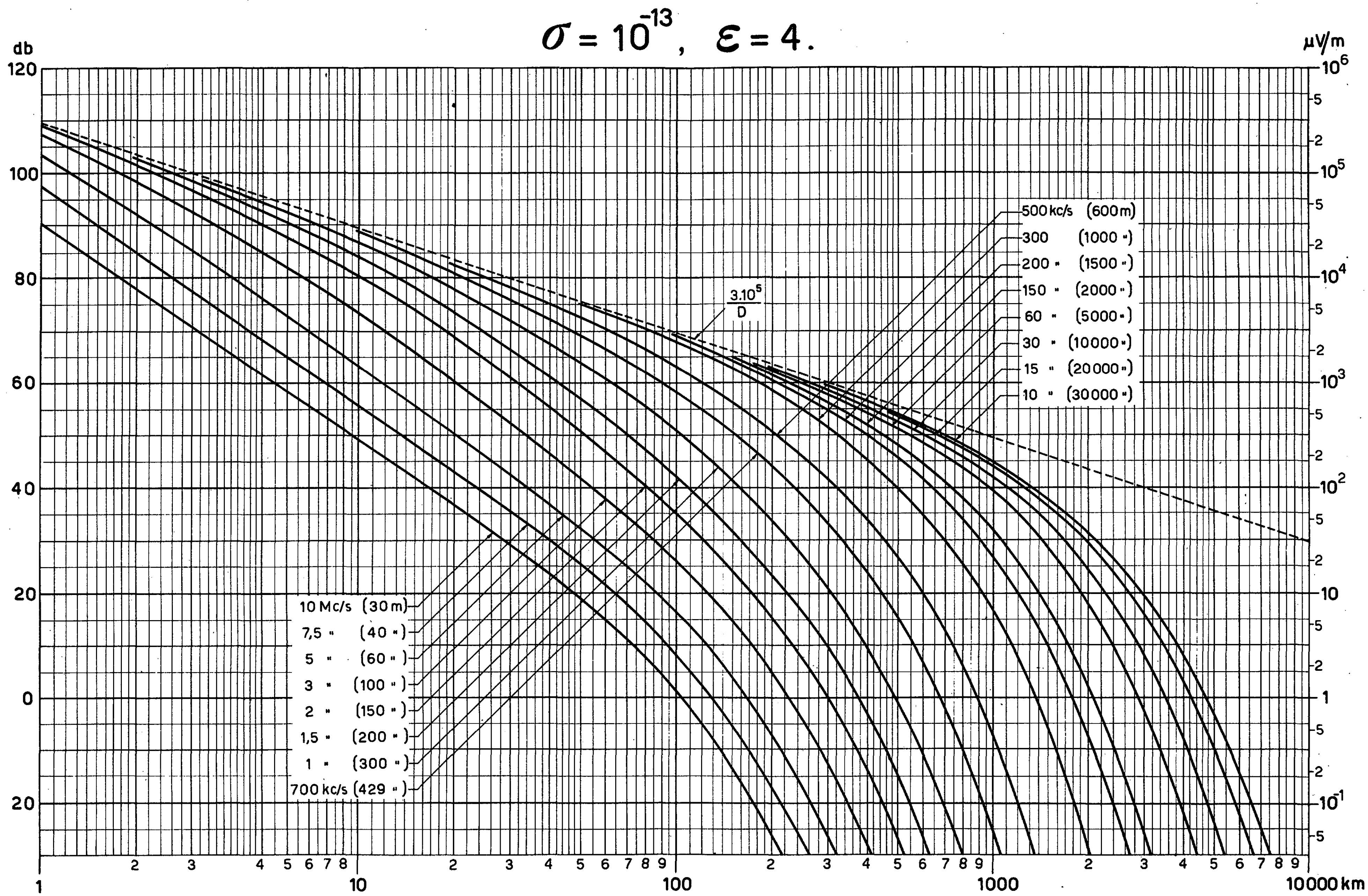
p. 362 in the fifth line of the question, after the word 'polarization' insert '**?**'.



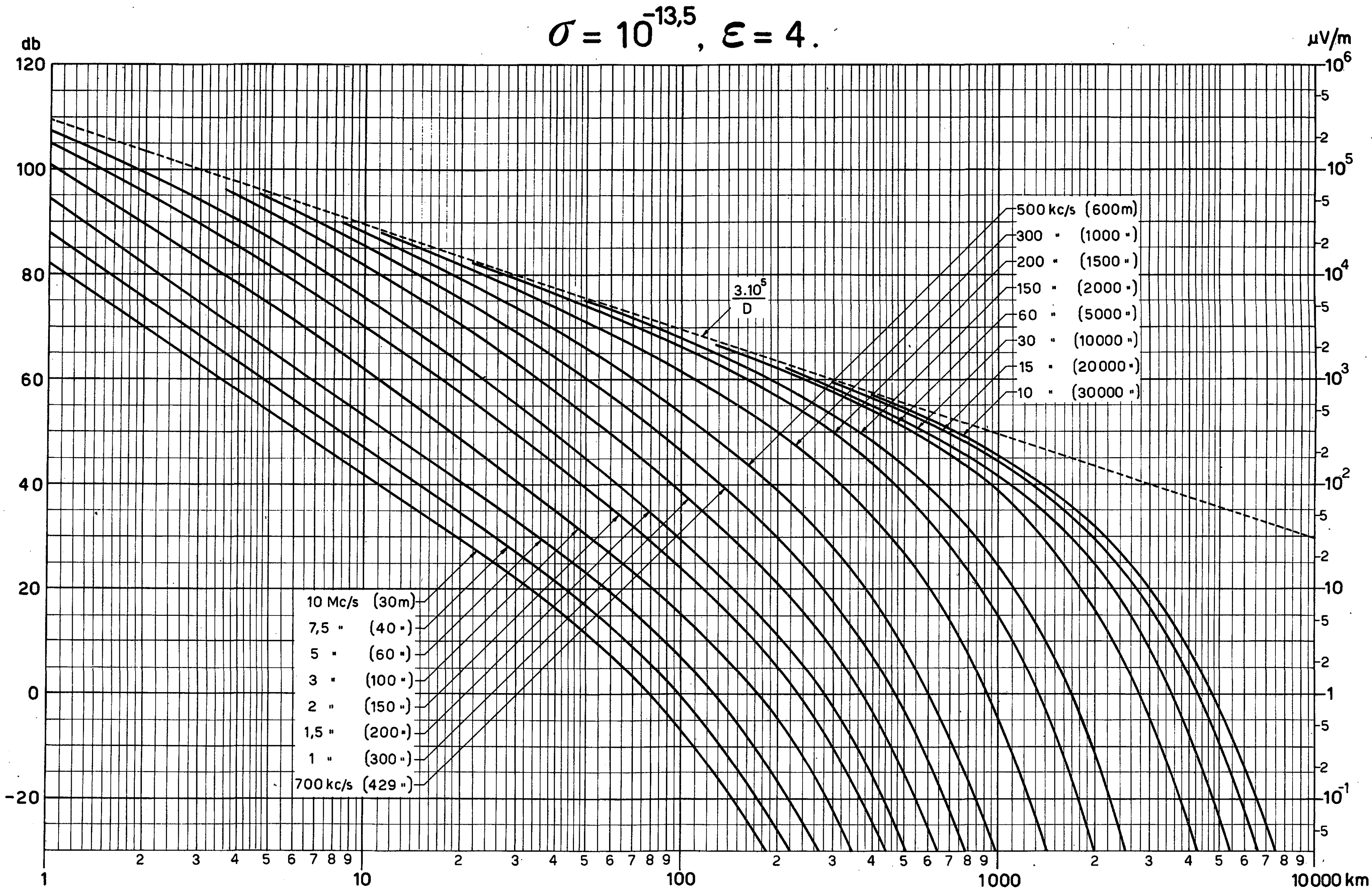
$\sigma = 4.10^{-11}$ , $\varepsilon = 80$ .
db
μV/m
$\frac{3.10^5}{D}$
500 kc/s (600m)
300 " (1000 ")
200 " (1500 )
150 " (2000 ")
60 " (5000 ")
30 " (10000 ")
15 " (20000 ")
10 " (30000 ")
10 Mc/s (30 m)
7,5 " (40 ")
5 " (60 ")
3 " (100 ")
2 " (150 ")
1,5 " (200 ")
1 " (300 ")
700 kc/s (429 ")
1
10
100
1000
10000 km



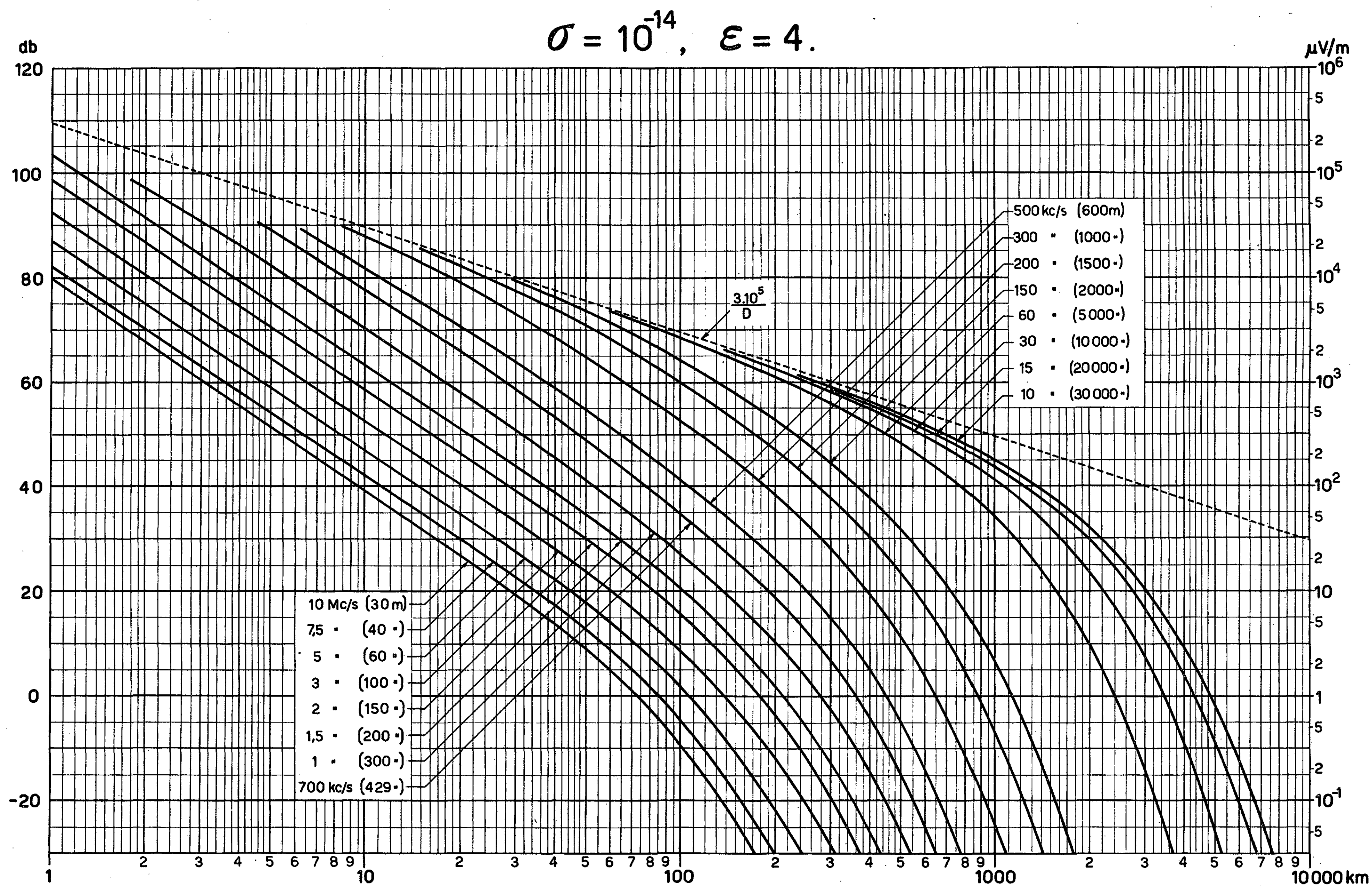
$\sigma = 10^{-12,5}$, $\varepsilon = 4$.
db
μV/m
$\frac{3.10^5}{D}$
500 kc/s (600m)
300 " (1000 ")
200 " (1500 ")
150 " (2000 ")
60 " (5000 ")
30 " (10000 ")
15 " (20000 ")
10 " (30000 ")
10 Mc/s (30m)
7,5 " (40 ")
5 " (60 ")
3 " (100 ")
2 " (150 ")
1,5 " (200 ")
1 " (300 ")
700 kc/s (429 ")
10000 km



σ = 10^-13, ε = 4.
db
120
100
80
60
40
20
0
20
μV/m
10^6
10^5
10^4
10^3
10^2
10
1
10^-1
3.10^5 / D
500 kc/s (600 m)
300 (1000 ")
200 " (1500 ")
150 " (2000 ")
60 " (5000 ")
30 " (10000 ")
15 " (20000 ")
10 " (30000 ")
10 Mc/s (30 m)
7,5 " (40 ")
5 " (60 ")
3 " (100 ")
2 " (150 ")
1,5 " (200 ")
1 " (300 ")
700 kc/s (429 ")
1
10
100
1000
10000 km



$\sigma = 10^{-13,5}$, $\varepsilon = 4$.
db
µV/m
$\frac{3.10^5}{D}$
500 kc/s (600m)
300 " (1000 ")
200 " (1500 ")
150 " (2000 ")
60 " (5000 ")
30 " (10000 ")
15 " (20000 ")
10 " (30000 ")
10 Mc/s (30m)
7,5 " (40 ")
5 " (60 ")
3 " (100 ")
2 " (150 ")
1,5 " (200 ")
1 " (300 ")
700 kc/s (429 ")
10000 km



σ = 10⁻¹⁴, ε = 4.
db
μV/m
3.10⁵ / D
500 kc/s (600m)
300 • (1000 •)
200 • (1500 •)
150 • (2000 •)
60 • (5000 •)
30 • (10000 •)
15 • (20000 •)
10 • (30000 •)
10 Mc/s (30 m)
7,5 • (40 •)
5 • (60 •)
3 • (100 •)
2 • (150 •)
1,5 • (200 •)
1 • (300 •)
700 kc/s (429 •)
10000 km

# ADDENDUM No. 3

to

Volume I of the Documents
of the VIIth Plenary Assembly of the C.C.I.R.
(London, 1953)

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**Note by Director C.C.I.R.**

The meetings of C.C.I.R. Study Groups Nos. I and XI, which took place in Brussels from 22nd March to 6th April 1955, proposed some new Questions and Study Programmes for study by the C.C.I.R.. Of the Administrations of Members of the I.T.U. present at these meetings twelve have requested that these Questions and Study Programmes should be studied (See Art. 7, § 2 of the Buenos Aires Convention), and accordingly they become officially C.C.I.R.. Questions and Study Programmes. The Director has allocated them to Study Group No. XI as indicated at the head of each Question or Study Programme. The texts are given overleaf for insertion in Volume I. The necessary additions should be made in the middle of pages 18 and 20 and near the top of page 384.

Study Group No. XI recommended some re-arrangement of its work to take proper account of the present emphasis on standards for colour television and certain of the Questions and Study Programmes are intended to replace existing Questions and Study Programmes. New numbers have been given to the new Questions and Study Programmes. It will remain for the VIIIth Plenary Assembly of the C.C.I.R. to decide, where necessary, on the cancellation of existing ones.

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## MEETINGS OF STUDY GROUPS Nos. I AND XI

(Brussels, 1955)

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### DRAFT REPORTS

**Note by Director C.C.I.R.**

The first draft report, the text of which is given below *(Frequency stabilisation of transmitters)*, was drawn up by Sub-Group I-B (Doc. No. 100) during the meetings of C.C.I.R. Study Groups Nos. I and XI in Brussels, 1955. This draft report was approved by Study Group No. I at its 8th session.

The second draft report, the text of which is also given below *(Requirements for the transmission of television over long distances)*, was drawn up by Sub-Group No. XI-B (Doc. No. 91) during the meetings of C.C.I.R. Study Groups Nos. 1 and XI in Brussels, 1955. This draft report was unanimously approved by Study Group No. XI at its 5th session.

These texts have not yet been submitted to a Plenary Assembly and therefore cannot be considered as official C.C.I.R. Reports.

Nevertheless, as they contain information which, although provisional, may be very useful to C.C.I.R. members (as well as to the C.C.I.F. in the case of the second draft report), the Director of the C.C.I.R., in agreement with the Chairmen of Study Groups Nos. I and XI, has thought it advisable to publish the texts of these two draft reports as part of Addendum No. 3 to London Volume I ;

The second draft report must be considered as a revision of the draft report on page 268 of London Volume 1.

Geneva, 1st July 1955.

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INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

# C.C.I.R.

DOCUMENTS OF THE

# VIIth PLENARY ASSEMBLY

LONDON 1953

## VOLUME I

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INTERNATIONAL TELECOMMUNICATION UNION
GENEVA

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RECOMMENDATIONS

REPORTS

RESOLUTIONS

QUESTIONS AND STUDY PROGRAMMES

QUESTIONS
**submitted by the C.C.I.R. to the C.C.I.F. and the C.C.I.T.**

ALLOCATION OF REPORTS, RESOLUTIONS, QUESTIONS AND STUDY PROGRAMMES TO STUDY GROUPS

VARIOUS ORGANIZATIONS
**mentioned in this volume**

ALPHABETICAL INDEX

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# INTRODUCTION

The International Radio Consultative Committee (C.C.I.R.) held its VIIth Plenary Assembly in London from 3rd September to 7th October 1953. It was attended by about 330 delegates, representatives, experts and observers from some 40 countries Members of the I.T.U., 16 recognized private operating agencies, 5 scientific or industrial organizations and 7 international organizations.

At the same time all the fourteen Study Groups of the C.C.I.R. held meetings in London and the Plenary Assembly adopted 58 Recommendations, 22 Reports and 10 Resolutions put forward by the Study Groups.

The programme of work for the next three years was also established. It consists of 39 Questions and 40 Study Programmes dealing with all aspects of radiocommunication including problems of the transmission, propagation and reception of electromagnetic waves which arise in the operation of all radio services.

This volume contains all the texts mentioned above, as well as all the texts adopted during the two preceding Plenary Assemblies which still remain valid. Hence it forms a complete collection of the texts of the C.C.I.R.

The two preceding Plenary Assemblies of the C.C.I.R. took place in Stockholm in July 1948 (Vth C.C.I.R. Plenary Assembly) and Geneva in June/July 1951 (VIth C.C.I.R. Plenary Assembly), respectively.

During its last meeting the VIIth Plenary Assembly of the C.C.I.R. accepted unanimously and by acclamation an invitation from the Administration of the People's Republic of Poland to hold the VIIIth Plenary Assembly of the C.C.I.R. in Warsaw.

# TABLE OF CONTENTS



*Note. — For ease of reference the page numbering in the English and French editions has been made the same.*

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## DEFINITION

### of the Recommendations, Reports, Resolutions, Questions and Study Programmes of the C.C.I.R.

The following definitions of Recommendations, Resolutions and Questions are those which appear in Doc. No. 373 of Geneva (Drafting Committee). The definition given for Study Programmes is that which appears in Doc. No. 630 of London (Drafting Committee). The definition given for Reports is that which appears in Doc. No. 731 of London (U.S.A.) modified by the addition of the words " by a Study Group ".

| | |
|---|---|
| **Recommendation** | Statement issued when the study of a Question, or part of a Question, has been concluded. |
| **Report** | Statement on the studies carried out by a Study Group on a given subject, for information. |
| **Resolution** | Statement of an opinion of the C.C.I.R. on a non-technical subject. |
| **Question** | Statement of a technical problem which the C.C.I.R. is to consider. |
| **Study Programme** | Text describing the work to be done on a given technical problem forming the subject of a Question. |

## NUMBERING

### of the Recommendations, Reports, Resolutions, Questions and Study Programmes of the C.C.I.R.

The Recommendations, Reports, Resolutions, Questions and Study Programmes of the C.C.I.R. are numbered consecutively in five series, each starting at No. 1.

The series of Recommendations, Questions and Resolutions were started at the Vth Plenary Assembly (Stockholm, 1948).

The series of Reports and Study Programmes were started at the VIth Plenary Assembly (Geneva, 1951).

The Questions and Study Programmes remaining for study after the VIIth Plenary Assembly (London, 1953) carry in Roman figures after the serial number, the number of the Study Group to which they have been submitted respectively.

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

| Plenary Assembly of C.C.I.R. | Recommendation No. | Report No. | Resolution No. | Question No. | Study Programme No. |
|---|---|---|---|---|---|
| Vth Stockholm (1948) | 1 to 35 | Nil | 1 and 2 | 1 to 33 * | Nil |
| VIth Geneva (1951) | 36 to 85 ** | 1 to 15 | 3 to 9 | 46 to 73 | 1 to 38 |
| VIIth London (1953) | 87 to 144 | 16 to 37 | 10 to 19 | 74 to 112 | 39 to 78 |

* Questions No. 34 to 45 were submitted to the C.C.I.R. between the Vth and VIth Plenary Assemblies.

** Recommendation No. 86 was issued after the meeting of Study Group No. X of the C.C.I.R. held at Geneva, 1952.

## GENERAL LAY-OUT IN THIS VOLUME

### of the Recommendations, Reports, Resolutions, Questions and Study Programmes of the C.C.I.R.

The Recommendations, Reports, Resolutions, Questions and Study Programmes of the C.C.I.R., the texts of which appear in this volume, are those which have been approved by the VIIth Plenary Assembly of the C.C.I.R., together with those which, approved by the Vth and VIth Plenary Assemblies, have been retained.

The Recommendations, Reports and Resolutions are arranged in numerical order.

The Questions and Study Programmes are grouped together and arranged in the numerical order of the Study Groups. For each Study Group the Questions are laid out in numerical order, each being followed by the Study Programme or Programmes to which they are related. Study Programmes which are not the result of a Question are indicated by a Note.

Questions submitted to the C.C.I.F. and C.C.I.T. form the subject of a separate chapter.

References to the texts, if any, forming the basis of Recommendations, Reports, Resolutions, Questions and Study Programmes, are given below the title. On the right, under this reference, is shown the Plenary Assembly or Assemblies which have approved or subsequently modified the text.

Mention is made in a footnote, when the occasion arises, of the text or texts which have been replaced by the text in question ; in the case of Questions, the Study Programmes are shown which arise from it ; and in the case of Study Programmes, mention has been made, where possible, of the Question to which they refer.

## ORIGIN

### of certain documents referred to in this volume

The documents referred to in this volume as " Stockholm ", " Geneva " and " London ", are respectively the documents of the Vth, VIth and VIIth Plenary Assemblies of the C.C.I.R., held in Stockholm in 1948, Geneva in 1951 and London in 1953.

The documents referred to in this volume as of " Mexico " and " Florence/Rapallo ", are respectively those of the High Frequency Broadcasting Conferences of Mexico City (1948/49) and of Florence/Rapallo (1950).

Other documents referred to in this volume are the documents of the meetings of certain Study Groups of the C.C.I.R. The following list of the meetings of these Study Groups is given for information :

| | |
|---|---|
| Zurich (July 1949) | Meeting of Study Group No. XI |
| Washington (March 1950) | Meeting of Study Groups Nos. VI and X |
| London (May 1950) | Meeting of Study Group No. XI |
| Geneva (July 1950) | Meeting of Sub-group Gerber of Study Group No. XI |
| The Hague (April 1952) | Meeting of Study Groups Nos. I and III |
| Stockholm (May 1952) | Meeting of Study Groups Nos. V, VI and XI |
| Geneva (August 1952) | Meeting of Study Group No. X |

# COMPLETE LIST OF RECOMMENDATIONS OF THE C.C.I.R.

# COMPLETE LIST OF REPORTS OF THE C.C.I.R.

## COMPLETE LIST OF RESOLUTIONS ADOPTED BY THE C.C.I.R.



## COMPLETE LIST OF QUESTIONS FORMULATED BY THE C.C.I.R.

## COMPLETE LIST OF STUDY PROGRAMMES OF THE C.C.I.R.

# LIST OF PARTICIPANTS IN THE VIIth PLENARY ASSEMBLY

## Administrations

(a) *Members of I.T.U.*

Australia
Austria
Belgium
Bielorussian Soviet Socialist Republic
Bulgaria (People's Republic of)
Canada
China
Denmark
Egypt
Spain
United States of America
Finland
France
Hungarian People's Republic
India
Ireland
Italy
Japan
Monaco
Norway
New Zealand
Netherlands
Peru
Poland (People's Republic of)
French Protectorates of Morocco and Tunisia
Federal German Republic
Federal People's Republic of Yugoslavia
Ukrainian Soviet Socialist Republic
Roumanian People's Republic
United Kingdom of Great Britain and Northern Ireland
Switzerland (Confederation)
Syrian Republic
Sweden
Czechoslovakia
Overseas Territories of the French Republic
Turkey
Union of South Africa
Union of Soviet Socialist Republics
Venezuela (United States of)

(b) *Associate Member of I.T.U.*

British East Africa

## Private Operating Agencies

British Broadcasting Corporation (B.B.C.)
Cable and Wireless Ltd.
Compagnie Générale de Télégraphie sans Fil
Compañia Internacional de Radio S.A.
Companhia Portuguesa Radio Marconi
International Marine Radio Company Ltd. (I.M.R.C.)
Italcable
Kokusai Denshin Denwa Co. Ltd. (K.D.D.)
Marconi International Marine Communication Co. Ltd. (M.I.M.C.C.)
Nippon Hoso Kyokai (N.H.K.)
Nippon Telegraph & Telephone Public Corporation (N.T.T.)
Radio Austria A.G.
Radio Italiana (R.A.I.)
Redifon Ltd.
Siemens Brothers & Co. Ltd.
Transradio Española S.A.

## International Organisations

International Radio Maritime Committee (I.R.M.C.)
International Electrotechnical Committee (I.E.C.)
International Amateur Radio Union (I.A.R.U.)
International Broadcasting Organisation (O.I.R.)
European Broadcasting Union (U.E.R.)
International Scientific Radio Union (U.R.S.I.)

## Scientific and industrial Organisations

Ateliers de Constructions Electriques de Charleroi (A.C.E.C.)
Brown, Boveri & Co. Ltd.
Hasler S.A.
Siemens & Halske A.G.
Telefonaktiebolaget L.M. Ericsson

## Specialized Agency of the United Nations

World Meteorological Organisation (W.M.O.)

## STATEMENTS MADE BY CERTAIN COUNTRIES ON THE SUBJECT OF THE ADOPTION OF THE TEXTS CONTAINED IN THIS VOLUME

In the following Table are shown, for each line, corresponding to one or more texts, the countries which have reserved their opinion on, or have not accepted the text or texts.

This is indicated by means of a letter which appears in the column relative to the country. The letters signify the following :

R : this country has stated that it reserves its opinion on the subject of the text or texts in question.

N : this country has stated that it does not accept the text or texts in question.

| | Bielorussian Soviet Socialist Republic | Bulgaria (People's Republic of) | Hungarian People's Republic | Poland (People's Republic of) | Ukrainian Soviet Socialist Republic | Roumanian People's Republic | Czechoslovakia | Union of Soviet Socialist Republics |
|---|---|---|---|---|---|---|---|---|
| **Recommendations. No.** 19 [1] | N | | N | N | N | N | N | N |
| 20 [2] | | | | | | R | | |
| 27 | R | | R | | N | R | | R |
| 28 [3] | N | N | N | N | N | N | N | N |
| 47, 48, 49, 52, 59 | R | R | R | R | R | R | R | R |
| 67 | N | N | N | N | N | N | N | N |
| 72, 73, 77, 80 | R | R | R | R | R | R | R | R |
| 82 | N | N | N | N | N | N | N | N |
| 83 | R | R | R | R | R | R | R | R |
| 84 [4] | | R | R | R | | R | R | |
| 87 | N | N | N | N | N | N | N | N |
| 91, 92 | R | R | R | R | R | R | R | R |
| 94 | R | | | R | R | | | R |
| 95 | R | | | R | R | | R | R |
| 96 | R | | | | R | | | R |
| 98 | R | | R | R | R | | | R |
| 99 | N | N | N | R | N | N | N | N |
| 100 | R | | | | R | | | R |
| 101 | N | | | N | N | | N | N |
| 102 | R | | | | R | | R | R |
| 103 | R | | | | R | | | R |
| 104 | R | R | R | R | R | R | R | R |
| 105 | N | N | N | N | N | N | N | N |
| 108 | R | | | | R | | | R |
| 109, 111 | R | R | R | R | R | R | R | R |
| 115 | R | | | | R | R | R | R |

[1] The Federal People's Republic of Yugoslavia has also stated that they do not accept Recommendation No. 19

[2] This Recommendation was unanimously agreed in Stockholm where the Roumanian P. R. was represented. Later, at the London Plenary Assembly, the delegate of the Roumanian P. R. stated that they reserved their opinion on the subject of this Recommendation.

[3] The People's Republic of Albania and the Federal People's Republic of Yugoslavia also stated that they do not accept Recommendation No. 28.

[4] Australia, Egypt, India and the Union of South Africa have also stated that they reserve their opinion on the subject of Recommendation No. 84.

| | Bielorussian Soviet Socialist Republic | Bulgaria (People's Republic of) | Hungarian People's Republic | Poland (People's Republic of) | Ukrainian Soviet Socialist Republic | Roumanian People's Republic | Czechoslovakia | Union of Soviet Socialist Republics |
|---|---|---|---|---|---|---|---|---|
| **Recommendations No.** 119 | R | R | R | R | R | R | R | R |
| *(contd.)* 120 | N | N | N | N | N | N | N | N |
| 121 | N | N | N | | N | N | N | N |
| 122 | N | | | N | N | N | N | N |
| 123 | R | | R | R | R | R | R | R |
| 131 [1] | | | | R | | | | |
| 132 | R | | | R | R | | R | R |
| 133; 134, 135 | N | N | N | N | N | N | N | N |
| 138 | N | | | R | N | | | N |
| 139 | R | | | R | R | | | R |
| 140 | | | | R | | | | |
| 143 | R | | | R | R | | | R |
| **Questions No.** 64 (XI) [2] | R | R | R | R | R | R | R | R |
| 67 (XI) | | | | R | | | | |
| 69 (XII) | R | R | R | R | R | R | R | R |
| 81 (III) | | | | R | | | | |
| 87 (VII) | R | | | R | R | R | R | R |
| 88 (VIII) | R | R | R | | R | R | R | R |
| 98 (X) | N | | | N | N | | N | N |
| 102 (XII) | | | | R | | | | |
| 104 (IX) | | | | | | | R | |
| 106 (XIII) | R | | | | R | | | R |
| 107 (XIII) | N | | | N | N | N | N | N |
| **Study Programmes No.** 2 (I) | R | R | R | R | R | R | R | R |
| 56 | R | R | R | | R | R | R | R |
| 63 (VI) | R | | | | R | | | R |
| 65 (VI) | R | | | R | R | R | R | R |
| 67 (VI) | N | | | N | N | N | N | N |
| 68 (VII) | R | | | R | R | R | R | R |
| 70 (VIII) | R | | R | | R | | | R |
| 71 (X) | R | R | R | R | R | R | | R |
| 74 (X) | R | | | | R | R | R | R |
| 77 (XII) | | | | R | | | | |
| 78 (XIII) | R | | | | R | | R | R |
| **Reports No.** 3, 9 | N | N | N | N | N | N | N | N |
| 13 | R | R | R | R | R | R | R | R |
| 27, 34 | R | | | | R | | R | R |
| 36 | | | | R | | | | |
| **Resolutions No.** 10 | R | | | | R | R | | R |
| 11 | R | R | R | R | R | R | R | R |
| 16 | R | R | | R | R | | | R |
| 19 | N | N | N | N | N | N | N | N |

[1] France has also stated that they reserve their opinion on Recommendation No. 131.

[2] The People's Republic of Albania and the Federal People's Republic of Yugoslavia also stated that they reserve their opinion on the subject of Question No. 64.

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# RECOMMENDATIONS

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## RECOMMENDATION No. 19

## ORGANIZATION OF AN INTERNATIONAL MONITORING SERVICE

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

*(a)* That the rapid supply of accurate monitoring information, on a world-wide scale, is essential to the I.F.R.B. in the efficient performance of its duties, and to administrations in the effective control of their radio services ;

*(b)* That such monitoring information will be essentially required in respect of a vast number of radio stations of many types, including those operating short-range services on low power ; and that, in such circumstances, a large number of monitoring stations spread throughout the world is necessary if the required measurements are to be quickly and accurately made ;

*(c)* That the information at the disposal of the C.C.I.R. shows that large and important areas of the world are not at present provided with monitoring stations ; and that, in consequence, the I.F.R.B. will have great difficulty in obtaining full and proper information from these areas, and especially from the tropical regions where, on account of the high levels of atmospheric noise and the large number of low-power services in operation, the effective coverage of any individual monitoring stations is likely to be small ;

*(d)* That in Art. 18 and App. C of the Radio Regulations of Atlantic City (1947), it is recognised that certain stations may not participate in the whole field of monitoring but may operate only within a limited part of that field ;

*(e)* That, owing to the different characteristics of transmitters and the different techniques and operating procedures employed in the various types of radio services, it would be advantageous for the I.F.R.B. to receive regularly the results of measurements by specialised monitoring stations operated by personnel experienced in the type of service concerned ;

*(f)* That, in particular, the radio stations of the mobile services, due to the special character of their exploitation and to the vital importance of certain categories of these stations for the safety of life at sea and in the air, should be systematically monitored and the results of the measurements transmitted to the I.F.R.B. ;

*(g)* That the exchange of requests for, and the results of measurements would be greatly facilitated if a single national centralizing office were designated in each country participating in a world-wide service of monitoring, in conformity with the provisions of Art. 18 of the Radio Regulations of Atlantic City (1947) ; that on the one hand a uniform distribution, between the monitoring stations of any country, of requests emanating from the I.F.R.B. and from administrations and of actual measurements, and that on the other hand the distribution of actual measurements to the I.F.R.B. and to those administrations would be facilitated through the agency of a single national centralizing office, thereby reducing the possibility of overloading certain monitoring stations and thus affording the possibility of expediting the clearance of harmful interference ;

RECOMMENDS :

**1.** That administrations, recognized private operating agencies, and international organizations should participate forthwith in the establishment of a coordinated, world-wide, monitoring service ;

2. That administrations, recognized private operating agencies, and international organizations in the regions of the world where few, or no, monitoring stations at present exist, particularly in the tropical regions, should endeavour, as far as they are able and as soon as possible, to establish such stations in order to ensure efficient monitoring not only of long-distance but of short-distance transmissions and with a view to the operation of not less than six monitoring stations suitably distributed in each continent ;

3. That some monitoring stations be principally devoted to the monitoring of mobile service transmissions and that their locations be chosen within the regions of the world where the density of such transmissions is the greatest and where harmful interference is most likely to be experienced ;

4. That the administrations of each country should designate, as far as they deem it possible and at an early date, a single national centralizing office for the exchange of all requests and information relating to the monitoring service ;

5. That the attention of the administrations is drawn to the need for rapid communications between the I.F.R.B. and the centralizing offices, between centralizing offices and between individual centralizing offices and the individual monitoring stations under their control.

## RECOMMENDATION No. 20

## ACCURACY OF FREQUENCY MEASUREMENTS IN MONITORING STATIONS

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

*(a)* The requirements of the I.F.R.B. in respect of the necessary frequency measurements for the efficient performance of its duties ;

*(b)* The general availability of suitable monitoring equipments for frequency measurements ;

*(c)* The desirability that the error of frequency measurement shall not exceed one-tenth of the tolerance specified in Col. 3 of the Atlantic City table of frequency tolerances (App. 3 to the Radio Regulations of Atlantic City, 1947) ;

UNANIMOUSLY RECOMMENDS :

That monitoring equipments and procedures used shall be such that frequency measurements shall be made with an accuracy better than that specified in the following table :

| Type of measurement | Accuracy |
|---|---|
| *(a)* Measurement of the frequencies of stations, excluding broadcasting stations, operating in the band 10 kc/s - 4000 kc/s | $\pm 5$ parts in $10^6$ (or where this would be less than $\pm 2$ c/s to an accuracy within $\pm 2$ c/s |
| *(b)* Measurement of the frequencies of broadcasting stations operating in the band 10 kc/s - 4000 kc/s | $\pm 2$ c/s |
| *(c)* Measurement of the frequencies of stations operating in the band 4000 kc/s - 50 Mc/s | $\pm 2$ parts in $10^6$ |

## RECOMMENDATION No. 22

## FORM OF REPORT FOR FREQUENCY AND FIELD-STRENGTH MEASUREMENTS MADE AT MONITORING STATIONS

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

The desirability of uniformity in furnishing monitoring data ;

UNANIMOUSLY RECOMMENDS :

1. That the form used in reporting frequency measurements should contain, at least, the following data :
   - *(a)* Serial number ;
   - *(b)* Identification of the monitoring station (administration or organization and location) ;
   - *(c)* Date ;
   - *(d)* Time (G.M.T.) ;
   - *(e)* Call letters and/or other means of identification of the measured station ;
   - *(f)* Classification of emission ;
   - *(g)* Assigned frequency or reference frequency ;
   - *(h)* Frequency tolerance ;
   - *(i)* Measured frequency ;
   - *(j)* Accuracy of measurement ;
   - *(k)* Deviation from assigned or reference frequency ;
   - *(l)* Additional observations (e.g. period covered by measurement, drift of measured frequency during that period, quality of signal and conditions of reception, etc.) ;
   - *(m)* Remarks ;
   - *(n)* Signature of responsible official of the administration or organization ;

2. That the form used in reporting field-strength measurements should contain, at least, the following data :
   - *(a)* Serial number ;
   - *(b)* Identification of the monitoring station (administration or organization and location) ;
   - *(c)* Date ;
   - *(d)* Time (G.M.T.) ;
   - *(e)* Call letters and/or other means of identification of the measured station ;
   - *(f)* Classification of emission ;
   - *(g)* Assigned frequency ;
   - *(h)* Value of measured field ;
   - *(i)* Estimated accuracy of measurement ;
   - *(j)* Polarization component ;
   - *(k)* Other elements or characteristics of the measurement ;
   - *(l)* Remarks ;

*(m)* Signature of responsible official of the administration or organization ;

3. That the I.F.R.B. should study the forms to be universally used in furnishing the foregoing data.

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## RECOMMENDATION No. 23

### SIGNALS MAYDAY AND PAN

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

*(a)* That the results of the tests presented to the C.C.I.R. by the various administrations and the interpretation and discussions thereon, relating to the question of changing the radiotelephone distress signal MAYDAY and the radiotelephone urgency signal PAN indicate that some technical advantage may be gained in using SOS instead of MAYDAY as the distress signal ;

That no such advantage, on the other hand, appears in the proposed use of URGENT instead of PAN ;

*(b)* That, from the operational point of view, the signal SOS is used in radiotelegraphy and is known to laymen as well as to persons in the field of communications throughout the world as the distress signal ;

*(c)* That, from the operational point of view, the association with the spoken signal SOS of an aurally recognizable signal, as proposed in Atlantic City Recommendation No. 6 to the C.C.I.R. (relative to ensuring the watch on the distress frequency 2182 kc/s by the aid of automatic devices), will tend to lessen any difficulty in changing from MAYDAY to SOS ;

UNANIMOUSLY RECOMMENDS :

1. That the international radiotelephone distress signal should henceforth consist of the three spoken letters S O S instead of the spoken word MAYDAY pronounced as the French expression " m'aider " ;

2. That the present international radiotelephone urgency signal PAN be retained.

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## RECOMMENDATION No. 27

### METHODS OF MEASUREMENT AND LIMITS OF TOLERANCES FOR INTERFERENCE CAUSED TO BROADCASTING BY ELECTRICAL INSTALLATIONS

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

*(a)* That there is no need to resume within the C.C.I.R. the study of methods of measurement since this question has already been entrusted to the Special International Committee on Radio Interference (C.I.S.P.R.), founded under the auspices of the International Electrotechnical Commission (C.E.I.) ;

(b) That the C.C.I.R. should keep in regular contact with the C.I.S.P.R. and send a representative to the meetings of this latter Committee ;

(c) That in view of the importance of the work undertaken by the various countries since the last meeting of the C.I.S.P.R., and which still remains unpublished, a detailed study of the results obtained by that Committee cannot be usefully carried out at this meeting ;

(d) That the measuring equipment designed by the C.I.S.P.R. may prove useful for the study of disturbances other than those caused by electrical apparatus, for example by atmospherics ;

(e) That the measurements should be extended to disturbances affecting all types of receivers constructed according to modern transmission technique, especially television ;

(f) That Bucharest Recommendation No. 88 should be extended to all disturbances due to causes other than signals produced by transmitters ;

(g) That in this respect, the most urgent problem relates to the disturbances affecting television receivers and caused particularly by other radio receivers, electrical ignition systems, industrial, scientific and medical equipment producing hertzian radiations ;

(h) That, in consequence, the means of measurement is to be extended to all the frequency bands used for sound and visual broadcasting ;

(i) That the work of the C.I.S.P.R. is directed according to the four preceding paragraphs ;

(j) That, with regard to the precautions to be taken for electrical apparatus and installations and radio equipment, collaboration is essential between the administrations and the organisations representing electrical industry, on the one hand, and broadcasting on the other hand ;

RECOMMENDS :

1. That the C.I.S.P.R. maintain regular contact with the C.C.I.R. and admit a representative of the C.C.I.R. to its meetings ;

2. That, if necessary, the C.I.S.P.R. take in consideration the suggestions by the C.C.I.R. regarding the relative urgency of the work carried out in various fields ;

3. That, in particular, C.I.S.P.R. pursue actively its work on interference caused to television receivers by other receivers, ignition systems, and industrial, scientific and medical equipment producing hertzian radiations.

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## RECOMMENDATION No. 28

### HIGH FREQUENCY BROADCASTING BANDWIDTH OF EMISSIONS

*The reasons which justify the following Recommendation are given in annex*

The C.C.I.R., (Stockholm, 1948)

RECOMMENDS :

1. That there is no evidence that, under the present day conditions, sensibly increased interference between broadcasting stations is caused by the use of modulating frequencies between 5000 and 6400 c/s, when the channel separation is 10 kc/s ;

2. Nevertheless recommends that broadcasting stations witha ssigned frequencies near the edge of the bands allocated to broadcasting, should be so adjusted that none of the sideband frequencies fall outside the broadcasting bands.

## ANNEX

Listening tests have been made in connection with this investigation on the quality obtainable on short-wave and the effect of reducing the frequency band occupied. From the tests made it is considered that, although there will be some loss in audio frequency quality in restricting the highest modulating frequency to 6400 c/s, the loss is not serious. Tests have also been made in further restricting the band of frequencies to 5000 c/s. The loss of quality in this further restriction is quite noticeable.

The principal causes of unsatisfactory reception of short-wave signals in decreasing order of importance are considered to be :

*(a)* fading and particularly selective fading resulting in heavy distortion,

*(b)* insufficient signal/noise ratio at the receiving point,

*(c)* heterodynes between carrier frequencies,

*(d)* heterodynes between sidebands of different stations or between a sideband of one station and the carrier of another, due to sideband frequencies being transmitted.

In the last case it has sometimes been found that the actual difficulties arise more from harmonics and spurious radiations generated during the process of modulation at the transmitter than from the actual fundamental modulating frequency components themselves. Of the above causes the first two are outside the scope of the present question. The third cause will be eliminated when all stations move to fully planned frequency allocations, while in the case of the fourth cause, a considerable amount of remedy is in the hands of the listener, who can usually so restrict the bandpass characteristics of his receiver as to eliminate or reduce interference.

It would be regrettable to eliminate desirable frequency bands from transmissions unless clearly necessary and effective in eliminating interference in particular cases.

The conclusion reached is that it is desirable to maintain the normal bandwidth of modulating frequencies at an upper limit of 6400 c/s.

In order 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 overmodulation with its inherent production of spurious frequencies.

To consider in some detail the effect in a receiver, the interfering signal is assumed to be a high frequency broadcasting double sideband signal with modulating frequencies up to and including 6400 c/s, and with the carrier 10 kc/s removed from the desired carrier. The out-of-band radiation (distortion) of the high frequency broadcasting signal shall not exceed 5%, and thus the out-of-band radiation falling within the band of the desired signal will be approximately 32 db below the level of the undesired carrier.

The receiver to be considered is the type in general use by the public. Comparison of a number of such receivers has indicated an average selectivity curve which will apply both to European and American receivers, and most employ a diode for demodulation. The average selectivity curve of such a receiver indicates that a signal 10 kc/s removed from the centre of the pass band (assumed position of the desired carrier) will be attenuated 24.4 db. The curve further shows that a signal 5 kc/s removed will be attenuated 8 db, and a signal 3.6 kc/s removed (6.4 kc/s sideband) will be attenuated 5.1 db.

Before considering the actual interference reproduced by the receiver it should be noted that the relatively simple problem of a carrier and two sidebands demodulated by a diode becomes a complex problem when only one sideband reaches the diode or when the amplitude or phase of the carrier and sidebands is altered. Of primary importance to this problem is the further fact that when a carrier is present at the diode, if another carrier is also applied at a lower level, the resultant output is less than either signal. This effect may be analyzed by the use of Bessel functions indicating that as the ratio of desired to undesired input to the diode is increased the ratio of desired to undesired output increases much more rapidly.

Assuming no pre-emphasis at the transmitter, and a ratio of desired to undesired signal of 1, the average receiver would admit a 5 kc/s undesired signal to the diode 22.2 db below the desired carrier. Similarly, the 6.4 kc/s interfering sideband would be 21.1 db below the desired carrier and the undesired diode output signal would be more than 40 db below the desired output signal at 100% modulation. The exact value of the diode output is complicated by the fact that the diode linearity varies with input signal and that, in most cases, the diode load varies with audio frequency. However, at desired to undesired signal ratios of one or greater, and without pre-emphasis, interference should not be caused.

If receivers are improved, and a much lower ratio of desired to undesired signal is then adopted, a point will be reached where interference will be caused by the part of the interfering signal which lies within the receiver pass band.

It has been shown that under usual circumstances the amplitude of the interference should not be troublesome. It may be further noted that the interfering signal will usually beat with the desired carrier and therefore be inverted, the 6400 c/s modulation becoming 3600 c/s interference. The interfering signal would not be intelligible to the listener, and it has been shown that such interference is more easily tolerated than intelligible interference.

At the present time there is no evidence that interference will be caused to the average receiver due to the transmission of normal signal intensities in those portions of the sidebands 5 to 6.4 kc/s removed from the carrier. It does not appear that a reduction in the desired to undesired signal ratio will change this conclusion with respect to present receivers. However, the use of pre-emphasis, more selective receivers and modified signal ratios, or a combination of these, may cause the transmission of energy at modulating frequencies up to 5000 c/s and 6400 c/s respectively, to assume new importance.

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## RECOMMENDATION No. 32

## USE OF SIMULTANEOUS INTERPRETATION

The C.C.I.R., (Stockholm, 1948)

With reference to the question set by the Administrative Council in Resolution No. 21, § 4, sub-para *(b)*, worded as follows :—

Should the simultaneous interpretation system be used for the sessions of the Plenary Assembly and/or the Study Groups ?

UNANIMOUSLY RECOMMENDS :

That in principle there is reason to use simultaneous interpretation only for the sessions of the Plenary Assemblies, and for Committees and Study Groups attended by a large number of members.

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RECOMMENDATION No. 33

## REGARDING THE METHOD OF DISPATCH OF REPORTS BY REPORTERS OF STUDY GROUPS TO THE GROUP CHAIRMAN AND BY THE GROUP CHAIRMEN TO THE DIRECTOR OF THE C.C.I.R.

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

The fundamental interest in ensuring that the reports of the Study Groups reach the Director in good time to be in accord with the time limit stipulated in Chap. 13, § 3 of the General Regulations (Atlantic City, 1947) ;

UNANIMOUSLY RECOMMENDS :

1. That the Reporters of each Study Group shall send their contribution to the Group Chairmen at least six months before the date of opening of the C.C.I.R. Plenary Assembly ;

2. That the Group Chairman shall send their reports to the Director of the C.C.I.R. so that he receives them at least four months before the date of opening of the C.C.I.R. Plenary Assembly ;

3. That the Director shall dispatch the documents in such a way that they may reach the Members preferably two months before the date of the meeting of the Plenary Assembly and in any case at least one month before this date in accordance with Chap. 13, § 3 of the General Regulations (Atlantic City, 1947) ;

4. That as a general rule, no report prepared in connection with Study Group work will be considered, which is sent directly to the Director instead of being sent to the appropriate Group Chairmen.

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RECOMMENDATION No. 40

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

(Questions Nos. 29 and 41)

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

CONSIDERING :

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

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

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

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

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

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

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

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

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

c.6 Although the effectively transmitted frequency band recommended for international landline circuits has been determined by a study of the requirements of the human ear, this band (in the case of a radiotelephone circuit operating at a frequency below 30 Mc/s) may be limited by the necessity of obtaining the maximum number of telephone channels in this part of the radio frequency spectrum, and in order that each telephone channel does not occupy a radio frequency band larger than necessary;

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

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

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

UNANIMOUSLY RECOMMENDS:

**1. Circuits above 30 Mc/s.**

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

**2. Circuits below 30 Mc/s.**

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

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

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

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

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

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

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

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

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

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

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## RECOMMENDATION No. 45

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

(Question No. 35)

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

CONSIDERING :

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

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

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

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

UNANIMOUSLY RECOMMENDS :

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

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

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## RECOMMENDATION No. 47

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

(Question No. 4)

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

CONSIDERING :

(a) That the power of transmitters for radio services in the tropical zone operating within the bands shared with tropical broadcasting (Art. 9, No. 244, Radio Regulations, 1947) should be determined so as to ensure full protection to broadcasting in the tropical zone ;

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

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

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

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

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

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

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

RECOMMENDS :

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

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

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

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## RECOMMENDATION No. 48

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

(Question No. 4)

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

CONSIDERING :

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

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

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

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

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

RECOMMENDS :

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

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

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

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

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## RECOMMENDATION No. 49

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

(Question No. 4)

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

CONSIDERING :

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

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

RECOMMENDS :

1. That administrations should make every effort to comply, as soon as possible, with the regulations with regard to the siting of stations and the use of directional 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.

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# RECOMMENDATION No. 52

## GROUND WAVE PROPAGATION CURVES BELOW 10 Mc/s

(Question No. 6)

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

CONSIDERING :

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

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

RECOMMENDS :

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

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

## ANNEX

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

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

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

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

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

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

* This Study Programme has been replaced by Study Programme No. 51 (IV).

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

*(f)* The presentation is given in two forms :

1. With a linear scale of distance out to 2000 km as abscissa and an ordinate scale which is linear in decibels for which the datum is a field strength of 1 $\mu$V/m. A subsidiary scale reading directly in $\mu$V/m is added on the right hand side. The linear distance scale has been retained to exhibit the linear aspect of the curves in the diffraction region where the field strength is approximately exponentially attenuated with distance. The linear scale in decibels replaces the logarithmic scale for $\mu$V/m used in the C.C.I.R. (1937) curves in view of its greater convenience in most engineering applications ;

2. With a logarithmic distance scale for short distances out to 2000 km. This has been done to make the curves more useful in the neighbourhood of the transmitter where they are very steep when the linear distance scale is used. It should be noted that at these short distances it is not practicable to include all the curves down to 10 kc/s where they differ very little from one another and from the unattenuated inverse distance curve; in fact it is not practicable to label all the curves that have actually been included ;

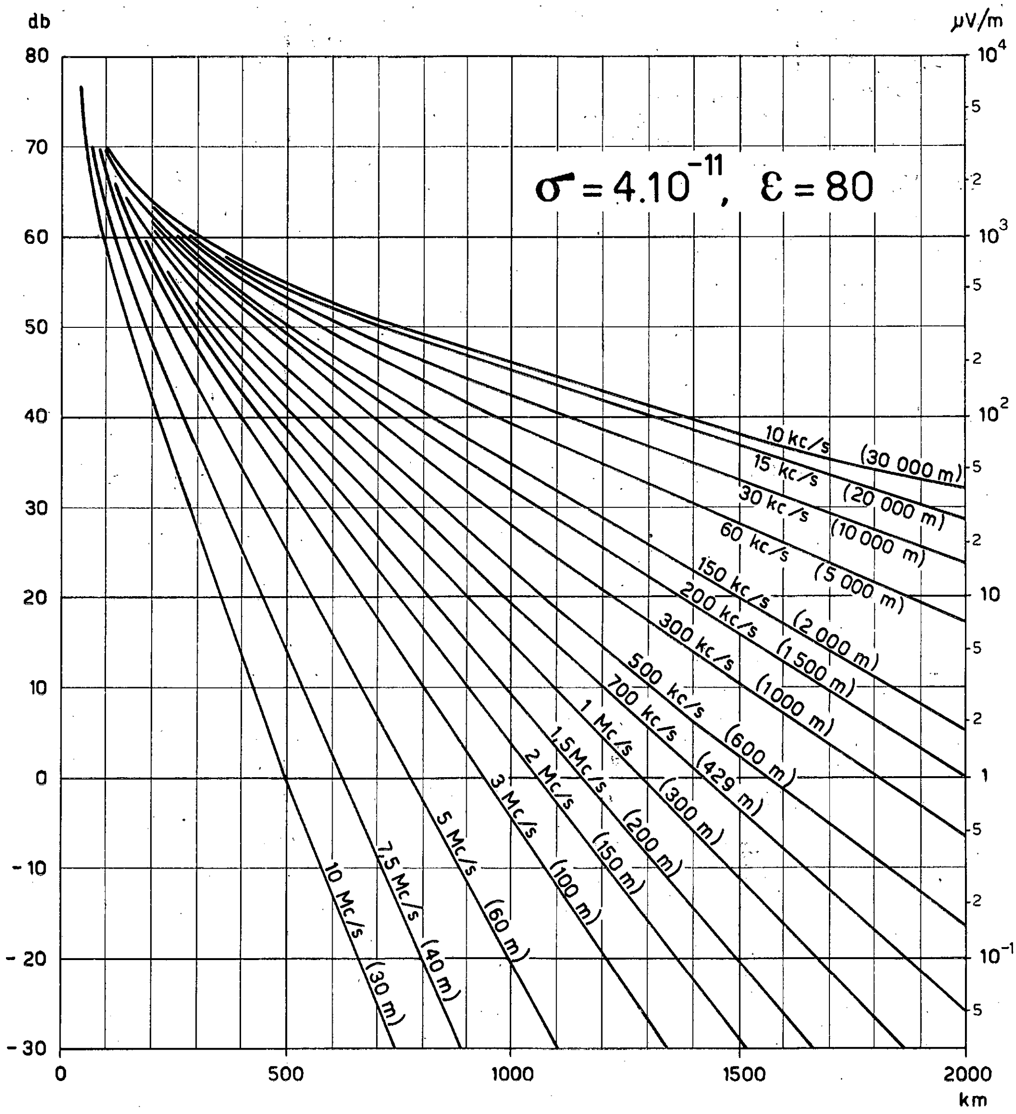
*(g)* The curves are no longer referred to a radiated power of 1 kW, but to what has been called an unattenuated field strength of $3 \times 10^5/D$ $\mu$V/m where D is the distance from the transmitter in kilometres. This field would actually correspond to the case of a vertical antenna, shorter than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

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

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

PROPAGATION CURVES

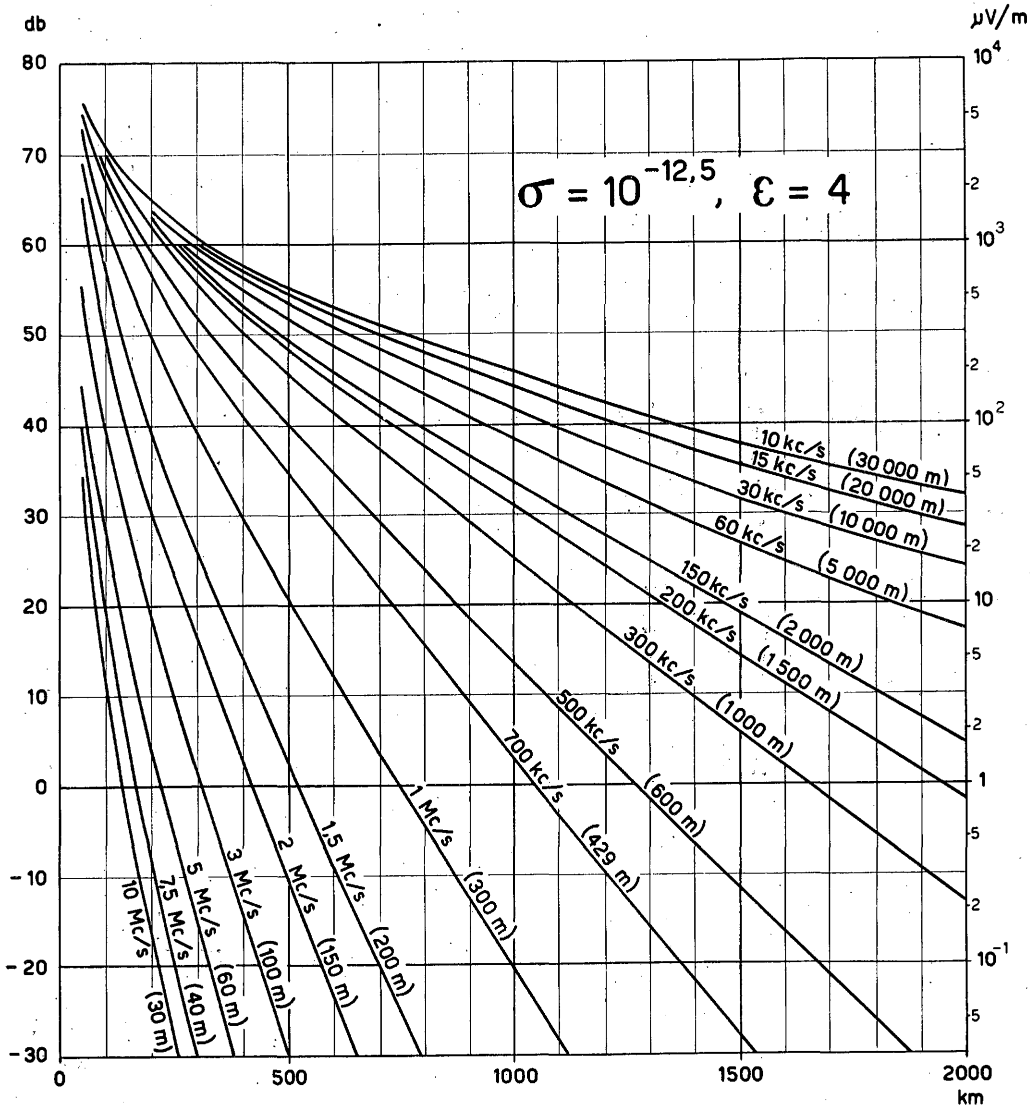
Ground wave corresponding to an unattenuated field of:
$3 \times 10^5/D_{km}$ $\mu V/m$




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

PROPAGATION CURVES

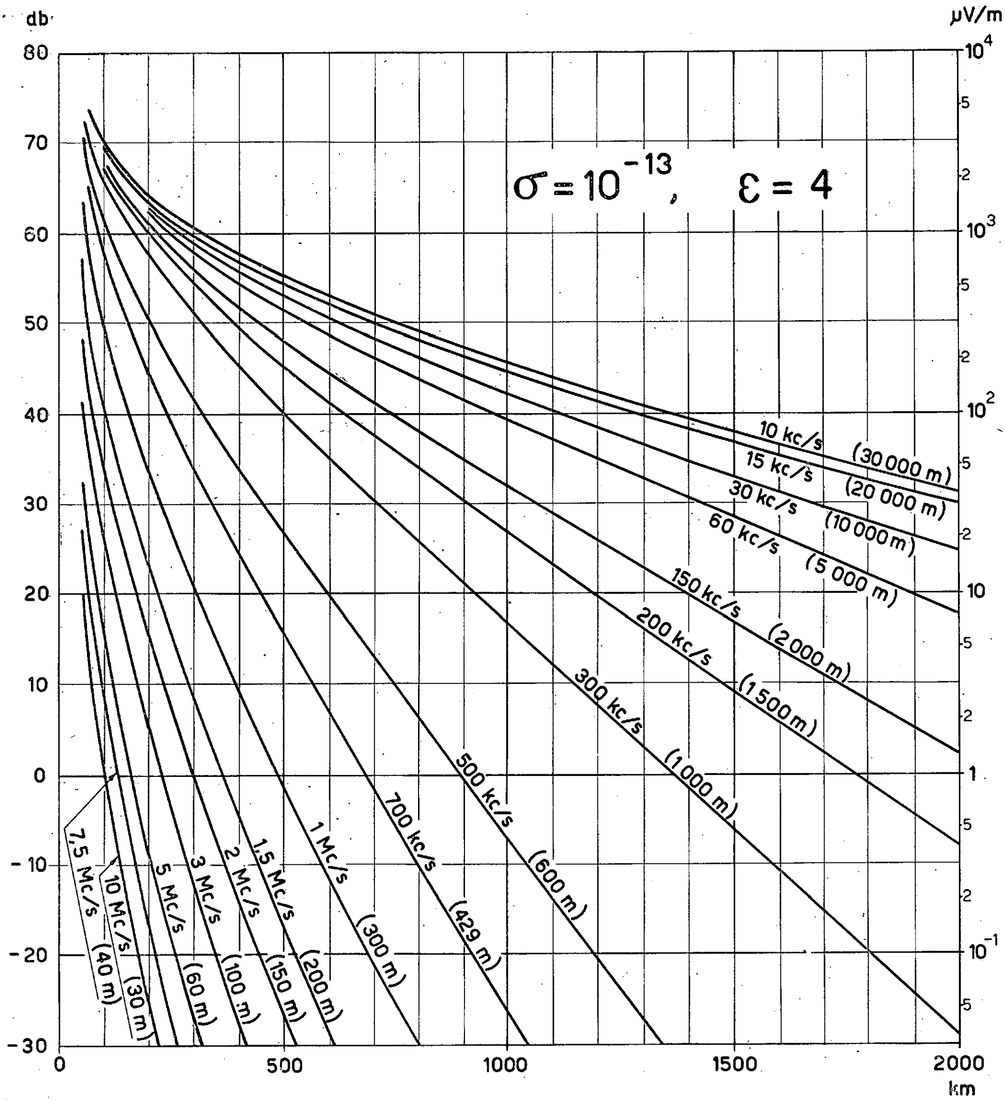
Ground wave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ $\mu$V/m




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

PROPAGATION CURVES

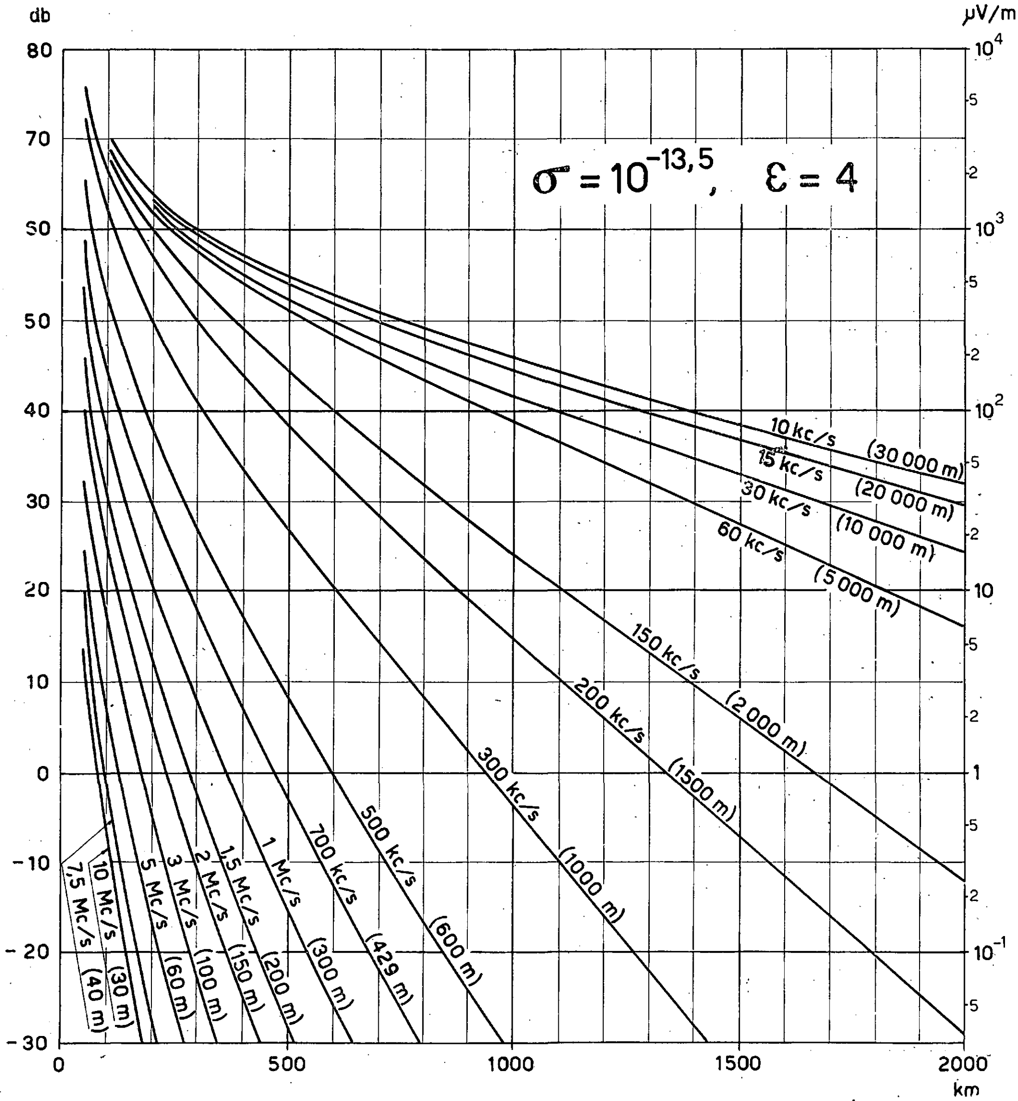
Ground wave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ µV/m




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

# PROPAGATION CURVES

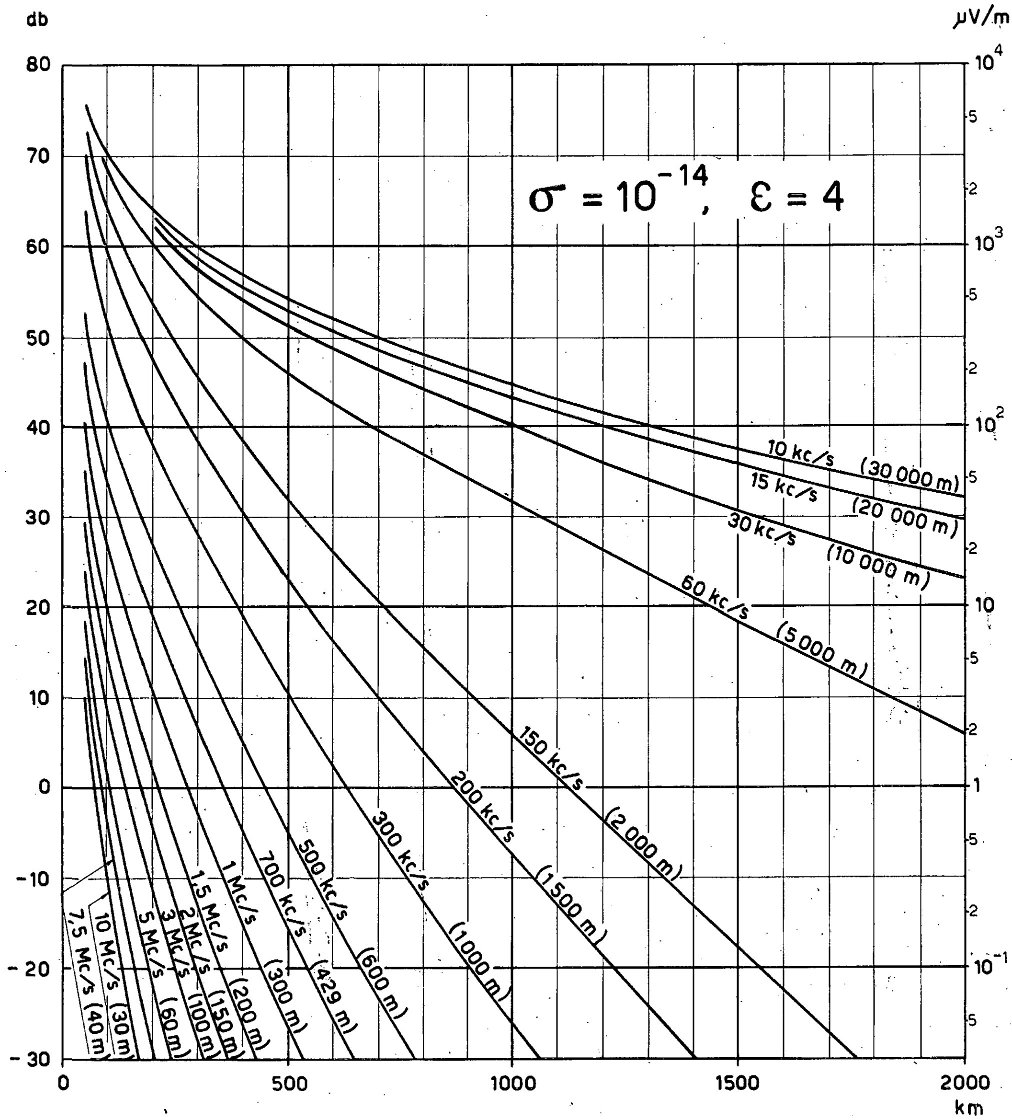
Ground wave corresponding to an unattenuated field of:
$3 \times 10^5 / D_{km}$ $\mu V/m$




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

PROPAGATION CURVES

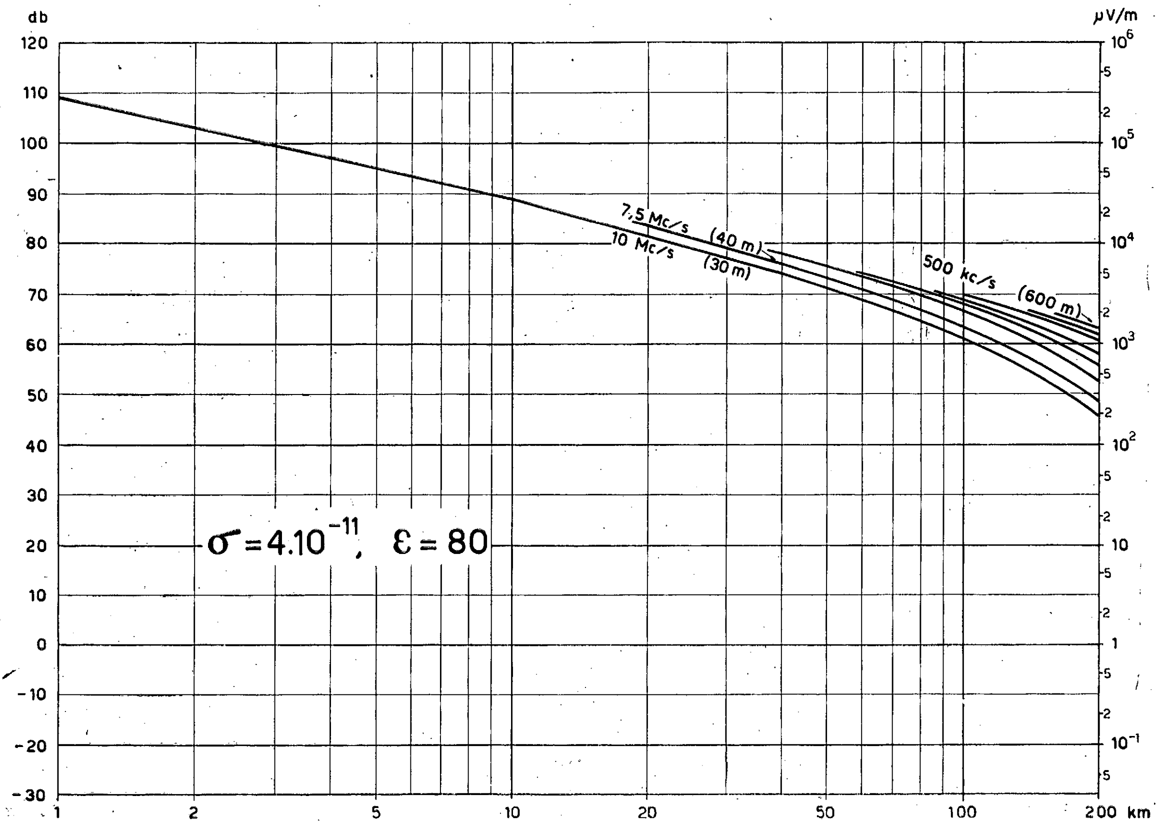
Ground wave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ $\mu$V/m




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

PROPAGATION CURVES

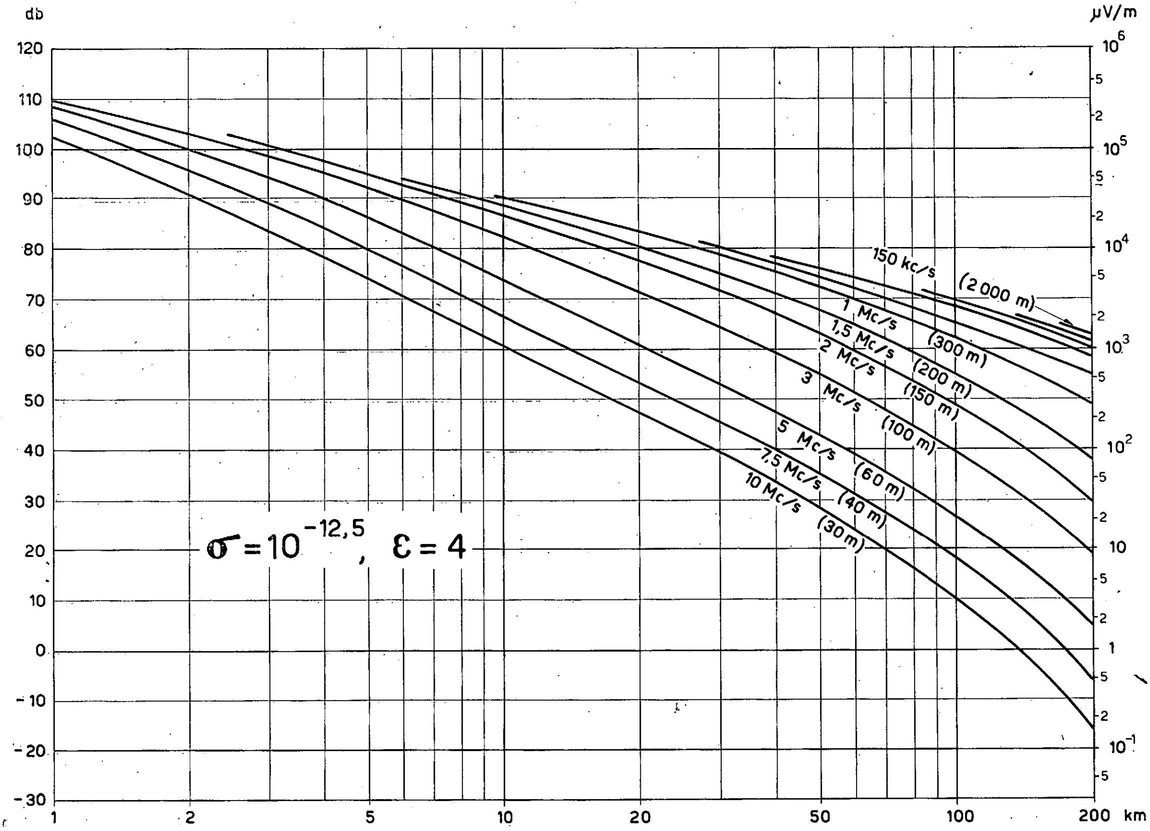
Ground wave corresponding to an unattenuated field of : $3 \times 10^5/D_{km}$ $\mu$V/m




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

PROPAGATION CURVES

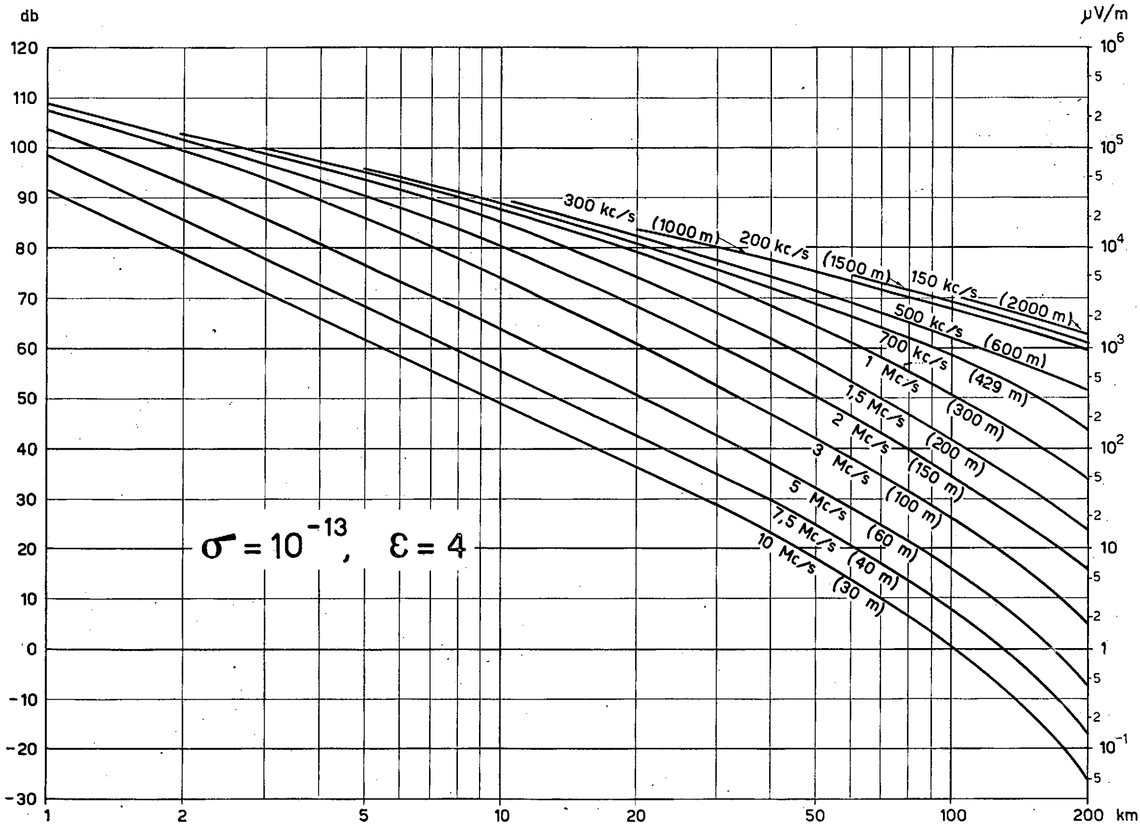
Ground wave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$




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

PROPAGATION CURVES

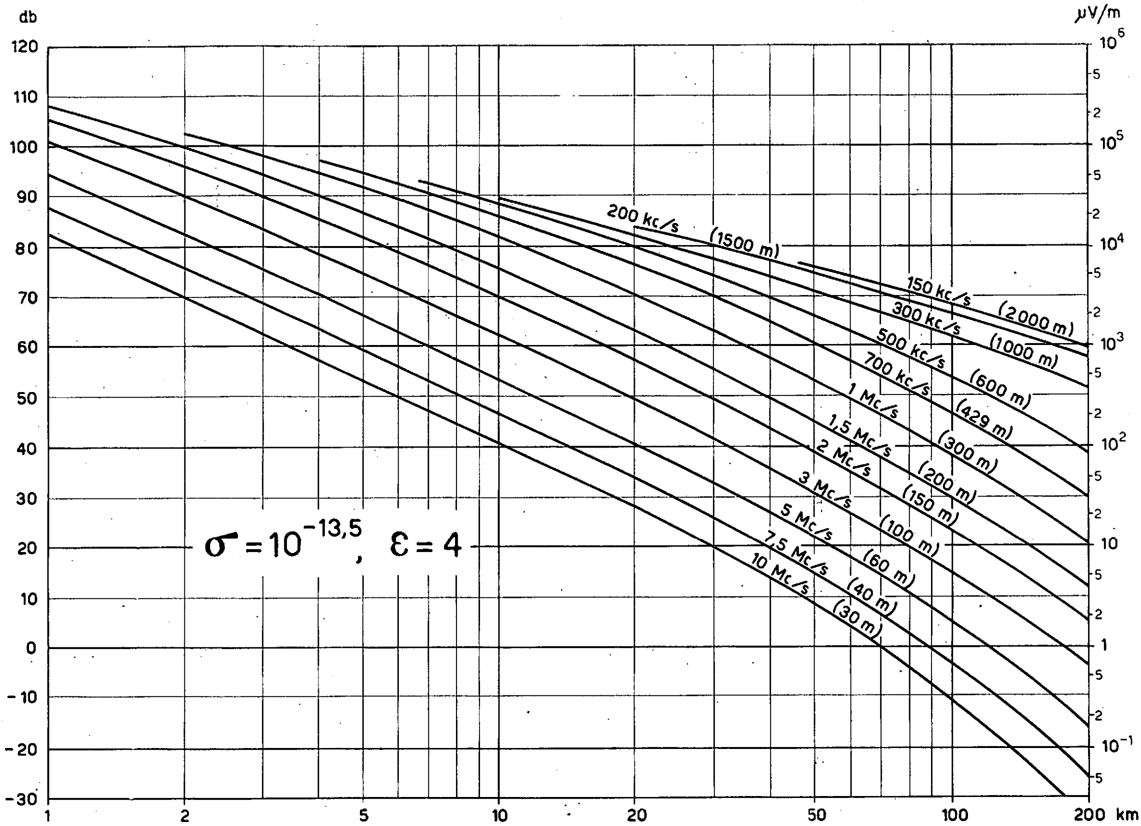
Ground wave corresponding to an unattenuated field of :
$3 \times 10^5 / D_{km}$ $\mu V/m$




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

PROPAGATION CURVES

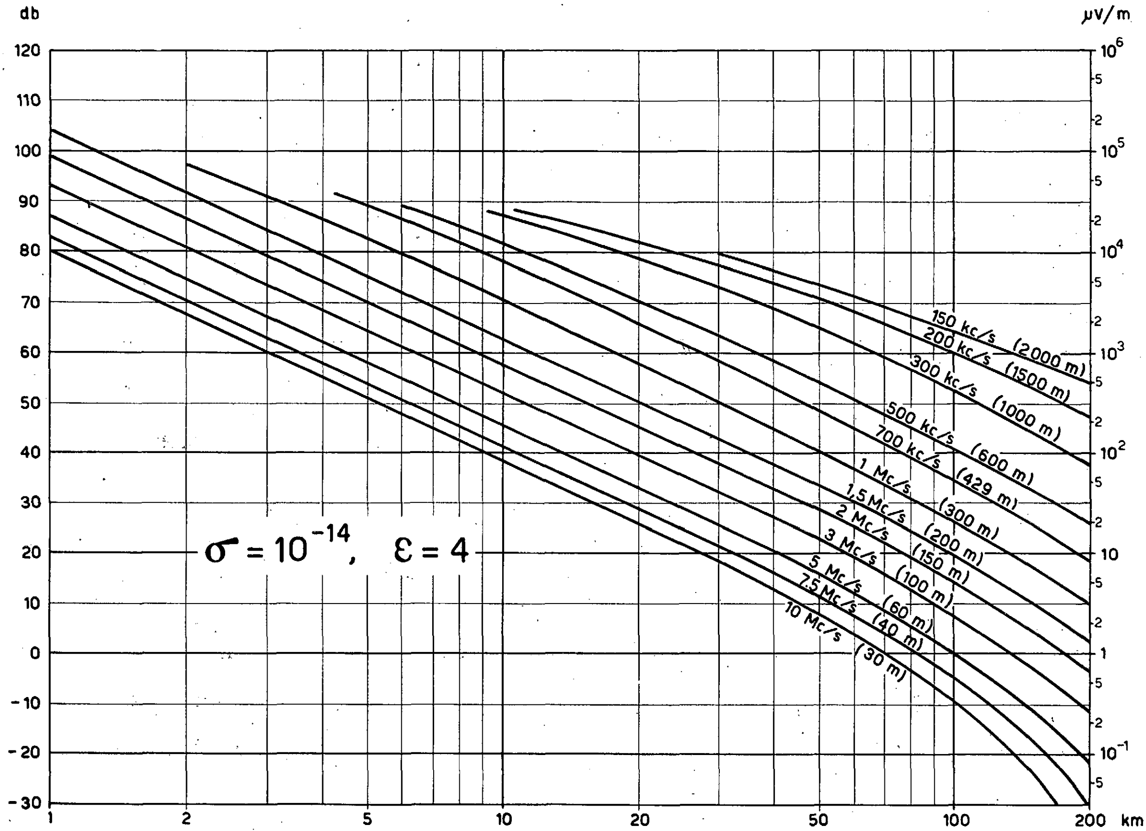
Ground wave corresponding to an unattenuated field of :
$3 \times 10^5/D_{km}$ $\mu$V/m




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

## PROPAGATION CURVES

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




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

# RECOMMENDATION No. 54

## DEFINITIONS OF TERMS RELATING TO PROPAGATION IN THE TROPOSPHERE

(Recommendation No. 15)

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

CONSIDERING :

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

UNANIMOUSLY RECOMMENDS :

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

### VOCABULARY OF TERMS USED IN RADIO PROPAGATION THROUGH THE TROPOSPHERE

| Term | Definition |
|---|---|
| 1. *Troposphere* | The lower part of the earth's atmosphere extending upwards from the earth's surface, in which temperature decreases with height except in local layers of temperature inversion. |
| 2. *Tropopause* | The upper boundary of the troposphere, above which the temperature increases slightly with respect to height, or remains constant. |
| 3. *Temperature Inversion* | In the troposphere : an increase in temperature with height. |
| 4. *Modified Refractive Index* | For a given height above sea level : the sum of the refractive index of the air at this height and the ratio of this height to the radius of the earth. |
| 5. *Refractive Modulus* | One million times the amount by which the modified refractive index exceeds unity. |
| 6. M *Unit* | A unit in terms of which refractive modulus is expressed in accordance with the preceding definition. |
| 7. M *Curve* | A curve showing the relationship between refractive modulus and height above the earth's surface. |
| 8. *Standard Refractive Modulus Gradient* | That uniform variation of refractive modulus with height above the earth's surface which is regarded as a standard for comparison. The gradient considered as normal has a value of 0.12 M Units per metre (3.6 M Units per hundred feet). |
| 9. *Standard Radio Atmosphere* | For tropospheric propagation : an atmosphere having the standard refractive modulus gradient. |
| 10. *Standard Refraction* | The refraction which would occur in a standard radio atmosphere (See Fig. 1). |

| Term | Definition |
|---|---|
| 11. *Super-refraction* | Refraction greater than standard refraction (See Fig. 1). |
| 12. *Sub-refraction* | Refraction less than standard refraction (See Fig. 1). |
| 13. *Standard Propagation* | The propagation of radio waves over a smooth spherical earth of uniform electrical characteristics under conditions of standard refraction in the atmosphere. |
| 14. *Tangential Wave Path* | In radio wave propagation over the earth : a path of propagation of a direct wave, which is tangential to the surface of the earth. The tangential wave path is curved by atmospheric refraction. |
| 15. *Radio Horizon* | The locus of points at which direct rays from the transmitter become tangential to the earth's surface. |
| 16. *Effective Radius of the Earth* | The radius of a hypothetical earth for which the distance to the radio horizon assuming rectilinear propagation is the same as that for the actual earth with an assumed uniform vertical gradient of refractive index. (For the standard atmosphere, the effective radius is $^4/_3$ that of the actual earth). |
| 17. *Tropospheric Radio Duct* | A stratum of the troposphere within which an abnormally large proportion of any radiation of sufficiently high frequency is confined and over part or all of which there exists a negative gradient of refractive modulus.<br>The upper bounding surface is determined by a local minimum value of the refractive modulus. The lower bounding surface is either the surface of the earth or a surface parallel to the local stratification of refractive properties at which the refractive modulus has the same values as that at the local minimum value of the refractive modulus (See Figs. 2, 3 and 4). |
| 18. *Surface Duct*<br>*Ground-based Duct* | A tropospheric radio duct having the earth as its lower boundary, and in which the modified refractive index is everywhere greater than the value at the upper boundary (See Figs. 2 and 3). |
| 19. *Elevated Duct* | A tropospheric radio duct of which the lower boundary is an elevated surface at which the modified refractive index has the same value as at the upper boundary (See Fig. 4). |
| 20. *Duct Thickness*<br>*Duct Width* | The difference in height between the upper and lower boundaries of a tropospheric radio duct. |
| 21. *Duct Height* | The height above the surface of the earth of the lower boundary of an elevated duct (See Fig. 4). |
| 22. *Tropospheric Mode* | Any one of the possible modes of propagation in the troposphere. |
| 23. *Trapped Mode* | A mode of propagation in which the energy is substantially confined within a tropospheric radio duct. |

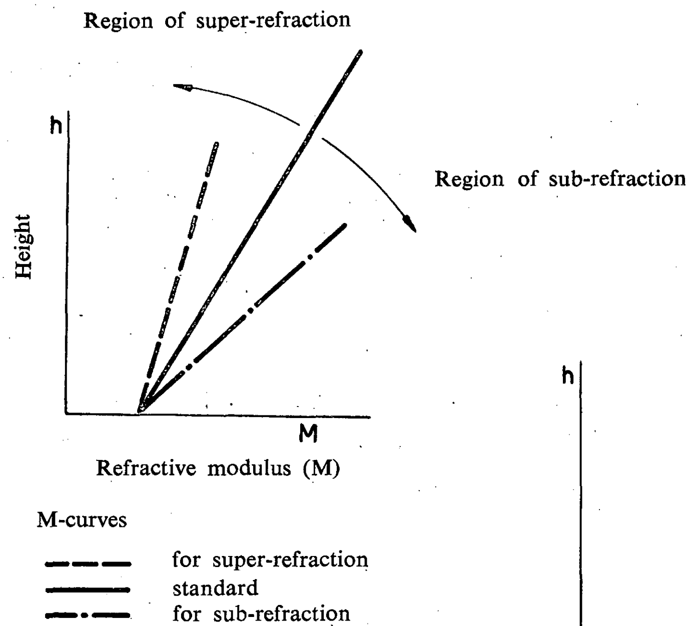
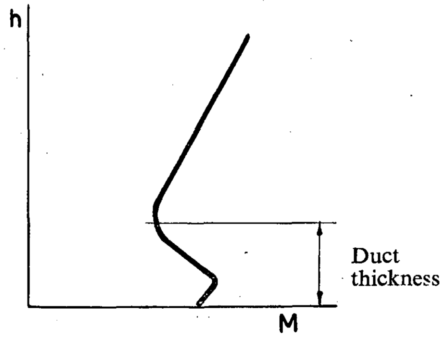
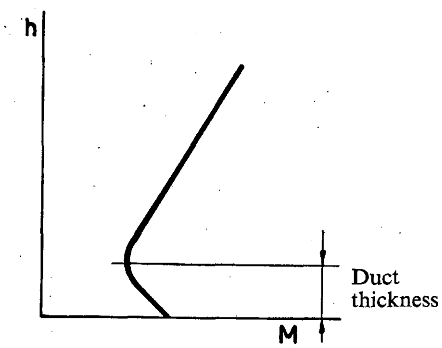



FIGURE 1



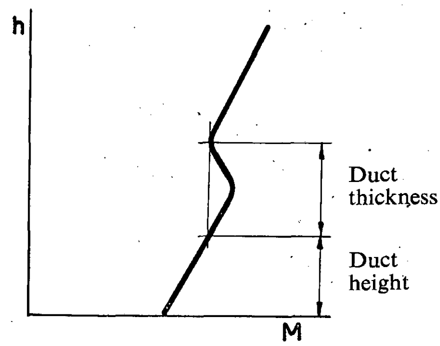

Surface duct

FIGURE 2




Surface duct

FIGURE 3




Elevated duct

FIGURE 4

## RECOMMENDATION No. 59

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

(Recommendations Nos. 11, 13 and 16)

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

CONSIDERING :

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

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

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

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

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

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

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

RECOMMENDS :

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

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

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

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

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

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

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

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

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

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

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## RECOMMENDATION No. 60

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

(Question No. 8, § A.1a)

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

CONSIDERING :

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

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

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

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

UNANIMOUSLY RECOMMENDS :

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

1.1 In respect to intensity,

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

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

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

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

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

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

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## RECOMMENDATION No. 61

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

(Question No. 8, § A.1b)

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

CONSIDERING :

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

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

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

UNANIMOUSLY RECOMMENDS :

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

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

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

# RECOMMENDATION No. 63

## BEST METHODS FOR EXPRESSING FIELD STRENGTH FOR REDUCED CARRIER TRANSMISSIONS

(Question No. 8, § A.1d)

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

CONSIDERING :

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

(1) the type of transmission,

(2) the magnitude of the independent side bands, relative to the carrier ;

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

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

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

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

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

UNANIMOUSLY RECOMMENDS :

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

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

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

# RECOMMENDATION No. 65

## FIELD STRENGTH MEASUREMENT

### Desirable and attainable Accuracy of Field Strength Measurement for each Frequency Band

(Question No. 8, § A.4)

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

CONSIDERING :

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

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

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

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

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

UNANIMOUSLY RECOMMENDS :

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

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

*Table I*

| Frequency band | Accuracy of measurement (db) | Minimum field strength at which this accuracy is obtained (μV/m) |
|---|---|---|
| 10-30 kc/s | ± 2 | 10 |
| 30-300 kc/s | ± 2 | 5 |
| 300-3000 kc/s | ± 2 | 2 |
| 3-30 Mc/s | ± 2 | 2 |
| 30-300 Mc/s | ± 3 | 5 |
| 300-3000 Mc/s | ± 5 | 50 |
| 3000-30 000 Mc/s | ± 5 | 10 * |

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

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

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

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

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## RECOMMENDATION No. 67

## ATMOSPHERIC NOISE DATA

(Question No. 10)

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

CONSIDERING :

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

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

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

RECOMMENDS :

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

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

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## RECOMMENDATION No. 72

## USE OF 8364 kc/s FOR RADIO DIRECTION FINDING

(Question No. 21)

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

CONSIDERING :

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

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

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

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

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

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

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

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

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

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

(i) That standardized distress transmissions are desirable ;

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

RECOMMENDS :

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

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

1.2 Of high and uniform ground conductivity ;

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

## ANNEX

### Accuracy of Bearings on 8364 kc/s

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

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

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

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## RECOMMENDATION No. 73

## STUDY OF RELATIONSHIPS BETWEEN PEAK POWER AND MEAN POWER

(Question No. 22)

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

CONSIDERING :

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

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

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

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

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

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

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

RECOMMENDS :

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

## ANNEX

### Conversion Table for Relationships between Peak Power and Mean Power

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

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

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

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

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

| Type of Modulated Emission | Characteristic Modulation | Condition of No Modulation | Conversion Factors (See 2 above) | |
|---|---|---|---|---|
| | | | Pm | Pp |
| *Amplitude Modulation*<br>A1<br>(On-off telegraphy) | Series of rectangular dots ; equal marks and spaces ; zero space amplitude | Key down | 0.5<br>(Note 1) | 1 |
| A2<br>(Telegraphy with keying of audio frequency modulating tone, or of modulated emission) | Series of rectangular dots ; equal marks and spaces ; single sine-wave audio frequency modulating tone ; 100% modulation<br>*(a)* Modulating tone keyed<br>*(b)* Modulated emission keyed | *(a)* Key up (tone removed)<br>*(b)* Key down (tone removed) | *(a)* 1.25<br>*(b)* 0.75 | *(a)* 4<br>*(b)* 4 |
| A3<br>(Double-sideband telephony full carrier) | *(a)* Single sine-wave audio frequency modulating tone ; 100% modulation<br>*(b)* Smoothly read text | *(a)* Carrier only (Note 2)<br>*(b)* Carrier only (Note 2) | *(a)* 1.5<br>*(b)* 1 to 1.08 | *(a)* 4<br>*(b)* 4 |
| A3a<br>(Single-sideband reduced carrier) | See Supplementary Table I and Note 3 | | | |
| A3b<br>(Two independent sidebands reduced carrier) | See Supplementary Table II and Note 3 | | | |
| A4<br>(Facsimile) | Black and white checkerboard picture giving square modulating wave ; 100% modulation | Full carrier amplitude | 0.5<br>(Note 6) | 1<br>(Note 6) |
| A5<br>(Television) | (See Note 4) | | | |
| *Frequency or phase modulation*<br>F1<br>F2<br>F3<br>F4<br>F5<br>F9 | (For all types of frequency or phase modulated transmissions the modulation changes the distribution of power in the frequency band of the emissions while leaving the total power of the emissions unchanged) | | 1<br>1<br>1<br>1<br>1<br>1 | 1<br>1<br>1<br>1<br>1<br>1 |
| *Pulse*<br>P1<br>(Simple telegraphy) | Pulse train keyed on and off ; mark and space equal ; rectangular pulses, constant amplitude and duty cycle | Key down<br>(Note 5) | 0.5<br>(Note 5) | 1/duty cycle |

| Type of Modulated Emission | Characteristic Modulation | Condition of No Modulation | Conversion Factors (See 2 above) | |
|---|---|---|---|---|
| | | | Pm | Pp |
| | Audio frequency tone-modulated telegraphy. Series of equal rectangular marks and spaces ; single sine-wave audio frequency modulating tone ; 100% modulation. | | | |
| P2d (Pulses, amplitude modulated ; constant duty cycle) | *(a)* Modulating tone keyed<br>*(b)* Modulated emission keyed | *(a)* Key up (tone removed) (Note 5)<br>*(b)* Key down (tone removed) (Note 5) | *(a)* 1.25<br>*(b)* 0.75 | *(a)* 4/duty cycle<br>*(b)* 4/duty cycle |
| P2e (Pulses, width or duration modulated ; constant amplitude) | *(a)* Modulating tone keyed<br>*(b)* Modulated emission keyed | *(a)* Key up (tone removed) (Note 5)<br>*(b)* Key down (tone removed) (Note 5) | *(a)* 1<br>*(b)* 0.5 | *(a)* 1/average duty cycle<br>*(b)* 1/average duty cycle |
| P2f (Pulses, position or phase modulated ; constant amplitude) | *(a)* Modulating tone keyed<br>*(b)* Modulated emission keyed | *(a)* Key up (tone removed) (Note 5)<br>*(b)* Key down (tone removed) (Note 5) | *(a)* 1<br>*(b)* 0.5 | *(a)* 1/average duty cycle<br>*(b)* 1/average duty cycle |
| | Telephony | | | |
| P3d (Pulses, amplitude modulated ; constant duty cycle) | *(a)* Single sine-wave audio frequency modulating tone ; 100% modulation<br>*(b)* Smoothly read text | *(a)* Pulse carrier only (Note 5)<br>*(b)* Pulse carrier only (Note 5) | *(a)* 1.5<br>*(b)* 1 to 1.08 | *(a)* 4/duty cycle<br>*(b)* 4/duty cycle |
| P3e (Pulses, width or duration modulated ; constant amplitude) | Single sine-wave audio frequency modulating tone ; 100% modulation ; rectangular pulses | Pulse carrier only (Note 5) | 1 | 1/average duty cycle |
| P3f (Pulses, position or phase modulated ; constant amplitude) | | Pulse carrier only (Note 5) | 1 | 1/average duty cycle |

*Note 1.* — For Morse Pm = 0.49 Pp.
For International Alphabet No. 2 : Pm = 0.58 Pp.

*Note 2.* — The peak power of double sideband transmitters is nominally four times the power of the unmodulated carrier. To determine the proper level for applying speech two tones are employed, as in the single sideband case described in Note 3. In a well-constructed transmitter, this should result in reasonably high percentages of modulation.

It has been found in connection with smoothly-read text that a reading of 2 (VU * meter readings) corresponds to a mean power of zero dbm ** measured in the audio frequency band, nominally up to 3000 or 4000 cycles/second.

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

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

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

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

SUPPLEMENTARY TABLE I

*Ratio of $P_m$ to $P_p$ for A3a Emission*

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

For notes see page 67.

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

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

SUPPLEMENTARY TABLE II

*Ratio of $P_m$ to $P_p$ for A3b Emission*

| Condition of No Modulation | Characteristic Modulation | | | |
|---|---|---|---|---|
| Carrier Level, Referred to Peak Power of Either Sideband | † Single Sine-wave Audio Frequency Modulating Tone on Each Channel : Transmitter Fully Loaded | †† Each Channel Fully Loaded by Smoothly-Read Text : Transmitter Fully Loaded | ††† Each Channel Fully Loaded by " Other " Programme Material : Transmitter Fully Loaded | Channel 1 Smoothly-read Text and Channel 2 " Other " Programme Material |
| −10 db | 0.392 (−4.07 db) | 0.078 (−11.1 db) | 0.056 (−12.5 db) | 0.067 (−11.8 db) |
| −20 db | 0.456 (−3.41 db) | 0.074 (−11.3 db) | 0.048 (−13.2 db) | 0.061 (−12.1 db) |
| −30 db | 0.485 (−3.14 db) | 0.077 (−11.1 db) | 0.049 (−13.1 db) | 0.063 (−12.0 db) |
| − ∞ (fully suppressed) | 0.500 (−3.01 db) | 0.079 (−11.0 db) | 0.050 (−13.0 db) | 0.065 (−11.9 db) |

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

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

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

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# RECOMMENDATION No. 74

## PRINCIPLES OF THE DEVICES USED FOR ACHIEVING PRIVACY OF RADIOTELEPHONE CONVERSATIONS

(Question No. 30)

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

CONSIDERING :

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

*(b)* That in the interests of maximum privacy, the details of the systems employed and of their performance, should be agreed upon between the administrations and private enterprises concerned ;

UNANIMOUSLY RECOMMENDS :

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

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

1.1 *Principles of the Devices*

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

1.1.1 *For Double-Sideband Systems*

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

1.1.2 *For Single-Sideband Systems*

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

1.2 *Characteristics of the Devices*

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

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

1.3 *Location of the Devices*

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

**2.** That for frequencies above about 30 Mc/s the details of the systems to be employed and of their performance should be agreed upon between the administrations or private enterprises concerned.

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## RECOMMENDATION No. 75

## CLASSIFICATION AND ESSENTIAL CHARACTERISTICS OF FEED-BACK SUPPRESSORS

(Question No. 31)

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

CONSIDERING :

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

UNANIMOUSLY RECOMMENDS :

That no classification of types nor terminology be adopted.

*Essential characteristics*

(§ *(b)* of Question No. 31)

The essential characteristics of the feed-back suppressors used on radiotelephone circuits in the United Kingdom and in the United States of America for fixed services are described respectively in Doc. Nos. 49 and 51 of Geneva. These are in substantial accord with the characteristics described in C.C.I.F., 1950-1951, 5th Study Group, Doc. No. 7, Question No. 2.

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## RECOMMENDATION No. 76

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

(Question No. 32)

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

CONSIDERING :

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

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

UNANIMOUSLY RECOMMENDS :

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

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

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

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

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

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

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

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

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## RECOMMENDATION No. 77

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

(Question No. 33)

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

CONSIDERING :

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

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

RECOMMENDS :

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

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

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

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

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

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## RECOMMENDATION No. 78

## PREVENTION OF INTERFERENCE TO RADIO RECEPTION ON SHIPS *

(Question No. 34)

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

CONSIDERING :

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

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

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

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

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

UNANIMOUSLY RECOMMENDS :

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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## RECOMMENDATION No. 80

## HIGH FREQUENCY BROADCASTING DIRECTIONAL ANTENNAE

(Question No. 23)

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

CONSIDERING :

*(a)* Question No. 23 ;

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

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

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

RECOMMENDS :

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

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## RECOMMENDATION No. 82

### TELEVISION STANDARDS

(Recommendation No. 29)

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

CONSIDERING :

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

RECOMMENDS :

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

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

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

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

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

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

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

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

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

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

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

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

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

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## RECOMMENDATION No. 83

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

(Question No. 26)

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

CONSIDERING :

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

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

RECOMMENDS :

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

*Note.* — This Recommendation concludes the study of Question No. 26.

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## RECOMMENDATION No. 84

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

(Question No. 27)

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

CONSIDERING :

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

RECOMMENDS :

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

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* As this service is defined in the considerations of Question No. 27, reproduced in the Annex to Study Programme No. 38 (XII).

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

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

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

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## RECOMMENDATION No. 87 *

## BANDWIDTH OF EMISSIONS

(Recommendations Nos. 3 and 36)

The C.C.I.R., (Stockholm, 1948 — Geneva, 1951 — London, 1953)

CONSIDERING :

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

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

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

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

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

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

*(g)* That one can thus realise the usefulness of three conceptions :

— the bandwidth necessarily occupied ;
— the bandwidth occupied ;
— the emitted spectrum outside the bandwidth necessarily occupied ;

which can be defined and applied according to the following principles :

* This Recommendation replaces Recommendation No. 38.

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

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

*g*.3 The emitted spectrum outside the bandwidth necessarily occupied must be determined by reconciling the following requirements ;
- the necessity to limit to a strict minimum the interference caused to the adjacent channels ;
- the technical and practical possibilities of transmitter design ;
- the limitation to a permissible value of the shaping or distortion of the signal ;

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

RECOMMENDS :

**1. Definitions.**

1.0 That in addition to the definition of bandwidth occupied by an emission, given in Chap. 1, Art. 58, of the Radio Regulations, and which is quoted for reference in § 1.1 below, the following definitions and explanatory notes should be employed as convenient conventions to facilitate and clarify the consideration of bandwidth problems.

1.1 *Bandwidth occupied by an emission:*

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

1.2 *Bandwidth necessarily occupied by an emission:*

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

1.3 *Out of band radiation of an emission:*

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

1.4 *Build up time of the signal:*

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

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

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

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

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

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

## 2. Limitations of the Emitted Spectra.

2.0 That, since some present emissions (particularly class A1 emissions) occupy an unduly wide bandwidth, administrations should endeavour, with the minimum practicable delay, to limit the emitted spectra to those shown below for various classes of emissions.

2.1 *Class A1 emissions with fluctuations:*

2.1.0 Under conditions where large short period variations of the received field are present the specifications given below for single channel, amplitude modulated, continuous wave telegraphy (class A1) represent desirable performance that can be obtained from transmitters with adequate input filters and sufficiently linear amplifiers, following that in which keying takes place.

2.1.1 *Bandwidth necessarily occupied:*

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

2.1.2 *Spectrum of the out of band radiation:*

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

2.1.3 *Build up time of the signal:*

The build up time of the transmitted signal depends essentially on the shape of the signal at the input of the transmitter, on the exact structure of the filters to which this signal is applied, on filtering and non-linear effects which may take place in the transmitter itself (assuming that the antenna has no influence on the shape of the signal). As a first approximation it can be accepted that a spectrum curve close to the limiting spectrum defined in § 2.1.1 and 2.1.2, corresponds to a build up time of the order of 20% of the initial duration of the telegraph dot, i.e. of the order of $\frac{1}{5\text{ B}}$.

2.2 *Class A1 emissions, without fluctuations:*

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

2.3 *Class A2 emissions:*

2.3.0 For single channel modulated telegraphy keyed on both the carrier and the modulating frequency, the percentage of modulation being 100% or less and the modulation frequency higher than twice the keying frequency (F>B), the specifications given below represent desirable performance that can be obtained from transmitters with fairly simple input filters and approximately linear stages.

2.3.1 *Spectrum:*

Outside a band with a width equal to twice the modulating frequency (referred to as F) plus five times the telegraph speed in Bauds, the envelope of the spectrum should lie below a curve starting at the points of abscissae $\pm\left(F + \frac{5\,B}{2}\right)$ and ordinates $-24$ db, presenting a slope of 12 db per octave, and extending over at least one octave, that is out to the points of abscissae $\pm$ (F + 5 B) and ordinate $-36$ db.

From these points onward the level of all the components emitted should be below $-36$ db.

The reference level is the carrier level during a steady dash.

2.3.2 *Modulation depth:*

With a view to reducing the components due to the harmonics of the modulating frequency it is recommended that, in general, the depth of modulation should not exceed 80%.

2.3.3 *Bandwidth necessarily occupied:*

The bandwidth necessarily occupied depends on the telegraph speed, on the frequency and depth of modulation and on non-linear effects. It must therefore be determined for each specific case.

2.4 *Class A3 emissions:*

The limitations given below for radiotelephone emissions have been deduced from measurements made by different methods. In one of these methods two pure audio frequency tones of equal amplitude are applied to the input of the transmitter and the amplitude of modulation products outside the normal bandwidth of the transmitter is measured at the output. In other methods the output voltage from a recording of conversational speech, or a white noise voltage, is substituted for the two audio frequency tones.

These fundamentally different methods do not lead to the same result ; however, the known results of measurements are within the limiting spectra specified below.

In the curves defined in § 2.4.1 and 2.4.2, the ordinates represent the energy intercepted by a receiver of a bandwidth practically equal to 3 kc/s, the central frequency of which is tuned to the frequency plotted on the abscissa, as compared to the energy which would be intercepted by the same receiver if it were tuned to the central frequency of the necessary band.

2.4.1 *Class A3 emissions, double-sideband:*

2.4.1.1 *Necessary frequency band*

The necessary bandwidth equals twice the highest audio frequency M which it is desired to transmit with a specified small attenuation

2.4.1.2 *Power within the necessary band*

To estimate statistically the distribution of power within the necessary band when no privacy equipment is connected with the transmitter, the distribution shown by the C.C.I.F. for the "commercial circuit psophometer" can be used (Recommendation No. 5, 16th Plenary Assembly, Volume VI); in addition, the relative power level of speech frequencies should be taken into account.

In cases where the transmitter is used in connection with a frequency inversion privacy equipment the same data can be used with appropriate frequency inversion of the resulting spectrum.

If a band-splitting privacy equipment is used, it has to be assumed that the statistical distribution of power is uniform within the frequency band.

2.4.1.3 *Power outside the necessary band*

2M being the necessary bandwidth, if a logarithmic abscissa frequency scale and an ordinate amplitude scale in decibels are used, the distribution curve of power outside the necessary band should lie below two straight lines starting from the points ($\pm$ M, 0 db) to the points ($\pm$1.4 M, $-20$ db). Beyond these points, and down to the level of $-60$ db, this curve should lie below two straight lines starting from the latter points and presenting a slope of 12 db per octave. Thereafter, the same curve should lie below the level $-60$ db.

The reference level corresponds to the level of a single pure tone which, when applied to the input of the transmitter, gives the peak modulation of the transmitter.

2.4.2 *Class A3a, A3b, etc.,,, emissions, independent sidebands and reduced carrier:*

2.4.2.1 *Necessary frequency band*

The necessary bandwidth 2F is equal to the difference of the two radio frequencies defining the limits of the necessary band. These two frequencies correspond to the extreme modulating frequencies which it is desired to transmit with a specified small attenuation in the outer channels of the emission.

2.4.2.2 *Power within the necessary band*

The distribution of power within the necessary band is determined as for double sideband transmitters. However, one must consider that independent sideband transmitters are, in general, used with a band-splitting privacy equipment; it has then to be assumed that power distribution is, in general, statistically uniform within each of the sidebands.

2.4.2.3 *Power outside the necessary band*

The power outside the necessary band is dependent on the number and position of the active channels. The curves described below are appropriate when all channels are active simultaneously. When some channels are idle the power outside the necessary band is less. 2F being the necessary bandwidth, if a logarithmic abscissa frequency scale and an ordinate amplitude scale in decibels are used, the distribution curve of power outside the necessary band should lie below two straight lines starting from the points ($\pm$F, 0 db) to the points ($\pm$1.4 F, $-30$ db).

Beyond these points, and down to the level of $-60$ db, this curve should lie below two straight lines starting from the latter points and presenting a slope of 12 db per octave. Thereafter, the same curve should lie below the level $-60$ db.

The reference level corresponds to the level of a single pure tone which, when applied to the input of one of the transmitter sidebands, gives the peak power of the transmitter.

2.5 *Class F1 emissions:*

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

2.5.1 *Bandwidth necessarily occupied:*

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

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

2.5.2 *Spectrum of the out-of-band radiation:*

Outside the bandwidth defined above, the envelope of the spectrum should lie below a curve of constant slope in decibels per octave, starting from points situated at the limiting frequencies for the bandwidth necessarily occupied, and at the level of $-15$ or $-20$ db, depending on the value of the modulation index, the curve extends to the level of $-60$ db. The levels are computed by comparison with a zero level corresponding to the amplitude of the emission ; the starting ordinates of the curve and its slopes are given in the following table, the entry depending on the modulation index :

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

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

2.5.3 *Build up time of the signal:*

A spectrum curve close to the limiting spectrum described in § 2.5.1 and 2.5.2 corresponds to a build up time equal to about 8 % of the duration of the initial telegraph dot, i.e. about $\frac{1}{12\,B}$ provided that an adequate filter is used for signal shaping.

2.5.4 *Bandwidth occupied, in the case of unshaped signals:*

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

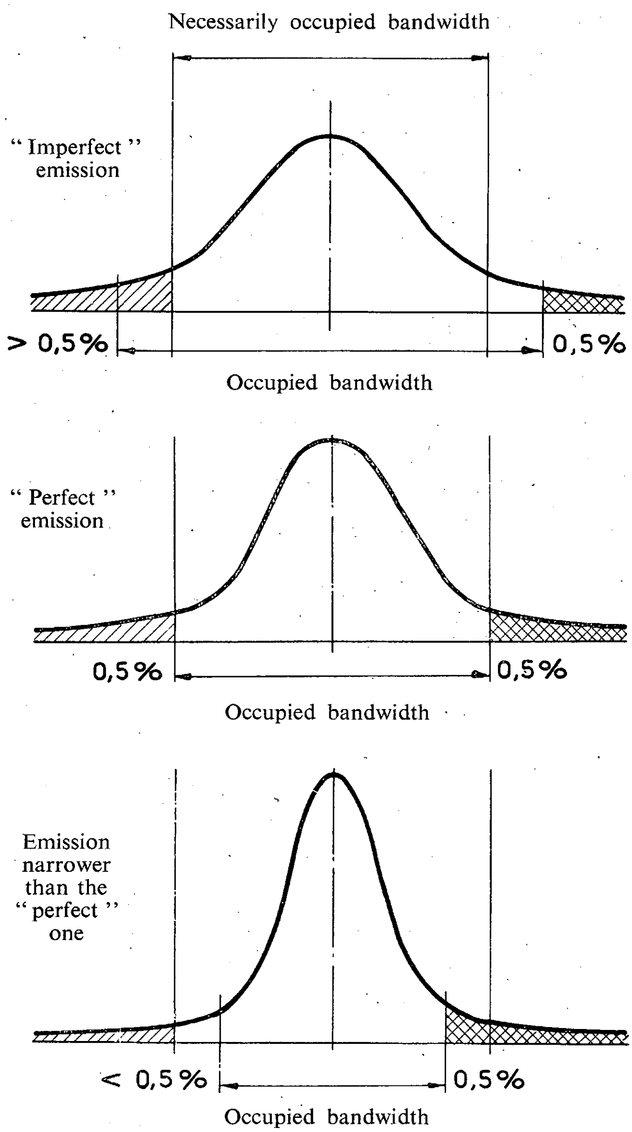
$$\frac{8}{3}\,D + \frac{4}{3}\,B \quad \text{for } 2.5 < m \leqslant 8$$
$$2.2\,D + 3.2\,B \quad \text{for } 8 \leqslant m \leqslant 20$$

# ANNEX

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

Abscissae : frequencies
Ordinates : power, per unit frequency

The spectra are assumed to be symmetrical




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

# RECOMMENDATION No. 88 *

## BANDWIDTH OF EMISSION MEASUREMENTS MADE NEAR THE TRANSMITTER

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

CONSIDERING :

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

*(b)* That Question No. 1 *(a)*, part 2, speaks of " practical methods of measuring the bandwidths actually occupied by emissions " ;

*(c)* That new methods of measurements are proposed ;

*(d)* That important progress has been made in the design of measuring apparatus ;

*(e)* That it is now possible to present some tentative values of the degree of accuracy to be attained ;

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

UNANIMOUSLY RECOMMENDS :

That attention should be paid to the following :

**1. Methods of measurement on frequencies below 30 Mc/s.**

Three main methods are at present in use.

1.1 The first one consists in completely analysing the spectrum of the transmission by means of a narrow band filter of fixed frequency, the frequency of each component being made to coincide with the central filter frequency by frequency transposition on the superheterodyne principle either manually or automatically.

1.2 The second method of measurement consists in directly measuring the proportion of the total energy which is contained in the frequency components more and more remote from the central frequency of the spectrum in order to determine the relative power of the out-of-band radiation.

The frequency components of the rectified signal are selected by means of a high-pass filter, the cut-off frequency of which is progressively increased (equipments based on this method are described in Doc. No. 128 of the Japanese Administration).

1.3 The third method consists in dividing the occupied band into narrow bands of say 100 c/s, for each of which a pass-band filter is provided ; the output of each of these filters is connected either individually and permanently to a measuring device, or successively and automatically to a single measuring device. This method seems to be especially suitable for the examination of non-periodic signals such as telephone transmissions (equipments based on this method are described in Doc. No. 79 of the U.S.A. Administration and No. 274 of the Austrian Administration).

**2. Accuracies required for bandwidth measurement.**

2.1 *Periodic signals of Class A1 :*

2.1.1 *Apparatus using method 1.1*

2.1.1.a *Laboratory apparatus.* This apparatus requires that the signals under test shall give rise to a spectrum the components of which should be stable in amplitude and in frequency. Amplitudes are measured by means of a calibrated attenuator with reference to a constant level ; frequencies are measured by means of a frequency meter.

* This Recommendation replaces Recommendation No. 37.

If the stability conditions referred to above are satisfied, the accuracy of the measurement depends only on the accuracy of calibration of the attenuator and of the frequency meter. An accuracy of $\pm 1\%$ in the measurement of the amplitude is obtainable, but an accuracy of $\pm 5\%$ is sufficient for most practical purposes.

2.1.1.b *Automatic sweep apparatus.* Provided the frequency exploration speed is sufficiently slow to take full advantage of the high selectivity of the filter, the amplitudes of the components adjacent to the carrier can be measured with an accuracy of $\pm 2$ db, but a higher inaccuracy must be expected for the amplitudes of the remote components, especially in the case of narrow spectra and/or of slow telegraph speeds.

The accuracy of measurement of frequency deviations depends on the linearity of the sweep, and on the width of the explored band. Nevertheless, in the case of periodic signals, the frequency deviations between successive components are generally known by the value of the telegraph speed.

2.1.2 *Apparatus using method 1.2*

The accuracy of this measuring equipment depends on the accuracy of the measurement of power ratio, and on the steepness of the attenuation curve of the high-pass filter. The accuracy of the measurement of power ratio should be of the order of $\pm 0.1\%$ but the errors due to the attenuation characteristics of the filter will of course depend on the type of filter employed.

2.1.3 *Apparatus using method 1.3*

When the component frequencies of the signal correspond approximately to the mid-band frequencies of the filters, accuracies of $\pm 1\%$ should be obtained.

2.2 *Periodic signals of Class F1:*

2.2.1 *Apparatus using method 1.1*

If it is possible to form periodic F1 signals for which there are corresponding components stable in amplitude and in frequency, the same accuracies as those mentioned in 2.1.1.a and 2.1.1.b for periodic signals of type A1 can be achieved. It is pointed out that of course, in the present case, the components which can be measured with an accuracy of $\pm 2$ db with automatic sweep apparatus, are those adjacent to the mark and space frequencies.

It is important to point out that for F1 signals it is generally difficult, in practice, to comply with the above mentioned conditions of stability. It is then necessary to consider the envelope of several spectra observed successively, but it is not yet possible to give a satisfactory physical significance to this envelope.

2.2.2 *Apparatus using method 1.2* (see under 2.1.2).

2.2.3 *Apparatus using method 1.3* (see under 2.1.3).

2.3 *Actual traffic signals:*

No data were presented in respect of such signals, which would allow the determination of the significance of the results given by the apparatus described above. It is thus not yet possible to propose any value of the accuracy to be recommended for such signals.

**3. Continuation of studies.**

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

# ANNEX I

## Characteristics of Measuring Equipment with Automatic Frequency Sweep

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

*Filter Bandwidth.*

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

*Exploration speed*

Although rather high exploration speeds might prove to be useful for preliminary adjustments, when it is desired to take full advantage of the resolving power of the filter for fine analysis, the exploration speed must be sufficiently slow for the response curve of the filter to be as near as possible to be steady state selectivity curve. The admissible value of the exploration speed depends essentially on the filter characteristics and should be determined experimentally in each case.

For information purposes only it can be said that for filters having a bandwidth of 10 c/s or so at $-3$ db, the exploration speed admissible is generally lower than 100 c/s per second.

*Scanning Range.*

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

*Suppression of automatic sweep.*

Provision should be made for the possibility of stopping the automatic sweep to enable a manual exploration to be used in certain cases.

*Form of Display.*

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

*Amplitude Range.*

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

*Frequency Stability.*

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

ANNEX II

PRINCIPAL CHARACTERISTICS OF THE FREQUENCY SPECTRUM ANALYSERS PRESENTED BEFORE THE C.C.I.R. VIITH PLENARY ASSEMBLY

| Administration | Doc. No. | Exploration | | | Filter | | | | Amplitude range db | Measuring instrument | | Measurement of the component freq. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Type | Sweep duration | Freq. band explored kc/s | Type | Bandwidth at − 3 db | Bandwidth at other level | Freq. kc/s | | Observations | Recording | |
| Japan | 127 | autom. | 1 min.<br>5 min. | 6 and 20 | crystal | — | 50 c/s at −25 db | 55 | 60 | voltm. | record. on paper | — |
| Netherlands | 136 | autom. | 20 sec.<br>2 min.<br>6.7 min. | 1 ; 5 ; 25 | Selective feed back amplifier | Adjustable between 8 and 40 c/s | — | 40 | 0-20<br>20-40<br>40-60 | oscillosc. | recorder | — |
| United Kingdom | 168 * | autom. | 0.1 ; 0.3 ;<br>1 ; 3 ;<br>10 ; 30 sec. | 0 to 30 | crystal | 6 c/s<br>30 c/s<br>150 c/s | —<br>—<br>— | 60 | 0-30<br>30-60 | oscillosc. | photo | — |
| Switzerland | 191 | autom. and man. | 0.1 to 60 sec. | 20<br>60 in 3 steps | electro-mechn. | — | 80 c/s at −43.5 db | 3 | | oscill. or peak voltm. | photo | marks each 1 kc/s |
| Italcable | 199 | man. | — | — | LF | | 50 c/s at −80 db | 1 | calibrated attenuator | voltm. | — | frequency-meter |
| France | 349 | autom. | 6 and 36 sec. | 2 and 6 | crystal | — | 6 or 30 c/s below 80 db | 70 | 60 | oscillosc. | photo | — |
| Belgium | ** | autom. | 6 ; 20 ; 45 sec. | 0.5 to 30 | crystal | 9 c/s | — | 195 | 20 db lin. scale<br>60 db log. scale | oscillosc. | photo | marks 0.5 or 1 kc/s |

* This apparatus has been demonstrated before S.G. Nº I.

** This apparatus has been demonstrated before S.G. Nº I, but was not described in a C.C.I.R. document.

# RECOMMENDATION No. 89 *

## HARMONICS AND PARASITIC EMISSIONS

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

CONSIDERING :

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

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

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

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

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

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

*(f)* That, in dealing with emissions of the fundamental frequency, the administrations customarily establish the power supplied to the antenna, and measure the field strength at a distance to aid in determining when an emission is causing interference with another authorized emission ; and, that a similar procedure would be helpful in dealing with harmonics in accordance with Art. 13, No. 376, of the Radio Regulations, 1947 ;

UNANIMOUSLY RECOMMENDS :

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

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

The auxiliary generator is substituted for the radio transmitter and is adjusted in power output until it produces the same field on the harmonic frequency as was produced by the

* This Recommendation replaces Recommendation No. 38.

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

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

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

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

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## RECOMMENDATION No. 90

## FREQUENCY STABILISATION OF TRANSMITTERS

(Question No. 1.c (I))

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

CONSIDERING :

*(a)* That although a large number of transmitters at present in use conform to the agreed tolerances, some transmitters still in use do not always conform to these tolerances, and this is a limiting factor in securing a reduction in spectrum space occupied ;

*(b)* That the additional cost involved in ensuring that many of these transmitters comply with the tolerances laid down by the Radio Regulations (Atlantic City, 1947), is negligible in comparison with the prime cost and operating expenses of the equipment ;

*(c)* That advance in technique, in many cases provides accuracy and stability of higher degree than that necessary to comply with Atlantic City tolerances thus improving the utilisation and the spectrum, while taking into account such practical factors as weigh tand bulk;

UNANIMOUSLY RECOMMENDS :

1. That the attention of administrations should be drawn to the fact that some transmitters do not appear to be conforming with the Atlantic City frequency tolerances and that interference is arising therefrom ;

2. That administrations and private operating agencies should continue to improve still further the degree of frequency stability and of accuracy of setting consistent with economic considerations ;

3. That the information given in Report No. 18 should be submitted to all administrations and that the studies should be continued.

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## RECOMMENDATION No. 91

## ARRANGEMENT OF CHANNELS IN MULTI-CHANNEL TRANSMITTERS FOR LONG-RANGE RADIO CIRCUITS OPERATING ON FREQUENCIES BELOW ABOUT 30 Mc/s

(Question No. 46)

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

CONSIDERING :

*(a)* That the lack of uniformity in the arrangement and designation of the channels in multichannel transmitters for long-range circuits operating on frequencies below about 30 Mc/s may give rise to certain difficulties when one transmitting station has to work with several receiving stations ;

*(b)* That, since it is necessary to economise in the use of the radio spectrum when considering inter-continental circuits consisting mainly of single long-distance radio links operating on frequencies less than 30 Mc/s, it is desirable :

— to use independent sideband transmissions to the maximum extent possible,
— to transmit a band less than the 300 to 3400 c/s recommended by the C.C.I.F. for land-line circuits, and
— to reduce the upper frequency to 3000 c/s or below but to not less than 2600 c/s, except in special circumstances ;

*(c)* That there are already in operation international multichannel radiotelephone circuits in which the bandwidth allocated to each channel is 3000 c/s actually transmitting a speech band of 250 to 3000 c/s ;

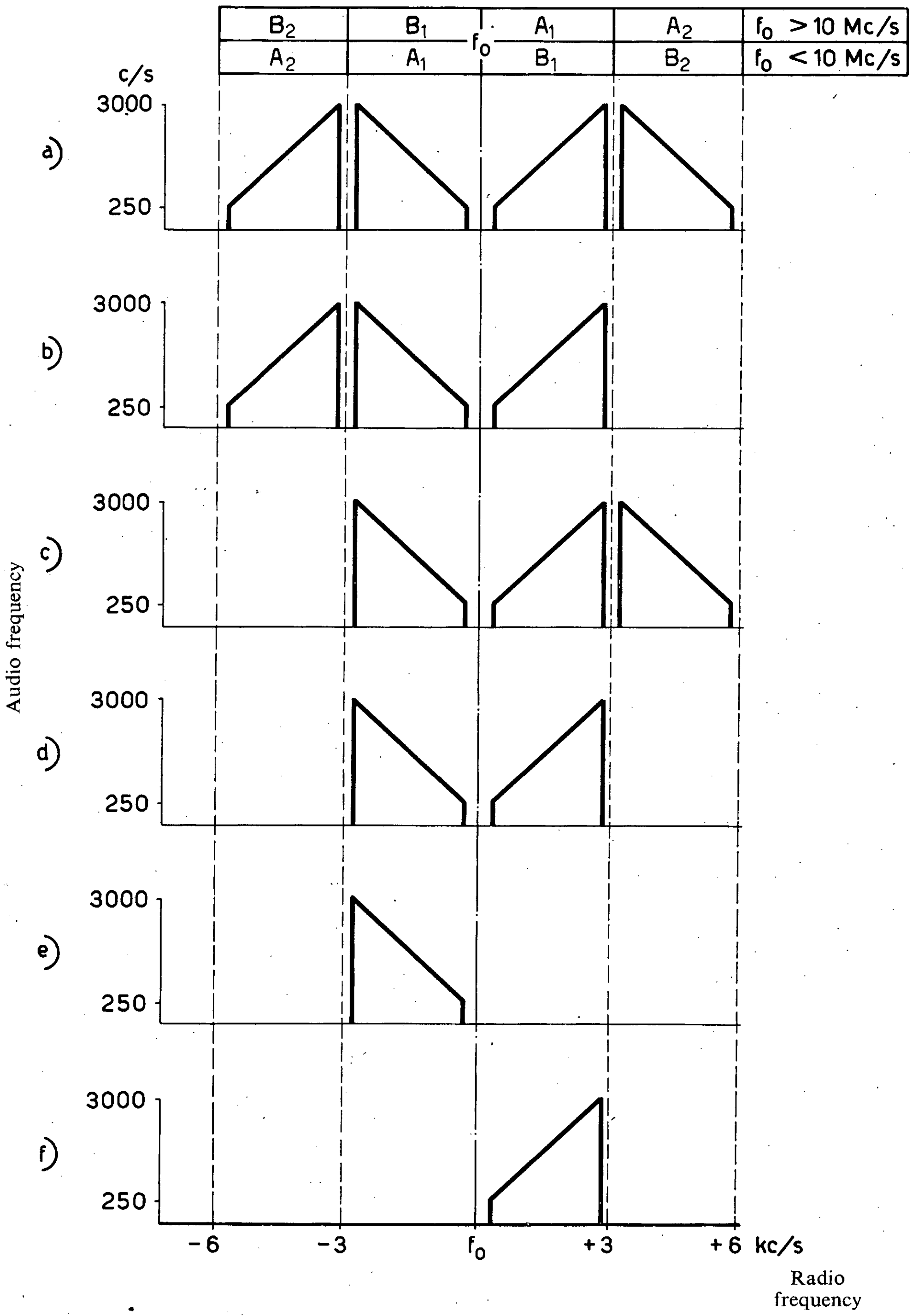
*(d)* That, in general, the outer channels are liable to cause and receive more interference to and from stations operating on adjacent assigned frequencies ; the outer channels being those located furthest from the assigned frequency ;

*(e)* That there are numerous transmitters in service which, when operated on a twin-channel basis, give rise to excessive cross-talk unless one of the channels is placed away from the carrier ;

*(f)* That there are transmitters in service which permit the addition of a third channel when it is desired to provide additional traffic capacity ;

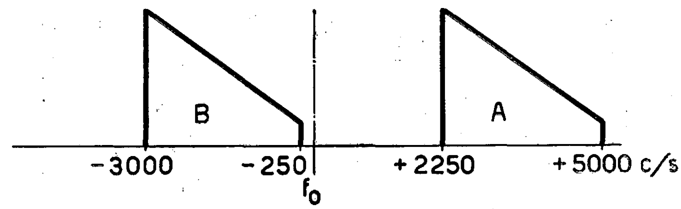
*(g)* That there are numerous types of multi-channel telegraph systems in use for long-distance radio circuits on which information is not sufficiently complete ;

Table

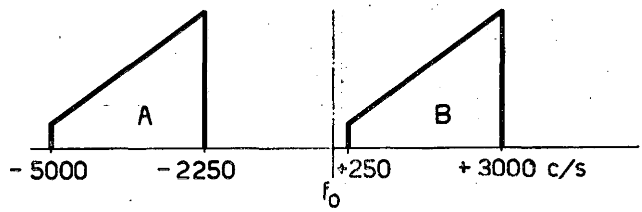



These figures represent the relationship between the audio-frequencies and the radio-frequencies for the various channel arrangements

FIGURE 1

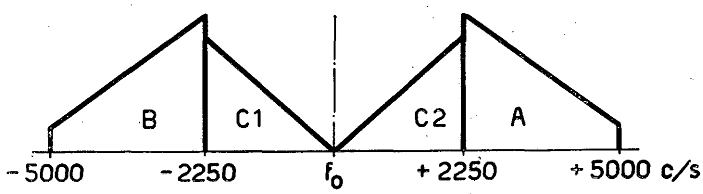



Reference frequency above 10 Mc/s

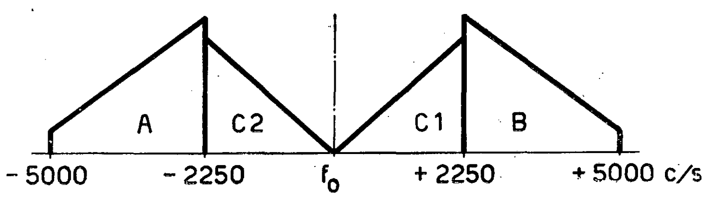



Reference frequency below 10 Mc/s

FIGURE 2




Reference frequency above 10 Mc/s




Reference frequency below 10 Mc/s

It is necessary that the subdivision of channel C into two parts C1 and C2 as well as the arrangement of these parts should be agreed upon by operating organizations.

FIGURE 3

RECOMMENDS :

1. That standard channel arrangements should be adopted for multi-channel radio-telephone systems but that it is not yet opportune to standardise the channel arrangements for radio telegraph systems ;

2. That the effective speech channel allocation should be 3000 c/s ;

3. That the transmitted band in each speech channel should be from 250 to 3000 c/s ;

4. That in four-channel systems the channel arrangement should be as shown in Fig. 1 *a)* ;

5. That in four-channel systems the channel designation should be as shown in the upper part of the Table when the reference frequency $f_0$ corresponding to the reduced carrier is above 10 Mc/s and in the lower part when below 10 Mc/s. The same table shall be used when less than four channels are employed ;

6. That when less than four channels are used the channels nearest to the carrier should be selected according to the arrangements shown in Figs. 1 *b)*, *c)*, *d)*, *e)* or *f)* ;

7. That with some transmitters in service, which do not give satisfactory operation with the arrangement shown in Fig. 1 *d)*, a channelling arrangement such as that shown in Fig. 2 may be used to minimise cross-talk ;

8. That with some transmitters in service, which do not give satisfactory operation with the arrangement shown in Figs. 1 *b)* or 1 *c)*, a third channel may be provided as shown in Fig. 3 ;

9. That when it is desirable to standardise the arrangements of radio-telegraph channels a new question should be raised.

*Note.* — This Recommendation completes the study of Question 46 in so far as radio-telephony is concerned. The case of radio-telegraphy is the subject of Question No. 74 (I).

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## RECOMMENDATION No. 92 *

## FREQUENCY-SHIFT KEYING

(Question No. 20 (I))

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

CONSIDERING :

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

*(b)* That it is desirable to adapt the frequency shift used to the telegraph speed ;

*(c)* That traffic interruptions should be reduced to a minimum by avoiding frequent changes of the shift employed ;

*(d)* That it is often necessary to employ the same radio transmitter to work with more than one receiving station ;

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

* This Recommendation replaces Recommendation No. 39.

(*f*) That various technical factors influence the choice of operating characteristics in such systems in particular :
- the economy of bandwidth and the consequent need to control the shape of the transmitted signals ;
- the signal distortion due to propagation conditions ;
- the instability of the characteristics of certain transmitter and receiver elements (such as oscillators, filters or discriminators) ; this instability being one of the reasons for the relatively large shift employed in many existing equipments ;

(*g*) That difficulties can arise from the use of the terms " mark " and " space " and also that the C.C.I.T., at its VIIth Plenary Assembly, Arnhem 1953, issued Recommendation No. I.4 introducing new terms ;

RECOMMENDS :

1. That it is too early to standardize the actual values of frequency shift but that every effort should be made to achieve this as quickly as possible for emissions using only two frequencies, one for mark and one for space ; that to assist in this, the characteristics shown below should be used as far as possible ;
2. That the value of the frequency shift employed should be the lowest compatible with the maximum telegraph speed regularly used, the propagation conditions and the equipment stability ;
3. That for frequency shift systems working on two conditions only (i.e. single channel and multichannel time division systems) and operating between 2 Mc/s and 27 Mc/s the values of frequency shift should be : 140, 280, 400 and 560 c/s ;
4. That for those services employing equipment designed to operate with a nominal 850 c/s shift, the shift value of 840 c/s may still be used provisionally ;
5. That the value of the frequency shift should if possible be maintained within $\pm 3\%$ of its nominal value and, in any case, within $\pm 10\%$ ;
6. That, in general, the marking frequency should be the higher frequency and the spacing frequency the lower frequency (see Note).

*Note.* — Paragraph 6 of this Recommendation has been adopted to ensure that, in the resting condition, all methods of signalling should cause the emission of the lower frequency. In countries where the terms " mark " and " space " may give rise to some ambiguity in interpreting § 6 of this recommendation the following may be of assistance :

" In general, the higher frequency emitted should correspond to the significant working condition (the start signal of a start-stop apparatus—condition A of C.C.I.T. Recommendation No. I.4) of the equipments connected to the two ends of the circuit, and the lower frequency should correspond to the resting condition (when no information is being exchanged—condition Z of C.C.I.T. Recommendation No. I.4) of the equipments."

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## RECOMMENDATION No. 93

## TELEGRAPHIC DISTORTION

(Question No. 18 (I))

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

CONSIDERING :

That a partial answer to Question No. 18 (I) of the C.C.I.R. is contained in Recommendation B.1 of the C.C.I.T. ;

UNANIMOUSLY RECOMMENDS :

1. That the C.C.I.T. Recommendation B.1 given in Annex I be adopted by the C.C.I.R. ;
2. That the studies of Question No. 18 (I) should be continued.

ANNEX

# C.C.I.T. RECOMMENDATION B.1

## DEFINITIONS RELATING TO TRANSMISSION IN ALPHABETICAL TELEGRAPH SYSTEMS

The C.C.I.T.,

CONSIDERING :

That in the telegraph systems which have been standardized the process of telegraph modulation entails the division of time into *significant intervals* (of modulation) whose durations are theoretically equal to a unit interval or to an integral multiple of this interval ;

That the process of restitution (of a modulation) also entails the division of time into significant intervals (of restitution) similar to those of the modulation ;

That each significant interval of the modulation or of the restitution is associated with a particular *significant condition* of the appropriate device in the sending or receiving apparatus ;

That consideration should be given to two types of modulation, and hence of restitution, according to whether the apparatus is continuously-working (isochronous modulation or restitution) or of a start-stop character (arythmic or start-stop modulation or restitution) ;

UNANIMOUSLY DECLARES THE VIEW :

That the following definitions should be adopted :

**1.** *Characteristic instants of a modulation (or of a restitution).*

Instants limiting significant intervals of modulation (or of restitution).

**2.** *Modulation rate : telegraph speed (deprecated).*

Reciprocal of the unit interval measured in seconds. This rate is expressed in *bauds*. Example : if the unit interval is 20 milliseconds, the modulation rate is 50 bauds.

**3.** *Restitution delay.*

The delay between a characteristic instant of modulation and the corresponding characteristic instant of restitution.

**4.** *Isochronous modulation (or restitution).*

Modulation or restitution in which all the intervals between two successive characteristic instants are significant.

**5.** *Arythmic (start-stop) modulation (or restitution).*

Modulation (or restitution) characteristic of start-stop systems.

**6.** *Theoretical duration of a significant interval (of modulation or of restitution).*

Duration corresponding exactly to the duration prescribed by the code for the whole of the signal elements represented in the significant interval, taking into account the average modulation rate or, when necessary, the standardized modulation rate.

**7.** *Perfect modulation (or restitution).*

Modulation (or restitution) such that all the significant intervals are associated with correct significant conditions and conform accurately to their theoretical durations.

**8.** *Ideal instant of a modulation (or of a restitution).*

Instants with which the characteristic instants would coincide under certain ideal conditions. For each particular case it will be necessary to indicate how one (or more) of these ideal instants is determined, all the others being placed in relation to it (or to them) at intervals equal to the corresponding theoretical significant intervals.

**9.** *Degree of individual distortion of a particular characteristic instant (of a modulation or of a restitution).*

Ratio to the unit interval of the displacement, expressed algebraically, of this characteristic instant from an ideal instant.

This displacement is considered positive when the characteristic instant occurs after the ideal instant.

The degree of individual distortion is usually expressed as a percentage.

**10.** *Modulation (or restitution) affected by telegraph distortion.*

A modulation (or restitution) suffers from telegraph distortion when the significant intervals have not all exactly their theoretical duration.

**11.** *Defective modulation (or restitution).*

Modulation (or restitution) such that its significant intervals are not all associated with the correct significant conditions, independently of any possible distortion.

*Note.* — A defective modulation (or restitution) does not of itself enable the transmitted text (or texts) to be reconstituted ; whereas a modulation (or restitution) which is not defective according to this definition does not necessarily permit the reconstitution of the text (or texts), this possibility depending upon the degree of distortion which the modulation (or the restitution) suffers.

**12.** *Efficiency factor of a telegraph communication.*

The ratio of the number of correctly translated signals to the number of signals transmitted, the keying being correct.

*Note.* — A telegraph communication may have a different efficiency factor in each direction.

**13.** *Quality index* (in a general sense for telegraphists and referring to a specific telegraphic operation).

Decimal logarithm of the reciprocal of the probability that an error (e.g. a false signal) will occur in a specific telegraphic operation (e.g. in the operator's keying, in translation by a receiving apparatus, in the transmission of a modulation, etc.).

*Note.* — In the case of a complete communication, the quality index is given by the decimal logarithm of the reciprocal of one minus the efficiency factor.

**14.** *Degree of distortion of an isochronous modulation (or restitution).*

Ratio to the unit interval of the maximum measured difference, irrespective of sign, between the actual and the theoretical intervals separating any two characteristic instants of modulation (or of restitution) these instants being not necesarily consecutive.

The degree of distortion (of an isochronous modulation or restitution) is usually expressed as a percentage.

*Note.* — The result of the measurement should be completed by an indication of the generally limited period of the observation. For a prolonged modulation (or restitution) it will be appropriate to consider the probability that an assigned value of the degree of distortion will be exceeded.

**15.** *Degree of distortion of a start-stop modulation (or restitution).*

Ratio to the unit interval of the maximum measured difference, irrespective of sign, between the actual and theoretical intervals separating any characteristic instant of modulation (or of restitution) from the characteristic instant of the start element immediately preceding it.

The degree of distortion of a start-stop modulation (or restitution) is usually expressed as a percentage.

*Note.* — As for definition No. 14.

*(a) Degree of gross start-stop distortion*

Degree of distortion determined when the unit interval and the theoretical intervals assumed are exactly those appropriate to the standardized modulation rate.

*Note.* — As for definition No. 14.

*(b) Degree of synchronous start-stop distortion (i.e. at the actual mean modulation rate)*

Degree of distortion determined when the unit interval and the theoretical intervals assumed are those appropriate to the actual mean rate of modulation (or of restitution).

*Note.* — 1. As for definition No. 14.

2. For the determination of the actual mean modulation rate, account is only taken of those characteristic instants of modulation (or of restitution) which correspond to a change of condition in the same sense as that occurring at the beginning of the start element.

**16.** *Degree of distortion in service.*

Degree of distortion of a modulation (or of a restitution), measured when the telegraph apparatus is in service.

*Note.* — 1. The duration of the measurement may be quoted in each particular case.

2. The notion of degree of distortion *in service* differs from that of degree *of service* distortion of the former Brussels Recommendation No. 301.

**17.** *Degree of standardized test distortion.*

Degree of distortion of the restitution measured during a specified period of time when the modulation is perfect and corresponds to a specific text.

*Note.* — *The degree of standardized test distortion* replaces the *degree of service distortion* defined in the former Brussels Recommendation No. 301.

**18.** *Quality index of a modulation (or of a restitution).*

Decimal logarithm of the reciprocal of the probability that an assigned value of degree of distortion will be exceeded.

*Note.* — When a defective modulation (or restitution) is concerned—or a modulation (or restitution) whose degree of distortion, is greater than the margin of the receiving apparatus, thus causing errors (false signals)—the notion of quality index (in the general sense for telegraphists) will be used to evaluate the quality of the modulation (or of the restitution).

**19.** *Various types of distortion.*

It is useful, for certain applications, to distinguish various types of distortion which may appear separately or in combination. They are as follows :

*(a) Characteristic distortion*

Distortion caused by transients which, as a result of the modulation, are present in the transmission channel and depend on its transmission qualities.

*(b) Fortuitous distortion*

Distortion resulting from causes generally subject to random laws (accidental irregularities in the operation of the apparatus and moving parts, disturbances affecting the transmission channel etc).

*(c) Bias or asymmetrical distortion*

Distorsion affecting a two-condition (or binary) modulation (or restitution) in which all the significant intervals corresponding to one of the two significant conditions have longer or shorter duration than the corresponding theoretical durations.

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## RECOMMENDATION No. 94 *

## NOISE AND SENSITIVITY OF RECEIVERS

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

CONSIDERING :

*(a)* That the sensitivity of a receiver is a measure of its ability to receive weak signals and reproduce them with usable strength and acceptable quality ;

*(b)* That the following parameters, which are determined by the particular service for which the receiver is used, are of special importance in relation to the sensitivity :

— necessary output level,
— necessary overall signal-band,
— necessary signal-to-noise ratio at the output ;

*(c)* That the following parameters relating to the internal noise of the receiver, which are determined by the receiver design, are also of importance in relation to the sensitivity of the receiver :

— the level of the internal noise, as defined e.g. by the noise factor,
— the width of the effective overall noise band, which is not necessarily identical with the width of the signal band ** ;

*(d)* That, in many cases, in order to economise in transmitted power, it is desirable that the sensitivity shall be as great as economic and technical considerations permit and is justified by the external noise level ;

*(e)* That the conditions for obtaining a high sensitivity may conflict with those for obtaining good protection against interfering signals ** ;

*(f)* That Question No. 76 (II) asks for data on noise factor and sensitivity for the various types of receivers used for the reception of different classes of emission in the different services ;

*(g)* That for the purpose of presenting, comparing and using data on the sensitivity of receivers, it is desirable to define the following terms :

— maximum usable (noise-limited) sensitivity ;
— gain-limited sensitivity ;
— reference sensitivity ;
— noise factor ;

*(h)* That values for noise factor are often particularly useful since they are more uniform than values of maximum usable sensitivity for the various types of receivers used for the reception of different classes of emission in the different services, and indicate the degree of improvement in maximum usable sensitivity which is theoretically possible, other factors remaining unchanged ;

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* This Recommendation replaces Recommendation No. 41.

** See Recommendation No. 95.

*(i)* That a single value of noise factor is adequate only for a linear receiver, and that, for a non-linear receiver, the noise factor is dependent on the signal input level and the receiver gain ;

*(j)* That the reference sensitivity is chiefly of value in comparing linear receivers ;

*(k)* That it is desirable to define a " linear " receiver ;

RECOMMENDS :

**1.** That a *linear* receiver should be defined as one operating in such a manner that the signal-to-noise ratio at the output is proportional to the signal level at the input, and to the degree of modulation ;

**2.** That the *noise factor* should be defined as follows : the noise factor is the ratio of noise power measured at the output of the receiver to the noise power which would be present at the output if the thermal noise due to the resistive component of the source impedance were the only source of noise in the system.

**3.** That the width of the *effective overall noise band* should be defined as the width of a rectangular frequency response curve having a height equal to the maximum height of the receiver frequency response curve and corresponding to the same total noise power * ;

**4.** That the *maximum usable sensitivity* should be defined as the minimum input signal (expressed as the e.m.f. of the unmodulated carrier) which must be applied in series with the specified source impedance (dummy antenna) to the input of the receiver in order to obtain at the output the signal level and the signal-to-noise ratio necessary for normal operation when the normal degree of modulation ** is applied to the carrier ;

**5.** That the maximum usable sensitivity as defined above should be described as " noise limited ", and that if the gain is insufficient, the maximum usable sensitivity should be described as " gain limited " ; in the latter case the sensitivity is measured as the minimum input required to obtain the same signal level, gain being adjusted to a maximum value without regard to output noise level ;

**6.** That, for the purpose of presenting and comparing data for particular classes of receivers and classes of emission for the different services (normally to be noise-limited cases), and for a particular frequency range, the *reference sensitivity* should be defined as the maximum usable sensitivity for specified values of :

— signal-to-noise ratio,
— receiver bandwidth,
— degree of modulation and
— source impedance (dummy antenna).

within the linear range the maximum usable sensitivity for any of these conditions should be derived from the reference sensitivity (the noise factor being considered as constant), and vice versa (see Ann. II) ;

**7.** That in case of uncertainty with regard to terms of the formulae relating noise factor and reference sensitivity (see Ann. II) ***) (e.g. the effective overall noise band) values, independently measured, for these two quantities should be given ;

**8.** That values for the maximum usable sensitivity and for the reference sensitivity should be considered in connection with the values for the one- and two-signal selectivity **** ;

**9.** That, since the reference sensitivity is of particular value for a receiver working in a linear condition, for the markedly non-linear condition only the maximum usable sensitivity and the noise factor for the normal operational condition should given ;

* See Doc. No. 3 (Geneva, 1951).
** A1 class of modulation is considered as 100% modulated.
*** See Doc. No. 197 (London, 1953).
**** See Recommendation No. 95.

**10.** That, since measured characteristics vary widely from one receiver to another, measurements should be made as far as possible on several receivers of the same type, and the values given for the type of receiver under consideration should be stated statistically (mean value, standard deviation), and that, wherever such information cannot be provided, a description of the condition of the receiver should be given * ;

**11.** That, when a psophometric weighting network is used for sensitivity measurements, this fact should be stated and the response curve given.

*Note.* — The Annexes give, for reference purposes, the noise and sensitivity values obtained for several types of receiver in current use in certain countries, based on data and information given in Recommendation No. 41 (Geneva 1951) and Doc. Nos. 118, 121, 133, 178 and 238 (London, 1953). The data were collected as part of the studies required by Question No. 47, (Geneva 1951).

## ANNEX I

CLASSIFICATION SCHEME FOR RECEIVERS

| | | | *Frequency sub-divisions* |
|---|---|---|---|
| 1. *Telegraphy* | | | |
| | A1, A2, F1 | Fixed service<br>General purpose<br>Mobile service | 30 - 600 kc/s<br>1 600 - 30 000 kc/s<br>30 - 300 Mc/s |
| 2. *Telephony* | | | |
| | A3 | Fixed service<br>General purpose<br>Mobile service | |
| | A3b | Fixed service | 30 - 600 kc/s<br>1 600 - 30 000 kc/s<br>30 - 300 Mc/s |
| | F3 | Fixed service<br>General purpose<br>Mobile service | |
| 3. *Sound Broadcasting* | | | |
| | A3<br>F3 | | 150 - 300 kc/s<br>500 - 1 600 kc/s<br>1 600 - 30 000 kc/s<br>30 - 100 Mc/s<br>100 - 300 Mc/s<br>300 - 1 000 Mc/s |
| 4. *Television* | | | |
| | A5 | Vision | 30 - 100 Mc/s<br>100 - 300 Mc/s<br>300 - 1 000 Mc/s |
| | A3, F3 | Sound | |

## ANNEX II

FORMULAE RELATING NOISE FACTOR AND SENSITIVITY OF LINEAR RECEIVERS
(See § 2 and 3 of this Recommendation)

1. *A1, A2, A3 Emissions (amplitude modulation).*

$$E^2 = 8kT \frac{BRn}{m^2} F \times 10^{12} \qquad (1)\ **$$

* See Doc. No. 197 (London, 1953).
** Refer to Recommendation No. 41.

where :

E = e.m.f. of the carrier in series with the equivalent series resistance of the source, measured in microvolts ;

F = noise factor (power ratio) ;

R = source (dummy antenna) equivalent resistance in ohms ;

n = signal-to-noise power ratio at the output ;

m = degree of modulation (modulation considered sinusoidal). For A1 class of emission, take m = 1 ;

k = Boltzmann constant = $1.37 \times 10^{-23}$ Joules/degree K ;

T = absolute temperature in degrees K (T is commonly taken as 293° K, when $KT \approx 400 \times 10^{-23}$ Joules) ;

B = width of the effective overall noise-band in c/s, taken as the smaller of the two following quantities :

*(a)* the postdetection bandwidth ;

*(b)* *half* the predetection bandwidth *.

2. *A3b Emissions (Single side-band amplitude modulation).*

$$E^2 = 4kTBRnF \times 10^{12} \qquad (2)\ ^{**}$$

where

E, F, R, n, k and T as described in § 1 ;

B = width of the effective overall noise-band in c/s, taken as the smaller of the two following quantities :

*(a)* the post detection bandwidth ;

*(b)* the *full* predetection bandwidth *.

3. *F1, F3 Emissions (frequency modulation).*

$$E^2 = 8kT \frac{BRn}{q^2} F \times 10^{12} \qquad (3)\ ^{***}$$

where :

$$q^2 = \frac{3}{4} \frac{D^2}{B^2}$$

E, F, R, n, k and T as described in § 1 ;

D = frequency shift in telegraphy or peak-to-peak value of the frequency deviations in telephony (modulation considered sinusoidal) ;

B = width of the effective postdetection noise-band *.

4. *Reference sensitivity* (see § 5 of this Recommendation).

The reference sensitivity may be calculated from the noise factor (see Ann. III) by means of formulae (1) to (3) above or the simplified formula (4) given below :

$$E^2 = C \times F \qquad (4)$$

Typical reference values for B, R, n, m and D are given in the following table, together with the corresponding values of the multiplying factor C used in formula (4). For case of computation the values of C given in the table are in decibels.

While formulae (1) to (4) can also be used to calculate the noise factor from the measured sensitivity, this procedure must be employed with caution because possible uncertainties in the various parameters (e.g., the effective overall noise band) may lead to less precise values for F than can be obtained by direct measurement (see § 1.5, Ann. IV).

* In some cases, it may be sufficient to approximate the bandwidth by taking limiting responses 6 db below the maximum response ; if a more accurate measurement of bandwidth is required, the effective noise bandwidth may be determined, in each case, as explained in § 10 of this Recommendation.

** Refer to Recommendation No. 41.

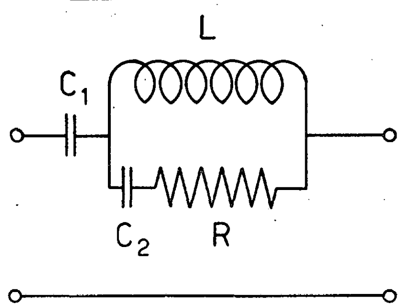
*** See Doc. Nos. 121 and 235, London.

TABLE I

*Typical reference values for parameters used in calculating and measuring reference sensitivity*

| Class of emission | Service | Effective overall noise-band c/s | Source resistance (ohms) | Output signal noise power ratio (db) | Degree of modulation | Frequency shift (for F1) peak deviation (for F3) c/s | Multiplying factor C (db) |
|---|---|---|---|---|---|---|---|
| A1 | Fixed | 100 | 75 | 20 | 1 | — | −16.2 |
| | | 300 | 75 | 20 | 1 | — | −11.4 |
| | General-purpose | 1000 | 75 | 20 | 1 | — | − 6.2 |
| | Mobile | 1000 | 75 | 20 | 1 | — | − 6.2 |
| A2 | Fixed | 100 | 75 | 20 | 0.3 | — | −5.7[2] −16.2[3] |
| | | 300 | 75 | 20 | 0.3 | — | −0.9 −11.4 |
| | General-purpose | 1000 | 75 | 20 | 0.3 | — | +4.3 − 6.2 |
| | Mobile | 1000 | 75 | 20 | 0.3 | — | +4.3 − 6.2 |
| A3 | Fixed General-purpose Mobile | 3000 | 75 | 20 | 0.3 | — | + 9.1 |
| | Sound broadcast (MF) | 5000 | dummy antenna[1] | 20 | 0.3 | — | — |
| | Sound broadcast (HF) | 5000 | 75 | 20 | 0.3 | — | +11.1 |
| A3b | Fixed | 3000 | 75 | 20 | — | — | − 4.4 |
| F1 | Fixed | 100 | 75 | 20 | — | 100 | −15.0 |
| | | 100 | 75 | 20 | — | 400 | −27.0 |
| | | 300 | 75 | 20 | — | 100 | − 0.7 |
| | | 300 | 75 | 20 | — | 400 | −12.7 |
| F3 | Fixed General-purpose Mobile | 3000 | 75 | 20 | — | ± 4500[4] | − 9.7 |
| | Sound broadcast | 5000 | 75 | 20 | — | ±22 500[4] | −17.0 |

[1] The values of the elements of the dummy antenna are shown in Fig. 1.
[2] Without IF oscillator.
[3] With IF oscillator.
[4] 30% of reference peak deviation
—Telephony 15 kc/s
—Sound Broadcasting 75 kc/s.




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

FIGURE 1

## ANNEX III

### General considerations relating to the noise factor of receivers

In a well-designed receiver, noise originating in the receiver is mainly due to the random voltages (thermal and shot-noise) generated in the early stages of the receiver, including that portion of the aerial circuit contained within the receiver.

Representative values of noise factor for good modern receivers, which are especially designed to have low noise factors, are given below :

| Frequency Mc/s | Noise Factor | |
|---|---|---|
| | Power Ratio | Decibels |
| up to 100 | 2.5 | 4.0 |
| 200 | 3.5 | 5.4 |
| 500 | 5.5 | 7.4 |
| 1 000 | 8.0 | 9.0 |
| 2 000 | 11.2 | 10.5 |
| 5 000 | 18.0 | 12.5 |
| 10 000 | 25.0 | 14.0 |

When, however, either the external noise level or the input signal level is high, the receiver noise factor becomes less important. For this reason, some receivers (e.g., many broadcast receivers) are not designed to have the best possible values of reference sensitivity or of noise factor (see § 4 of this Recommendation).

The measurement of noise factor is generally best carried out by means of the noise-generator method (particularly for frequencies above 30 Mc/s) (see Doc. No. 117, London).

When the receiver contains a non-linear element (e.g., a detector, limiter or discriminator), it is desirable that overall measurements of noise factor be made under conditions of linear operation, such as may be obtained by simultaneously injecting a carrier at an appropriate level and frequency (see Doc. Nos. 197 and 235, London).

## ANNEX IV

### Representative values for the noise factor and reference sensitivity of receivers (excluding television receivers)

1. *Introduction.*

1.1 In the following Tables an attempt has been made to present in a systematic way representative data for noise and sensitivity characteristics of the various classes of receivers. In order to facilitate the use of these data, and at the same time to reduce the amount of data presented, in general only three figures (called for convenience " maximum ", " mean ", and " minimum " values) have been given for each characteristic for a number of similar receivers in each class. The terms *maximum*, *mean* and *minimum* refer to *values expressed in decibels* for sensitivity or noise factor according to the column. It is important to note therefore, that for a given case, the *maximum* value in the sensitivity column indicates a poorer *sensitivity* than that of the *minimum* value. For some medium-frequency sound broadcasting receivers, statistical values (mean value and standard deviation) are given.

1.2 The figures in the Tables are taken partly from Ann. II to Recommendation No. 41 (Geneva), but for the most part are deduced from data and information contained in London Doc. Nos. 118, 121, 133, 178 and 238. The data given in these documents were collected as part of the studies required by Question No. 47, (Geneva). The methods of measuring sensitivity were discussed in Ann. II of Recommendation No. 41 (Geneva) and in Doc. Nos. 116 and 118 (London).

1.3 Only limited data, and in some cases no data are available for certain classes of receiver (e.g., frequency modulation receivers for fixed and mobile services) ; there is also a lack of data for all classes of receivers at frequencies above about 30 Mc/s.

1.4 It is hoped, nevertheless, that the incomplete data given in the Tables will be of value to the users and that it will be possible to add to these data in the future.

1.5 It was found that the values for maximum usable sensitivity, reference sensitivity and noise factor, obtained from the different sources, were not always consistent with the formulas (1) to (4) in Ann. II. As the values for noise factor were considered more reliable in such cases, these were taken as the basic information, and the values for reference sensitivity given in the Tables in Ann. IV were derived from those for the noise factor by the use of formula (4) in Ann. II.

REFERENCE SENSITIVITY AND NOISE FACTOR

*Table 1. — Radio-telegraphy receivers*

| Class of emission | Service | Frequency range in kc/s | | Reference sensitivity (db rel. to 1 μV) | Noise factor (db) | Reference bandwidth (c/s) | Remarks |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| A1 | Fixed | 1 600-30 000 | Max. | − 6.2 | 10 | 100 | Many receivers tested |
| | | | Mean | − 9.2 | 7 | | |
| | | | Min. | −11.2 | 5 | | |
| | General-purpose | 1 600-30 000 | Max. | + 7.8 | 14 | 1000 | Several receivers tested |
| | | | Mean | + 2.3 | 8.5 | | |
| | | | Min. | − 1.2 | 5 | | |
| | Mobile | 1 600-30 000 | Max. | +11.3 | 17.5 | 1000 | Few receivers tested |
| | | | Mean | + 5.8 | 12 | | |
| | | | Min. | + 0.3 | 6.5 | | |
| F1 | Fixed | 1 600-30 000 | Max. | −19.0 | 8 | 100 | Reference frequency shift = 400 c/s<br>Few receivers tested |
| | | | Mean | −21.0 | 6 | | |
| | | | Min. | −23.0 | 4 | | |

2. *Notes on Tables 1 to 3.*

Column No.

(1) (2) and (3) *Receivers* are tabulated in terms of the class of emission, service and frequency range, respectively.

(4) See § 1.1 of this Annex.

(5) *Reference Sensitivity.* See § 5 and Ann. II, § 4 of this Recommendation; the values for the reference sensitivity given in the Tables assume the reference values for overall noise-band, source resistance, output signal-to-noise ratio and degree of modulation (frequency-shift or deviation in frequency modulation receivers), given in Table I of Ann. II.

(6) *Noise Factor.* See § 2 and Ann. II and III of this Recommendation.

(7) *Reference Bandwidth.* See Ann. II, Table 1 of this Recommendation.

(8) *Remarks.* This column contains information on the number of receivers on which the representative values for noise and sensitivity are based, and when possible some indication of the spread of the data.

*Table 2. — Radio-telephony receivers*

| Class of emission | Service | Frequency range in kc/s | | Reference sensitivity (db rel. to 1 μV) | Noise factor (db) | Reference bandwidth (c/s) | Remarks |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| A3 | Fixed | 1.6 - 30 | Max. | +19.1 | 10 | 3000 | Few receivers tested |
| | | | Mean | +16.1 | 7 | | |
| | | | Min. | +13.1 | 4 | | |
| | General-purpose | 1.6 - 30 | Max. | +23.1 | 14 | 3000 | Several receivers tested |
| | | | Mean | +16.8 | 7.7 | | |
| | | | Min. | +11.1 | 2 | | |
| | Mobile | 30 - 300 | Max. | +20.1 | 11 | 3000 | Few receivers tested |
| | | | Mean | +18.8 | 9.7 | | |
| | | | Min. | +17.5 | 8.4 | | |
| A3b | Fixed | 1.6 - 30 | Max. | + 4.1 | 8.5 | 3000 | Several receivers tested |
| | | | Mean | + 2.1 | 6.5 | | |
| | | | Min. | − 0.4 | 4.0 | | |
| F3 | Mobile | 30 - 300 | Max. | — | — | 3000 | Few receivers tested |
| | | | Mean | + 0.8 | 10.5 | | |
| | | | Min. | — | — | | |

*Table 3. — Sound broadcast receivers*

| Class of emission | Service | Frequency range in kc/s | | Reference sensitivity (db rel. to 1 $\mu$V) | Noise factor (db) | Reference bandwidth (c/s) | Remarks |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| A3 | | 500-1 600 | Mean | +42.6 | 26 | 5000 | 170 low-cost receivers tested. Standard deviation on reference sensitivity : 3.8 db * |
| | | 1 600-30 000 | Max. | +32.1 | 21 | 5000 | Several receivers tested, all had one R.F. stage |
| | | | Mean | +25 | 13.9 | | |
| | | | Min. | +17.1 | 6 | | |
| | | 1 600-30 000 | Mean | +34.1 | 23 | 5000 | 69 low-cost receivers tested. Standard deviation on reference sensitivity : 5.0 db * |
| | | in Mc/s 30 - 300 | Mean | +19.1 | 8 | 5000 | Several receivers tested, all had one R.F. stage |
| F3 | — | 30 - 300 | Max. | + 9 | 26 | 5000 | Few receivers tested |
| | | | Mean | + 0 | 17 | | |
| | | | Min. | — 9 | 8 | | |

* See Doc. No. 178 (London).

# ANNEX V

## Representative values for the reference sensitivity and noise factor of television receivers

1. *Introduction.*

1.1 The methods of test of television receivers have not, as yet, been fully standardised in the various countries and the data given in this Annex and the relevant documents must be regarded as tentative until such standardisation is more complete.

1.2 The Table given below contains representative values for the sensitivity of the vision and sound channels of typical television receivers (405-line system), as required by Question No. 47 (Geneva). The data given in the Table are deduced from information contained in Doc. Nos. 116 and 118 (London).

2. *Notes on Table.*

Column No.

(1) (2) (3) and (6) The significance of these columns is the same as in the case of the columns with corresponding titles in Ann. IV.

(4) In the case of the vision channel the reference sensitivity has been taken as the larger of the input signal levels required to produce at the output :

*(a)* a vision signal output level of 20 V (peak-to-peak, black-to-white picture signal),

or *(b)* a vision signal-to-noise ratio of 12 db (peak-to-peak values of vision signal and noise).

If the gain is insufficient to enable *(a)* and *(b)* to be simultaneously satisfied, the receiver is referred to as gain-limited ; otherwise it is noise-limited.

The sensitivity is stated as the R.M.S. value of the input carrier corresponding to peak-white modulation (positive modulation system) ; for test purposes a carrier sinusoidally modulated to a depth of 50%, corresponding to a black-to-white picture signal in a system with 70/30 picture/synchronising-pulse amplitude ratio, is assumed.

The following reference values are also assumed :

| | |
|---|---|
| Source resistance | 75 ohms |
| Width of overall effective noise-band | 3 Mc/s |

In the case of the sound channel the reference values for the output signal/noise ratio, the width of the overall effective noise-band and the modulation of the test signal are the same as for sound broadcasting receivers (see Table 1, Ann. II).

TABLE

*Reference sensitivity and noise factor television receivers*

<table>
<tr><th rowspan="2">Frequency range in Mc/s</th><th rowspan="2">Class of emission</th><th rowspan="2"></th><th colspan="3">Reference sensitivity (db rel. to 1 μV)</th><th rowspan="2">Noise factor (db)</th><th rowspan="2">Remarks</th></tr>
<tr><th>Noise-limited</th><th>Gain-limited</th><th>All types</th></tr>
<tr><td>(1)</td><td>(2)</td><td>(3)</td><td colspan="3">(4)</td><td>(5)</td><td>(6)</td></tr>
<tr><td rowspan="6">30-100</td><td rowspan="3">A5 (vision)</td><td>Max.</td><td>56</td><td>57</td><td>57</td><td>14</td><td rowspan="3">9 receivers tested (7 noise-limited, 2 gain-limited) ; synchronisation satisfactory in all cases<br>(405-line system)</td></tr>
<tr><td>Mean</td><td>46</td><td>54</td><td>48</td><td>8</td></tr>
<tr><td>Min.</td><td>42</td><td>51</td><td>42</td><td>5</td></tr>
<tr><td rowspan="3">A3 (sound)</td><td>Max.</td><td>28</td><td>35</td><td>35</td><td>13</td><td rowspan="3">9 receivers tested (4 noise-limited, 5 gain limited)</td></tr>
<tr><td>Mean</td><td>22</td><td>27</td><td>25</td><td>9</td></tr>
<tr><td>Min.</td><td>18</td><td>20</td><td>18</td><td>6</td></tr>
</table>

## RECOMMENDATION No. 95 *

## SELECTIVITY OF RECEIVERS

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

CONSIDERING :

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

* This Recommendation replaces Recommendation No. 42.

*(b)* That the selectivity of a receiver is a measure of its ability to discriminate between a desired signal to which the receiver is tuned and undesired signals on other frequencies ;

*(c)* That economy in the use of the radio spectrum requires the maximum selectivity compatible with the technical and economic considerations relating to the particular class of receiver ;

*(d)* That when the levels of the desired and undesired signals are sufficiently low to make non-linear effects in the receiver (e.g. cross-modulation) negligible, the performance is adequately expressed by the " single-signal " selectivity ;

*(e)* That, if the desired or undesired signal levels are sufficiently high to produce appreciable non-linear effects, the performance must be ascertained by other means, e.g. by the " two-signal " selectivity ; these non-linear effects may be very numerous and it is necessary to select the most representative cases in order to simplify the measurements ;

*(f)* That uniform methods of single-signal and two-signal measurement of the selectivity are desirable in order to permit comparison of receivers ;

RECOMMENDS :

**1.** That the pass-band of the receiver shall be no wider than is essential for the transmission of the necessary modulation of the desired signal without significant distortion (see § 1.2 of Recommendation No. 36, Geneva *), together with an allowance for the unavoidable instabilities of the frequencies of the transmitter and of the receiver ;

**2.** That the attenuation-slope on each side of the pass-band shall be as large as possible, taking into account :

— the unavoidable spread of the spectrum of signals in adjacent channels (see § 2 of Recommendation No. 36 *) ;
— the limitation of the selectivity of the receiver by unavoidable amplitude non-linearity, e.g. cross-modulation ;
— the fact that an excessively large attenuation-slope may lead to serious distortion of the phase/frequency characteristic in the pass-band ;

**3.** That the filters which determine the selectivity shall be included as near as possible to the receiver input, and the valve stages preceding the filters shall be sufficiently linear, in order to avoid significant loss of selectivity, e.g. by cross-modulation of the desired signal by strong undesired signals ;

**4.** That for the purpose of studying the *single-signal selectivity in the linear regions* the following definitions are recommended :

4.1 " *Pass-band* " : the pass-band is the band of frequencies limited by the two frequencies for which the attenuation exceeds that of the most favoured frequency by some agreed value ; in general this value is 6 db, except for high-quality radio telephony receivers where the value is 2 db.

4.2 "*Attenuation-slope* " : the attenuation-slope on each side of the pass-band is the ratio :

$$\frac{\text{difference of attenuation obtained for frequencies beyond the pass-band}}{\text{difference between these frequencies}}$$

4.3 " *Image-response ratio* " : the image-response ratio is the ratio of :

— the input signal level at the image frequency required to produce a specified output from the receiver,
— to the level of the desired signal required to produce the same output.

* This Recommendation has become Recommendation No. 87.

The image-frequency is the desired signal frequency plus or minus twice the intermediate-frequency, according to whether the frequency change oscillator is higher or lower in frequency than the desired signal frequency respectively.

If the receiver incorporates more than one frequency change there will be more than one image frequency, and for each of these there will be a corresponding image-response ratio.

4.4 "*Intermediate-frequency response ratio*" : the intermediate-frequency response ratio is the ratio :

— of the level of a signal at the intermediate frequency applied to the receiver input and which produces a specified output from the receiver,

— to the level of the desired signal required to produce the same output ;

**5.** That in order to express the selectivity in the linear region it is desirable that single-signal measurements be made of the pass-band, the attenuation-slope, the image-response and the intermediate-frequency response ratios as defined above.

In the case of the attenuation-slope sufficient indication is generally obtained by considering the frequency difference corresponding to attenuations of 20, 40, 60 and if possible 80 db, reckoned from the limit frequencies of the pass-band. When the values thus obtained are essentially equal for the two sides of the pass-band it is sufficient to give mean values.

Since, when plotting in decibels to a logarithmic scale of frequency, the sides of the selectivity characteristic are often almost straight beyond a certain frequency difference relative to the mid-band frequency, the attenuation outside the pass-band can also be expressed as the slope of the attenuation/frequency characteristic, in decibels per octave of the frequency difference (see Fig. 1) ;

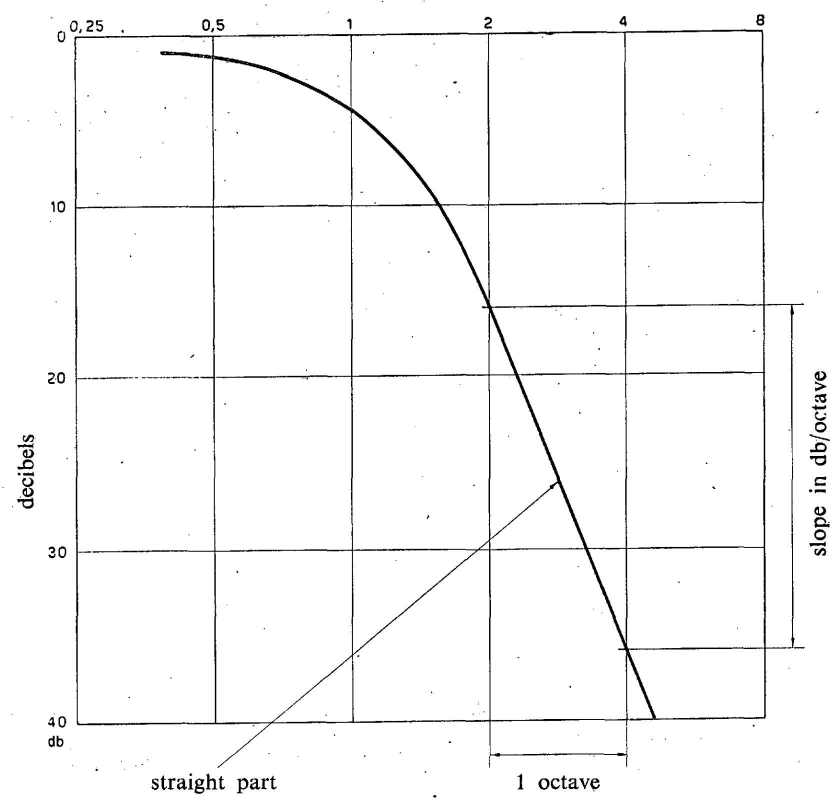



FIGURE 1

Abscissae : Frequency difference relative to the mid-band frequency ; logarithmic scale, arbitrary units.

**6.** That for the purpose of studying the selectivity in the non-linear region with *two or more input signals* the following definitions are recommended :

6.1 " *Effective selectivity* " : The effective selectivity is the ability of the receiver to discriminate between the desired signal to which the receiver is tuned and an undesired signal having a frequency generally outside the pass-band and the level of which is such as to produce non-linear effects, both desired and undesired signals acting simultaneously and one or both being modulated. The effective selectivity can be measured by the blocking, cross-modulation and inter-modulation characteristics defined below ;

6.2 " *Blocking* " : Blocking is defined as the level of an undesired signal on a near-by frequency, e.g. in an adjacent channel, which results in an assigned change (generally a reduction) e.g. 3 db, in the output due to a modulated * desired signal of specified level applied to the receiver input ;

6.3 " *Cross-modulation* " : Cross-modulation is defined as the level of a modulated undesired signal on a frequency near to an unmodulated desired signal, e.g. in an adjacent channel, which results in an output from the receiver a specified amount, e.g. 20 db **, below that which would be obtained if the desired signal were modulated ;

6.4 " *Inter-modulation* " : Inter-modulation is defined as the levels of two undesired signals which produce at the receiver output a given level (e.g. 20 db ** below that corresponding to the normal input signal), when the frequencies of these two undesired signals have :

— a difference equal to the intermediate frequency ;
— a sum or difference equal to the frequency of the desired signal ;

the two interfering signals being simultaneously applied :

— in general the signals are equal in level, one being modulated and the other unmodulated, and both frequencies are simultaneously adjusted so that the level of the inter-modulation product is a maximum. The gain of the receiver when measuring the inter-modulation performance should be that corresponding to the specified input and output levels of the desired signal.

Other orders of inter-modulation product may occur in practice ; those selected are typical and are generally sufficient to specify the performance in respect of inter-modulation ;

**7.** That in order to express the selectivity in the non-linear region, it is desirable that two-signal measurements be made of the effective selectivity in terms of the blocking, cross-modulation and inter-modulation characteristics as defined above.

*Note.* — Ann. I gives representative values for the selectivity of a limited number of receivers (excluding television receivers) and is based on data and information given in the Ann. to Recommendation No. 42 and Doc. Nos. 98, 123, 178, 236, 239 and 290 (London).

Ann. 2 gives representative values for the selectivity of television receivers and is based on data given in Doc. No. 99 (London). The data given in Ann. I and II were collected as part of studies required by Study Programme No. 6 (Geneva).

## ANNEX I

### Selectivity of receivers, excluding television receivers

1. *General.*

In the following Tables an attempt has been made to present in a systematic way representative data for the selectivity characteristics of the various classes of receiver. In order to facilitate the use of these data, and at the same time to reduce the amount of data presented, only

* Except for A1 signals when an unmodulated carrier is used.

** Other values may be desirable for certain special classes of receivers.

TABLE 1

*Single-Signal Selectivity*

Radio-Telegraphy Receivers

| Class of emission | Service | Frequency range in Mc/s | | R.F. and I.F. pass-band in kc/s | Attenuation-slope in db/kc/s 26 db | 46 db | 66 db | 86 db | Ultimate slope in db/octave | Image response ratio in db | I.F. response ratio in db | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | | | | (7) | (8) | (9) | (10) |
| A1 | Fixed | 1.6-30 | | 1.1 | 165 | 200 | 200 | 200 | — | 113 * 83 ** | | 1 Receiver tested |
| | General-purpose | 0.03-0.6 | Max. | 2.7 | 16 | 15 | 12 | — | — | >100 | >100 | 4 Receivers tested |
| | | | Mean | 1.1 | 13 | 12 | 10 | — | — | >90 | 90 | |
| | | | Min. | 0.2 | 10 | 10 | 8 | — | — | > 80 | 78 | |
| | | 1.6-30 | Max. | 4.7 | 28 | 28 | 28 | — | — | 119 * 53 ** | >110 | 6 Receivers tested |
| | | | Mean | 1.4 | 16 | 15 | 15 | — | — | 73 * 28 ** | > 90 | |
| | | | Min. | 0.2 | 10 | 10 | 8 | — | — | 41 * 7 ** | > 80 | |
| | Mobile | 30-300 | | 43 | 0.8 | 0.7 | 0.6 | — | 63.5 | — | — | 1 Receiver tested |
| A2 | Fixed | 1.6-30 | | 2.2 | 100 | 110 | 120 | 130 | — | 113 * 83 ** | — | 1 Receiver tested |
| | General-purpose | 0.03-0.6 | Max. | 6.8 | 16 | 15 | 10 | — | — | 122 | >100 | 7 Receivers tested |
| | | | Mean | 3.4 | 10.5 | 10 | 8 | — | — | 100 | > 90 | |
| | | | Min. | 2.0 | 5 | 4 | 4 | — | — | > 80 | 78 | |
| | | 1.6-30 | Max. | 6.8 | 13 | 12 | 10 | — | — | 119 * 53 ** | >110 | 8 Receivers tested |
| | | | Mean | 3.4 | 10 | 10 | 8 | — | — | 73 * 28 ** | > 90 | |
| | | | Min. | 1.5 | 5 | 4 | 4 | — | — | 41 * 7 ** | > 80 | |
| | Mobile | 30-300 | | 43 | 0.8 | 0.7 | 0.6 | — | 63.5 | — | — | 1 Receiver tested |
| F1 | Fixed | 1.6-30 | | 2.2 | 100 | 110 | 120 | 130 | — | 113 * 83 ** | — | 1 Receiver tested |

* At 2 Mc/s. ** At 30 Mc/s.

TABLE 2

*Single-Signal Selectivity*

Radio-Telephony Receivers

| Class of emission | Service | Frequency range in Mc/s | | R.F. and I.F. pass-band in kc/s | Attenuation-slope in db/kc/s | | | | Ultimate slope in db/octave | Image response ratio in db | I.F. response ratio in db | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 26 db | 46 db | 66 db | 86 db | | | | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | (7) | (8) | (9) | (10) |
| A3 | General-purpose | 0.03-0.6 | Max. | 6.8 | 11 | 11 | 11 | — | — | 122 | >100 | 5 Receivers tested |
| | | | Mean | 5.5 | 8.4 | 8.0 | 8.0 | — | — | >100 | > 90 | |
| | | | Min. | 4.0 | 5 | 4 | 4 | — | — | > 80 | > 78 | |
| | | 1.6-30 | Max. | 6.8 | 12 | 11 | 11 | — | — | 119 * 53 ** | >110 | 7 Receivers tested |
| | | | Mean | 5.3 | 8.5 | 8 | 8.0 | — | — | 73 * 28 ** | > 90 | |
| | | | Min. | 4.0 | 5 | 4 | 4 | — | — | 41 * 7 ** | > 80 | |
| | Mobile | 30-300 | Max. | 52 | 1.45 | 1.7 | 1.75 | — | — | — | — | 3 Receivers tested |
| | | | Mean | 40 | 1.15 | 1.27 | 1.28 | — | — | — | — | |
| | | | Min. | 26 | 0.8 | 0.7 | 0.6 | — | — | — | — | |
| A3b | Fixed | 1.6-30 | Max. | 6.4 | 240 | 240 | 240 | 100 | — | 115 * 85 ** | >110 | 4 Receivers tested for cols. (5) and (6); 3 Receivers tested for cols. (8) and (9) |
| | | | Mean | 6.15 | 100 | 114 | 118 | 70 | — | 112 * 84 ** | > 95 | |
| | | | Min. | 6.0 | 12 | 12 | 12 | 10 | — | 110 * 82 ** | > 80 | |
| F3 | Mobile | 30-300 | | 6.5 | 4.0 | 5.0 | 5.5 | 5.7 | 54 | — | — | Average of several receivers covering frequency range 152-174 Mc/s |

* At 2 Mc/s.  ** At 30 Mc/s.

TABLE 3

*Single-Signal Selectivity*

Sound Broadcasting Receivers

| Class of emission | Frequency range in Mc/s | | R.F. and I.F. pass-band in kc/s | Attenuation-slope in db/kc/s | | | | Ultimate slope in db/octave | Image response ratio in db | I.F. response ratio in db | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 26 db | 46 db | 66 db | 86 db | | | | |
| (1) | (3) | (4) | (5) | (6) | | | | (7) | (8) | (9) | (10) |
| A3 | 0.15-0.3 | Max. | 13.3 | 4.5 | 3.75 | — | — | | > 80 | 76 | 8 Receivers tested |
| | | Mean | 8.95 | 3.57 | 3.0 | — | — | | 64 | 64 | |
| | | Min. | 4.0 | 2.5 | 2.1 | — | — | | 30 | 40 | |
| | 0.5-1.6 | Max. | 13.3 | 4.5 | 3.75 | — | — | | 91 | 72 | 11 Receivers tested |
| | | Mean | 8.05 | 3.64 | 3.09 | — | — | | 54 | 62 | |
| | | Min. | 4.0 | 2.5 | 2.1 | — | — | | 12 | 23 | |
| | 0.5-1.6 | Max. | 7.3 | | | | | | | | Data is obtained from a statistical analysis of the performance of 170 low cost receivers manufactured to the same specification |
| | | Mean | 5.3 | 4.83 | 4.3 | 3.39 | — | 30 | 35 σ=5.6* | — | |
| | | Min. | 3.3 | | | | | | | | |
| | 1.6-30 | Max. | 13.3 | 4.5 | 3.75 | — | — | | 44 ** | >120 ** | 10 Receivers tested |
| | | Mean | 8.05 | 3.6 | 3.1 | — | — | | 25 ** | 90 ** | |
| | | Min. | 4.0 | 2.5 | 2.1 | — | — | | 9 ** | 37 ** | |

* σ = standard deviation. ** at 10 Mc/s.

TABLE 4

*Two-Signal Selectivity*

Telegraphy Receivers

| Class of emission | Service | Frequency range in Mc/s | $F_d$–$F_u$ (kc/s) | | Blocking Level of undesired signal (db rel. to 1 $\mu$V) for level of desired signal (db rel. to 1 $\mu$V) of : | | | | Cross-modulation Level of undesired signal (db rel. to 1 $\mu$V) for level of desired signal (db rel. to 1 $\mu$V) of : | | | | Inter-modulation | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | $F_d$ (Mc/s) | Level of undesired signal (db rel. to 1 $\mu$V) | | | |
| | | | | | +20 | +40 | +60 | +80 | +20 | +40 | +60 | +80 | | $F'_u-F''_u = F_{if}$ | $F'_u-F''_u = F_d$ | $F'_u+F''_u = F_d$ | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | (7) | | | | (8) | | | | (9) |
| A1 | Fixed | 1.6-30 | 10 | | 90 | 105 | 115 | 120 | — | — | — | — | | — | — | — | 1 Receiver tested |

TABLE 5

*Two-Signal Selectivity*

Radio Telephony Receivers

| Class of emission | Service | Frequency range in Mc/s | $F_d-F_u$ (kc/s) | | Blocking Level of undesired signal (db rel. to 1 $\mu$V) for level of desired signal (db rel. to 1 $\mu$V) of: | | | | Cross-modulation Level of undesired signal (db rel. to 1 $\mu$V) for level of desired signal (db rel. to 1 $\mu$V) of: | | | | Inter-modulation | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | $F_d$ (Mc/s) | Level of undesired signal (db rel. to 1 $\mu$V) | | | |
| | | | | | +20 | +40 | +60 | +80 | +20 | +40 | +60 | +80 | | $F'_u-F''_u=F_{if}$ | $F'_u-F''_u=F_d$ | $F'_u+F''_u=F_d$ | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | (7) | | | | (8) | | | | (9) |
| A3 | General-purpose | 1.6-30 | 10 | Max. | 86 | >120 | >120 | >120 | — | 93 | 106 | 115 | 10 | 93 | 82 | 93 | 6 Receivers tested for cols. 6 and 7; 4 Receivers tested for col. 8 See Note |
| | | | | Mean | 75 | 95 | 108 | 117 | — | 81 | 94 | 101 | | > 70 | > 71 | > 80 | |
| | | | | Min. | 66 | 78 | 94 | 111 | — | 61 | 79 | 78 | | 43 | 60 | > 60 | |
| | | | 20 | Max. | 96 | >120 | >120 | >120 | — | 100 | 114 | 122 | 30 | 78 | >100 | >100 | 5 Receivers tested for cols. 6 and 7; 3 Receivers tested for col. 8 See Note |
| | | | | Mean | 88 | >109 | >112 | >115 | — | 83 | 96 | 102 | | > 71 | > 80 | > 80 | |
| | | | | Min. | 79 | 89 | 102 | 111 | — | 73 | 79 | 78 | | > 60 | > 60 | > 60 | |
| | Mobile | 0.03–0.6 | 10 | | 102 | 112 | 127 | — | — | — | 109 | 114 | | — | — | — | 1 Receiver texted See Note |
| A3b | Fixed | 1.6-30 | 10 | Max. | 72 | 90 | 110 | 110 | 76 | 92 | 105 | 115 | | > 94 | 94 | > 94 | 3 Receivers tested for cols. 6 and 7; 1 Receiver for col. 8 (measured at 3 frequencies) See Note |
| | | | | Mean | 70 | 89 | 105 | 105 | 72 | 87 | 101 | 105 | | > 92 | 90 | > 94 | |
| | | | | Min. | 69 | 86 | 104 | 100 | 64 | 84 | 97 | 96 | | 89 | 88 | > 94 | |

*Note.* The undesired signal levels quoted for inter-modulation and cross-modulation are those which result in outputs from the receiver that are 0 db and 30 db, respectively, below that which would be obtained if the desired signal were modulated (modulation depth = 30%).

TABLE 6

*Two-Signal Selectivity*

Sound Broadcasting Receivers

| Class of emission | Frequency range in Mc/s | $F_d$–$F_u$ (kc/s) | | Blocking Level of undesired signal (db rel. to 1 $\mu$V) for level of desired signal (db rel. to 1 $\mu$V) of: | | | | Cross-modulation Level of undesired signal (db rel. to 1 $\mu$V) for level of desired signal (db rel. to 1 $\mu$V) of: | | | | Inter-modulation | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $F_d$ (Mc/s) | Level of undesired signal (db rel. to 1 $\mu$V) | | | |
| | | | | +20 | +40 | +60 | +80 | +20 | +40 | +60 | +80 | | $F'_u-F''_u$ $=F_{if}$ | $F'_u-F''_u$ $=F_d$ | $F'_u+F''_u$ $=F_d$ | |
| (1) | (3) | (4) | (5) | (6) | | | | (7) | | | | (8) | | | | (9) |
| A3 | 0.15-0.3 | — | Max. | — | — | — | — | — | — | — | — | | — | > 80 | > 80 | 5 Receivers tested See Note |
| | | | Mean | — | — | — | — | — | — | — | — | | — | > 74 | > 62 | |
| | | | Min. | — | — | — | — | — | — | — | — | | — | 66 | 54 | |
| | 0.5-1.6 | 10 | Max. | — | 72 | 88 | 107 | — | 61 | 85 | 115 | 1 | > 90 | > 90 | > 80 | 3 Receivers tested for cols. 6 and 7; 7 Receivers tested for col. 8 See Note |
| | | | Mean | — | 67 | 86 | 104 | — | 55 | 79 | 101 | | 78 | 72 | 76 | |
| | | | Min. | — | 64 | 85 | 102 | — | 50 | 73 | 93 | | 58 | 53 | 61 | |
| | | 20 | Max. | — | 93 | 113 | 126 | — | 78 | 105 | >126 | | — | — | — | 2 Receivers tested See Note |
| | | | Mean | — | 91 | 107 | 122 | — | 77 | 101 | >121 | | — | — | — | |
| | | | Min. | — | 89 | 102 | 119 | — | 77 | 97 | 116 | | — | — | — | |
| | | 30 | Max. | — | 105 | 120 | >126 | — | 93 | 119 | 120 | | — | — | — | 2 Receivers tested See Note |
| | | | Mean | — | 104 | 117 | >126 | — | 92 | 112 | 120 | | — | — | — | |
| | | | Min. | — | 104 | 114 | >126 | — | 91 | 105 | 120 | | — | — | — | |
| | 1.6-30 | — | Max. | — | — | — | — | — | — | — | — | 10 | 56 | 73 | > 90 | 6 Receivers tested See Note |
| | | | Mean | — | — | — | — | — | — | — | — | | 50 | 66 | > 80 | |
| | | | Min. | — | — | — | — | — | — | — | — | | 38 | 59 | 68 | |

*Note.* The undesired signal levels quoted for inter-modulation and cross-modulation are those which result in outputs from the receiver that are 0 db and 30 db, respectively, below that which would be obtained if the desired signal were modulated (modulation depth = 30%).

three figures (called for convenience " maximum ", " mean " and " minimum " values) have been given for each characteristic for a number of similar receivers of each class. It should be noted, however, that in many cases, because of the small number of receivers (indicated in the " Remarks " columns of the tables), these figures have not a precise statistical significance.

Only limited data, and in some cases no data, are available for certain classes of receiver (e.g. frequency modulation receivers for sound broadcasting, fixed and mobile services) ; there is also a lack of data for all classes of receivers at frequencies above about 30 Mc/s.

It is hoped that, nevertheless, the incomplete data given in the Tables will be of value to the users and that it will be possible to add to these data in the future.

2. *Notes to the Tables.*

2.1 *Single-signal selectivity.*

Column

(1) (2) and (3) Receivers are tabulated in terms of the class of emission, class of receiver and frequency range respectively, according to the " Classification Scheme for Receivers " contained in Ann. 1, of Recommendation No. 24.

(4) See Section 1 above (General).

(5) See § 4.1 of this Recommendation.

(6) See § 4.2 and 5 of this Recommendation.

(7) See § 5 and Fig. 1 of this Recommendation. The " ultimate slope " is the value, generally constant, that the attenuation slope attains at frequencies remote from the pass-band.

(8) See § 4.3 of this Recommendation.

(9) See § 4.4 of this Recommendation.

(10) This column shows the number of receivers on which the representative values for the single-signal selectivity are based, and, when possible, some indication of the spread of the data.

2.2 *Two-signal selectivity.*

Column

(1) (2) and (3) See Section 2.1 above.

(4) Frequency difference between the desired signal ($F_d$) and the undesired signal ($F_u$).

(6) See § 6.2 of this Recommendation.

(7) See § 6.3 of this Recommendation.

(8) See § 6.4 of this Recommendation.

(9) This column shows the number of receivers on which representative values for the two-signal selectivity are based, and the values for the ratios of the desired to the undesired signal at the receiver output (in cross-modulation and inter-modulation tests when these differ from those suggested in § 6.3 and 6.4 of this Recommendation).

## ANNEX II

### Selectivity of Television Receivers

*General.*

The methods of test of television receivers have not, as yet, been fully standardised in the various countries and the data given in this Annex and the relevant documents must be regarded as tentative until such standardisation is more complete.

## Table

*Single-Signal Selectivity*

Television Receivers

| Class of emission | Frequency range in Mc/s | | Attenuation in decibels, rel. to maximum response, at the frequency shown below in Mc/s, rel. to vision carrier frequency | | | | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sound carrier | | | | | Vision carrier | | | |
| | | | −5 | −4.5 | −4 | −3.5 | −3 | −2.5 | −2 | −1 | 0 | +0.5 | +1 | |
| (1) | (2) | (3) | (4) | | | | | | | | | | | (5) |
| A5 (vision) | 30-100 | Max. | >60 | >60 | >60 | 54 | 20 | 5 | 1 | 0 | 9 | 27 | 46 | 4 Receivers tested (405-line system) |
| | | Mean | >60 | >60 | >60 | 40 | 15 | 3 | 0 | 0 | 6 | 23 | 41 | |
| | | Min. | 40 | 18 | 32 | 36 | 10 | 1 | 0 | 0 | 4 | 20 | 37 | |
| A3 (sound) | | Max. | >60 | 60 | 37 | 0 | 39 | 60 | >60 | >60 | >60 | >60 | >60 | |
| | | Mean | >60 | 48 | 20 | 0 | 27 | 50 | >60 | >60 | >60 | >60 | >60 | |
| | | Min. | 55 | 34 | 10 | 0 | 15 | 38 | 53 | >60 | >60 | >60 | >60 | |

*Notes:*

| Colum No. | |
|---|---|
| (1) (2) (3) and (5) | The significance of these columns is the same respectively as in the case of of columns 1, 3, 4 and 10 in Ann. I, Section 2.1. |
| (4) | Because of the special shape of the selectivity characteristic of the vision channel (sometimes involving a guard-band near the sound channel), the methods usually employed to describe this characteristic (e.g. attenuation-slope) are not altogether suitable in the case of television receivers ; in the latter case the attenuation, relative to the maximum response in the pass-band, is shown in the Table for a range of frequencies on both sides sides of the vision carrier. |

The Table contains representative values for the single-signal selectivity of the vision and sound channels of typical television receivers (405-line system only). The methods of measurement are described in Doc. No. 166 (London). This document also refers to the measurement of the two-signal selectivity of television receivers, e.g., the blocking and cross-modulation characteristics, and the undesired responses of such receivers.

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## RECOMMENDATION No. 96

### FREQUENCY STABILITY OF RECEIVERS

(Study Programme N° 5)

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

CONSIDERING :

*(a)* That, in practice, the pass-band of receivers (§ 1 of Recommendation No. 87), is often increased beyond that essential for the transmission of the modulation of the desired signal without significant distortion ;

*(b)* That the reasons for this increase in the pass-band width, in the most usual order of importance, are :

— the frequency instability of the receiver frequency-change oscillators,
— the inaccuracies in resetting these oscillators to a desired frequency,
— the instability of the receiver filters,
— and the instability of the frequency of received signals ;

*(c)* That, in order to achieve the greatest economy in the use of the radio spectrum, it is desirable to keep to a minimum the increase of pass-band necessitated by the foregoing causes ;

RECOMMENDS :

**1.** That in cases where economic considerations prevent the use of more effective frequency stabilising devices, e.g., in some general-purpose communication receivers and broadcast receivers, attention should, as far as possible, be given to :

— the stability of the inductors and capacitors,
— the stability of the oscillator circuit, including the valve and its power supply,
— the use of temperature compensating components (e.g., negative temperature coefficient capacitors),
— the protection of the frequency-controlling components from the effects of humidity, e.g., by means of protective coatings ;

**2.** That, in cases where operation over a frequency band is required with a better degree of stability than that afforded by the methods referred to in § 1 (e.g., in good quality communication receivers), consideration may be given to the use of variable frequency oscillators contained in constant temperature compartments, hermetically sealed to avoid frequency instability which would be caused by changes of humidity ;

**3.** That, in cases where operation over a frequency band with a high degree of stability is required, it is desirable to consider frequency-synthesis methods (e.g., methods whereby the frequency change oscillation is derived from the combination of two frequencies, one being a harmonic of a quartz-crystal oscillator and the other being a variable frequency (interpolating) oscillator of limited range), noting, however, that special care may have to be taken to avoid undesired responses in the receiver from unwanted frequency components present with the frequency-change oscillations ;

**4.** That, in cases where fixed-frequency operation (with its resulting simplicity) is required together with the highest degree of stability (i.e. for high-grade communication services), high-stability frequency-controlling components such as quartz crystals should be employed using, if necessary, the constant-temperature hermetically-sealed compartments referred to in § 2 above ;

**5.** That, in cases where the instability of the frequency-change oscillator would otherwise be such as to require an appreciable increase in the width of the receiver pass-band, an automatic frequency-control is desirable to reduce the frequency variation of the intermediate-frequency signal to a sufficiently small fraction of the width of the pass-band ;

**6.** That, in cases where a high degree of synchronisation is required (e.g., systems employing a partially suppressed pilot-carrier), it is desirable to use a more accurate automatic frequency control capable of correcting the frequency of a local oscillator in the receiver so that the intermediate-frequency carrier is within a few cycles per second of the frequency of another oscillator used to demodulate the signal ;

**7.** That consideration be given to reducing to a minimum the frequency instability caused by changes of humidity and temperature, of the receiver filters, by applying methods similar to those referred to in § 1 and 2 above, and by the use of high-stability components such as quartz crystal resonators where technical and economic considerations permit ;

**8.** That, in order to reduce to a minimum frequency variations due to mechanical shock and vibration, due attention should be paid to the mechanical design of the receiver oscillators and filters and, in the case of variable-frequency oscillators, to the resetting accuracy of the variable capacitors or inductors and the frequency-range changeover switches employed.

*Note.* — The Annex gives the stability values obtained for several types of receivers in certain countries, based on data and information given in London Doc. Nos. 122, 132, 167, 237, 240 and 372. The data were collected as part of the studies required by Study Programme No. 5.

## ANNEX

1. *General.*

In the following tables an attempt has been made to present in a systematic way representative data for the frequency-instability (generally that of the frequency-change oscillators) for the various classes of receiver. In order to facilitate the use of these data, and at the same time to reduce the amount of data presented, only three figures (called for convenience "maximum", " mean " and " minimum values ") have been given for each characteristic for a number of similar receivers in each class. It should be noted, however, that, in many cases, because of the small number of receivers (indicated in the " Remarks " columns of the tables), these figures have no precise statistical significance.

Only limited data, and in some cases no data, are available for certain classes of receiver (e.g., telegraphy, frequency modulation, sound broadcasting and television receivers). For nearly all classes of receiver there is also a lack of data at frequencies above 30 Mc/s approximately

It is hoped that, nevertheless, the incomplete data given in the tables will be of value to users and that it will be possible to add to these data in the future.

2. *Notes on the tables.*

Column

(1) (2) and (3) Receivers are tabulated in terms of the class of emission, of service and the frequency range respectively, according to the " Classification Scheme for Receivers ", contained in Ann. 1 of Recommendation No. 94.

(4) This column indicates that the frequency-change oscillators in the receivers are, or are not, quartz-crystal controlled.

(5) See Section 1 above.

TABLE 1

*Radio Telegraphy Receivers*

| Class of emission | Service | Frequency range in Mc/s | With or without quartz crystal control | | Frequency drift ($\times 10^{-6}$) at the following times (minutes) after switching on : | | | | | Frequency variation ($\times 10^{-6}$) due to supply voltage variation of : | | Frequency variation ($\times 10^{-6}$) due to temperature variation of : | | Frequency variation ($\times 10^{-6}$) due to mechanical shock | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 10 | 30 | 60 | 120 | 10% | 20% | 1° C | from −25° C to +55° C | | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | | (7) | | (8) | | (9) | (10) |
| A1 A2 | General-purpose | 1.6-30 | without | Max. | — | 390 | 160 | 0 | — | 53 | — | — | — | 140 | Col. (6) : 7 Receivers tested<br>Col. (7) : 3 Receivers tested<br>Col. (9) : 6 Receivers tested |
| | | | | Mean | — | 183 | 81 | 0 | — | 33 | — | — | — | 32 | |
| | | | | Min. | — | 87 | 20 | 0 | — | 15 | — | — | — | 2.5 | |
| A1 A2 | Fixed | 1.6-30 | without | Max. | — | 33 | 20 | 0 | 8 | — | — | 17 | — | — | Col. (6) : 6 Receivers tested<br>Col. (7) : 1 Receivers tested<br>Col. (8) : 7 Receivers tested |
| | | | | Mean | — | 17 | 9 | 0 | 4 | $<10$ | — | 7 | — | — | |
| | | | | Min. | — | 3 | 0 | 0 | 1 | — | — | 0 | — | — | |
| A2 | Mobile | 100-1000 | without | Max. | — | — | — | — | — | 4 | — | 1.7 | — | — | 1 Receiver tested |
| | | | | Mean | — | — | — | — | — | 3.3 | — | 1.1 | — | — | |
| | | | | Min. | — | — | — | — | — | 2.6 | — | 0.4 | — | — | |

TABLE 2

*Radio Telephony Receivers*

| Class of emission | Service | Frequency range in Mc/s | With or without quartz crystal control | | Frequency drift ($\times 10^{-6}$) at the following times (minutes) after switching on: | | | | | Frequency variation ($\times 10^{-6}$) due to supply voltage variation of: | | Frequency variation ($\times 10^{-6}$) due to temperature variation of: | | Frequency variation ($\times 10^{-6}$) due to mechanical shock | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 10 | 30 | 60 | 120 | 10% | 20% | 1° C | from −25° C to +55° C | | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | | (7) | | (8) | | (9) | (10) |
| A3 | Fixed | 1.6-30 | without | Max. | — | 33 | 20 | 0 | 8 | — | — | 17 | — | — | Col. (6) : 6 Receivers tested<br>Col. (7) : 1 Receiver tested<br>Col. (8) : 7 Receivers tested |
| | | | | Mean | — | 17 | 9 | 0 | 4 | <10 | — | 7 | — | — | |
| | | | | Min. | — | 3 | 0 | 0 | 1 | — | — | 0 | — | — | |
| A3 | General-purpose | 1.6-30 | without | Max. | — | 390 | 160 | 0 | — | 53 | — | — | — | 140 | Col. (6) : 7 Receivers tested<br>Col. (7) : 3 Receivers tested<br>Col. (9) : 6 Receivers tested |
| | | | | Mean | — | 183 | 81 | 0 | — | 33 | — | — | — | 32 | |
| | | | | Min. | — | 87 | 20 | 0 | — | 15 | — | — | — | 2.5 | |
| A3 | General-purpose | 1.6-30 | with | Max. | — | 235 | 130 | 0 | — | — | — | 3 | — | <1 | Col. (6) : 3 Receivers tested<br>Col. (7) : 1 Receiver tested<br>Col. (8) : 2 Receivers tested |
| | | | | Mean | — | 124 | 41 | 0 | — | 0.6 | — | 2 | — | <1 | |
| | | | | Min. | — | 5 | 1 | 0 | — | — | — | 1.5 | — | <1 | |
| A3b | Fixed | 1.6-30 | without | Max. | — | — | — | — | — | — | — | — | — | — | 1 Receiver tested<br>Frequency variation measured with AFC off |
| | | | | Mean | 28 | 20 | 8 | 0 | 8 | 1.5 | — | 5.5 | — | — | |
| | | | | Min. | — | — | — | — | — | — | — | — | — | — | |
| A3 | Mobile | 100-1000 | without | Max. | — | — | — | — | — | 4 | — | 1.7 | — | — | 1 Receiver tested |
| | | | | Mean | — | — | — | — | — | 3.3 | — | 1.1 | — | — | |
| | | | | Min. | — | — | — | — | — | 2.6 | — | 0.4 | — | — | |

TABLE 3

*Sound Broadcasting Receivers*

| Class of emission | Service | Frequency range in Mc/s | With or without quartz crystal control | | Frequency drift ($\times 10^{-6}$) at the following times (minutes) after switching on : | | | | | Frequency variation ($\times 10^{-6}$) due to supply voltage variation of : | | Frequency variation ($\times 10^{-6}$) due to temperature variation of : | | Frequency variation ($\times 10^{-6}$) due to mechanical shock | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 10 | 30 | 60 | 120 | 10% | 20% | 1° C | from −25° C to +55° C | | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | | (7) | | (8) | | (9) | (10) |
| A3 | Sound broadcast | 0.5-1.6 | without | Max. | — | 830 | 400 | 0 | — | 510 | — | — | — | 150 | Cols. 6 and 7 : 17 Receivers tested Col. (9) : 3 Receivers tested |
| | | | | Mean | 510 | 292 | 278 | 0 | — | 125 | — | — | — | 67 | |
| | | | | Min. | — | 120 | 50 | 0 | — | 30 | — | — | — | 20 | |
| A3 | Sound broadcast | 1.6-30 | without | Max. | — | 770 | 320 | 0 | — | 475 | — | — | — | 142 | Col. (6) : 14 Receivers tested Col. (7) : 10 Receivers tested Col. (9) : 12 Receivers tested |
| | | | | Mean | — | 248 | 125 | 0 | — | 110 | — | — | — | 35 | |
| | | | | Min. | — | 20 | 3 | 0 | — | 8 | — | — | — | 1 | |
| A3 | Sound broadcast | 30-100 | without | Max. | — | — | — | — | — | — | — | — | — | — | 1 Receiver tested |
| | | | | Mean | — | 494 | 17 | 0 | — | 108 | — | — | — | — | |
| | | | | Min. | — | — | — | — | — | — | — | — | — | — | |
| F3 | Sound broadcast | 30-100 | without | Max. | — | 494 | 33 | 0 | — | 107 | — | — | — | — | 2 Receivers tested |
| | | | | Mean | — | 339 | 25 | 0 | — | 107 | — | — | — | — | |
| | | | | Min. | — | 184 | 18 | 0 | — | 107 | — | — | — | — | |

TABLE 4

*Television Receivers*

| Class of emission | Service | Frequency range in Mc/s | With or without quartz crystal control | | Frequency drift ($\times 10^{-6}$) at the following times (minutes) after switching on : | | | | | Frequency variation ($\times 10^{-6}$) due to supply voltage variation of : | | Frequency variation ($\times 10^{-6}$) due to temperature variation of : | | Frequency variation ($\times 10^{-6}$) due to mechanical shock | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 10 | 30 | 60 | 120 | 10% | 20% | 1° C | from −25° C to +55° C | | |
| (1) | (2) | (3) | (4) | (5) | (6) | | | | | (7) | | (8) | | (9) | (10) |
| A5<br>F3 | Vision<br>Sound | 100-300 | without | Max. | 600 | — | — | 0 | — | 1000 | — | — | — | — | 8 Receivers tested<br>* approximate values |
| | | | | Mean | 400 | — | — | 0 | — | 615 | — | 12* | — | 350* | |
| | | | | Min. | 200 | — | — | 0 | — | 230 | — | — | — | — | |

Column

(6) Frequency-drift during the warming-up period is indicated without regard to sign in parts in $10^6$, at 1, 10, 30, 60 and 120 minutes after switching on, the value at 60 minutes being used as a reference datum.

(7) The frequency variation is that due to an A.C. mains supply voltage variation of $\pm 10\%$, or H.T. and L.T. battery voltage variations of $\pm 20\%$, according to the type of receiver.

(8) The frequency variation is that due to 1° C variation near the normal ambient temperature, or, in the case of certain mobile service receivers, due to a variation from $-25°$ to $+55°$ C.

(9) The indicated frequency variation resulting from light mechanical shock, e.g., due to striking the front of the receiver lightly with the hand. In certain cases, e.g. mobile service receivers, more comprehensive vibration and shock tests are desirable.

(10) This column contains information on the number of receivers used for the determination of the representative values for the frequency drift and variation, including, when possible, some indication on the spread of the data ; information on the vibration and shock tests referred to under Column (9) above is also to be included in this column.

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## RECOMMENDATION No. 97 *

## CHANNEL SEPARATION

The C.C.I.R., (Stockholm, 1948 — Geneva, 1951 — London, 1953)

CONSIDERING :

*(a)* That the primary factors which determine frequency separation between channels in the more usual cases include :

— the signal power required by the receiver ;
— the interference power intercepted by the receiver including that from interfering signals and from noise ;

*(b)* That transmitters in general emit radiations outside the frequency bandwidth necessarily occupied by the emission ;

*(c)* That a large number of factors are also involved, including the properties of the transmission medium, which are variable in character and difficult to determine, as well as the characteristics of the receiver and, in the case of aural reception, the discriminating properties of the human ear ;

UNANIMOUSLY RECOMMENDS :

**1.** That the required separation between channels be calculated by the following method :

— first finding the signal power intercepted by the receiver ;
— finding the interfering power intercepted, including both noise and interfering signal, and
— from these data determining the degree of frequency separation that produces acceptable ratios of signal power to the interfering power for an acceptable percentage of the time for the type of communication desired, taking into account the fluctuating nature both of signal and interference and, whenever appropriate, the discriminating properties of the human ear ;

* This Recommendation replaces Recommendations Nos. 1 and 43.

2. That at every stage of the calculation, comparison should be made, as far as possible, with data obtained under controlled representative operating conditions, especially in connection with the final figure arrived at for the channel separation ;

3. That the study of the problem should be undertaken in connection with Question No. 3 (III)

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## RECOMMENDATION No. 98

## CHANNEL SEPARATION ACHIEVED IN PRACTICE

(Question No. 3 (III))

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

CONSIDERING :

*(a)* That it is not yet possible to give a full answer to Question No. 3 (III) ;

*(b)* That in the case of telegraphy using A1 and F1 emissions, a large number of machine telegraph circuits are operating successfully with nominal separations of 2.5 kc/s, particularly in the frequency range below 12 Mc/s ;

*(c)* That there is evidence (in particular Doc. No. 457 of Geneva, 1951) that, with reception of F1 at a speed of 50 bauds, a separation of about 1.5 kc/s is satisfactory when the two signals have the same median value at the input to the receiver, and that in certain cases a separation of about 2 kc/s provides fairly satisfactory operation when the median value of the wanted signal is 6 db below that of the unwanted signal * ;

*(d)* That, when allowance is made for frequency tolerance, this evidence suggests the possibility of a separation of about 2.5 kc/s between emissions under the particular conditions of the test ;

*(e)* That, while due regard must be paid to the frequency tolerances provided for in the Radio Regulations, 1947, App. 3, a higher degree of frequency stability is possible and is actually achieved in practice ;

RECOMMENDS :

1. That administrations should :

1.1 Collect data relating to transmitters at present working in adjacent channels, indicating :
- the channel separations observed in practice ;
- the field strengths of the signals on adjacent channels received at the same location ;
- the effect of interference due to signals on adjacent channels (see Study Programme No. 45 (III) for the method of expressing the effect of interference) ;

1.2 Carry out tests similar to those described in Doc. No. 457 of Geneva ;

2. That administrations who have made these tests should submit the result to the Director of the C.C.I.R., as early as possible.

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* These tests are related to separate emissions without common control of the respective frequencies radiated.

# RECOMMENDATION No. 99 *

## BANDWITHS AND SIGNAL TO NOISE RATIOS IN COMPLETE SYSTEMS

(Question No. 3 (III))

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

CONSIDERING :

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

RECOMMENDS :

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

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

## ANNEX I

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

*Note 2.* — Carrier keyed. Beat frequency oscillator used.

*Note 3.* — For A3 telephony the figures in this column represent the ratio of the audio signal as measured on a standard VU-meter to RMS noise for a bandwidth of 3 kc/s. (The corresponding peak signal power, i.e., when the transmitter is 100% tone-modulated, is assumed to be 6 db higher.)

*Note 4.* — For 90% intelligibility of unrelated words.

*Note 5.* — When connected to public service network.

*Note 6.* — These values are based on Washington Doc. No. 138, Geneva Doc. No. 112 and The Hague Doc. No. 11.

* This Reconmendation replaces Recommendation No. 44.

SIGNAL-TO-NOISE RATIOS REQUIRED

(Stable conditions)

(Note 6)

| Type of Service | Receiver Audio bandwidth kc/s | Audio S/N db | Receiver bandwidth kc/s | Ratio of Peak R.F. Signal/Noise in kc/s band (Note 1) db |
|---|---|---|---|---|
| *A1 Telegraphy* | | | | |
| 8 baud low grade . . . . . . . . . . . . | 1.5 | −4 | 3 | −7 |
| 24 baud . . . . . . . . . . . . . . . . | 1.5 | 11 | 3 | 8 |
| 120 baud recorder . . . . . . . . . . . . | 0.6 | 10 | 0.6 | 0 |
| 50 baud printer . . . . . . . . . . . . | 0.25 | 16 | 0.25 | 2 |
| *A2 Telegraphy* | | | | |
| 8 baud low grade . . . . . . . . . . . . | 1.5 | −4 | 3 | −3 (Note 2) |
| 24 baud . . . . . . . . . . . . . . . . | 1.5 | 11 | 3 | 12 (Note 2) |
| *F1 Frequency shift Telegraphy* | | | | |
| 120 baud recorder . . . . . . . . . . . . | 0.25 | 4 | 1.5 | 2 |
| 50 baud printer . . . . . . . . . . . . | 0.10 | 10 | 1.5 | −2 |
| *Facsimile A4* . . . . . . . . . . . . . . . | 3 | 35 | 6 | 41 |
| *Hellschreiber* . . . . . . . . . . . . . . . | 1.5 | 10 | 3 | 13 |
| *A3 Telephony* | | (Note 3) | | |
| Double Sideband, just usable quality, operator to operator . . . . . . . . . (Note 4) | 3 | 6 | 6 | 18 |
| Double Sideband, marginally commercial (Note 5) | 3 | 15 | 6 | 27 |
| Double Sideband, good commercial quality (Note 5) | 3 | 33 | 6 | 35* |
| SSB 1 channel . . . . . . . . . . . . . . | 3 | 33 | 3 | 26* |
| 2 channels . . . . . . . . . . . . . | 3 | 33 | 3** | 28* |
| 3 channels . . . . . . . . . . . . . | 3 | 33 | 3** | 29* |
| 4 channels . . . . . . . . . . . . . | 3 | 33 | 3** | 30* |
| *Broadcasting* . . . . . . . . . . . . . . . | 5 | 33 | 10 | 47 |

* Assuming 10 db improvement due to the use of noise reducers.
** Per channel.

## ANNEX II

FACTORS TO BE TAKEN INTO ACCOUNT FOR VARIOUS SERVICES IN DETERMINING THE MINIMUM SEPARATION BETWEEN FREQUENCIES OF STATIONS OPERATING ON ADJACENT CHANNELS

1. Required signal-to-interference ratios.
2. Necessary bandwidth for required intelligence.
3. Transmitters :
   *(a)* Out of band radiations.
   *(b)* Frequency instability.

4. Propagation :

   Allowances for fluctuations due to absorption and fading.

5. Receivers :

   *(a)* Necessary bandwidth.
   *(b)* Attenuation slope.
   *(c)* Frequency instability.

6. Effect of :

   *(a)* Inequalities of received field strength on desired and adjacent channels.
   *(b)* Antenna directivity at transmitter and receiver.

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## RECOMMENDATION No. 100

## REDUCTION OF OCCUPIED BANDWIDTH AND TRANSMITTER POWER IN RADIOTELEPHONY

(Question No. 3 (III))

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

CONSIDERING :

*(a)* The urgent need for improved utilization of the radio spectrum, particularly in the range below 30 Mc/s ;

*(b)* That a very great improvement in the utilization of the spectrum will arise from the replacement of double sideband by single sideband technique (see Recommendation No. 40, § 2.1 and 2.2) ;

*(c)* Further, that improvements can be obtained by the use of noise reducers and devices enabling the average percentage of modulation to be maintained at a high level, e.g. peak clipping devices (see Recommendation No. 44 *) ;

RECOMMENDS :

**1.** That Administrations should, whenever possible, make use of single sideband systems in preference to double sideband systems ** ;

**2.** That noise reducers should be employed at the receiving terminal of all circuits where an improvement in signal to noise ratio is to be obtained *** ;

**3.** That devices should be employed at the transmitting terminal of all circuits to enable the average percentage of modulation to be maintained at a high level (for example, peak clipping devices). With the use of these devices adequate precautions must be taken to prevent radiation outside the necessary bandwidth (for example, by the use of an adequate low-pass filter after the device) ****.

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* This Recommendation has become Recommendation No. 99.

** Improvement of signal to noise ratio or a reduction in pover of at least 9 db is obtained by the use of single sideband systems instead of double sideband systems.

*** The improvement which may be obtained in practice by the use of a noise reducer is dependent upon the signal to noise ratio at the input to the noise reducer (for example, an improvement of the order of 10 db may be obtained on radiotelephone circuits of good commercial quality).

**** The improvement which may be obtained in practice is dependent upon the original average percentage modulation of the transmitter. Improvement up to 6 db may be obtained in practice.

## RECOMMENDATION No. 101

### BANDWIDTH REQUIRED AT A TELEGRAPH OR TELEPHONE RECEIVER OUTPUT

(Question No. 3 (III))

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

CONSIDERING :

*(a)* The urgent need to determine the minimum separation between frequency assignments of stations operating on adjacent channels, in the range 10 kc/s to 30 000 kc/s ;

*(b)* That the width of the frequency band which is necessary at the output of the receiver is one of the factors which determine the band of frequencies required for the overall system ;

*(c)* That, in the case of telegraphy the permissible degree of distortion is not yet defined ;

*(d)* That, in the case of telephony the bandwidth may depend among other factors upon the type of privacy equipment in use ;

RECOMMENDS :

**1.** That in the case of telegraphy a provisional value for the bandwidth necessary at the output of the receiver, under average practical conditions, should be as follows :

1.1 For A1 emissions, the bandwidth in cycles per second, after the final detector stage, should be equal to 2.5 times the signalling speed in bauds ;

1.2 For F1 emissions, the bandwidth in cycles per second after the discriminator should be equal to 1.4 times the signalling speed in bauds.

The extent to which these values can be applied to permit closer spacing of adjacent channels, depends upon the degree and speed of amplitude variations due to fading and upon the differential fading of the mark and space frequencies.

**2.** That, in the case of telephony, as a compromise between intelligibility and economy of bandwidth, the bandwidth necessary for each speech channel at the output of the receiver should be as follows :

2.1 In accordance with Recommendation No. 40 the upper limit frequency should be reduced to 3000 c/s or less but not lower than 2600 c/s.

2.2 For systems employing privacy equipment the necessary bandwidth for satisfactory service may require the use of an upper limit frequency greater than 2600 c/s (e.g. in five-band privacy equipment the necessary bandwidth is 2750 c/s, the upper limit being 3000 c/s).

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## RECOMMENDATION No. 102 *

### DIRECTIVITY OF ANTENNAE AT GREAT DISTANCES

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

CONSIDERING :

*(a)* That the study of the directivity of antennae at great distances concerns chiefly radio communication on frequencies between 3000 and 30 000 kc/s ;

* This Recommendation replaces Recommendation No. 46.

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

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

RECOMMENDS :

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

2. That the method used for the study of § (*c*) could be either the statistical method described in Doc. No. 23 of Geneva (see also Doc. No. 206 of London) or any other appropriate method ;

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

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## RECOMMENDATION No. 103

## USE OF DIRECTIONAL ANTENNAE

(Question No. 3 (III) — Study Programme No. 8 *)

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

CONSIDERING :

(*a*) The urgent need to determine the minimum separation between frequencies of stations operating on adjacent channels, below 30 Mc/s ;

(*b*) That the improvement in the signal to noise ratio and signal to interference ratio to be obtained by the use of directional receiving antennae is an important means of reducing the necessary channel spacing to a minimum ;

(*c*) That the use of directional transmitting antennae considerably reduces the level of interference by

— providing at the receiver the necessary field strength with reduced transmitted power and

— by reducing the field strength received at stations situated outside the principal lobe of the transmitting antennae ;

(*d*) That, in addition, the use of a directional antenna can contribute an improvement by reducing echo and multipath effects ;

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* This Study Programme has become Study Programme No. 45 (III).

(*f*) That, despite the non-homogeneous nature of the transmission medium, it is possible to employ transmitting and receiving antennae with appreciably greater directivity than that of antennae in general use ;

(*g*) That it is not yet possible to give full and precise answers to the questions posed in Study Programme No. 8 *, § 1.1.9 and 1.2.9 ;

RECOMMENDS :

**1.** That, meanwhile, the values given in the Annex, based on characteristics for rhombic antennae in general use, should be adopted as provisional values for the gain and discrimination which might reasonably be expected from the use of directional antennae for point to point services ; although, in certain cases, better results can be obtained by suitable adjustment of the polar diagram and with different types of antennae ;

**2.** That administrations should, to the maximum extent practicable, make use of directional antennae having high gain and discrimination ;

**3.** That a study should be made to specify the minimum gain and discrimination of the antennae that should be provided in the various frequency bands.

## ANNEX

CHARACTERISTICS WHICH MIGHT REASONABLY BE EXPECTED FOR ANTENNAE AT PRESENT IN USE FOR POINT TO POINT CIRCUITS

(See Note 1)

| Frequency range | Gain relative to optimum gain for half wave horizontal dipole at the same height | | Azimuthal range |
|---|---|---|---|
| | In the correct azimuthal direction db (Note 2) | Outside the azimuthal range db (Note 3) | Degrees |
| About 5 Mc/s . . . . . . . | 6 | 0 | ± 25 |
| About 10 Mc/s . . . . . . . | 10 | 0 | ± 15 |
| 15 to 30 Mc/s . . . . . . . . . | 15 | 3 | ± 10 |

*Note 1.* — Values are given as a provisional guide to the characteristics which might reasonably be expected for rhombic antennae. They are based on two antennae covering together the whole frequency range indicated.

*Note 2.* — These values refer to the gain for the correct azimuthal direction and for the appropriate vertical angle of propagation. The improvement in signal-to-noise ratio equivalent to these values may not always be achieved in practice for the receiving antennae if these antennae are directed towards the source of interference or noise.

*Note 3.* — Subsidiary lobes may cause the actual values to be higher in certain directions.

* This Study Programme has become Study Programme No. 45 (III).

# RECOMMENDATION No. 104

## SIGNAL-TO-INTERFERENCE PROTECTION

(Question No. 3 (III) — Study Programme No. 8 *)

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

CONSIDERING :

*(a)* That no documentation is available which could provide reliable data on the tolerable signal-to-interference ratio for various types of service, when the interfering signal lies within the bandwidth occupied by the wanted signal (Study Programme No. 8*, § 2.1.3) ;

*(b)* That there is an urgent need for these figures ;

*(c)* That Study Programme No. 8 *, § 2.2, indicates some of the factors to be taken into account when expressing the effect of the interference ;

*(d)* That, however, the London Doc. No. 236, relating to Study Programmes Nos. 6 * and 7 *, gives some results which can be used as a provisional guide when A1 and F1 emissions are subject to interference by an A1 emission ;

RECOMMENDS :

1. That administrations, in carrying out tests in connection with Study Programmes Nos. 6 * and 7 * regarding the separation of channels, should take into account the need for information as to tolerable interference levels when the interfering signal lies within the band occupied by the signal (see London Doc. No. 236) ;

2. That administrations should submit the results of these tests to the Director of the C.C.I.R. as soon as possible ;

3. That, as a provisional guide, the figures mentioned in the table be accepted, under the special conditions of the test, for the signal-to-interference protection ratio when the interfering signal lies within the bandwidth occupied by the wanted signal. These figures can be used in conjunction with the fading allowances in the Annex to Recommendation No. 105.

*Table*

| Wanted signal | Interfering signal | Protection radio db |
|---|---|---|
| A1 (50 baud printer) . . . . . | A1 (50 baud) | 10 |
| F1 (50 baud printer) . . . . . | A1 (50 baud) | 2 |

* Study Programmes Nos. 6, 7 and 8 have become respectively Study Programmes Nos. 42 (III), 43 (III) and 45 (III).

## RECOMMENDATION No. 105 *

## FADING ALLOWANCES FOR THE VARIOUS CLASSES OF SERVICE

(Question No. 3 (III) — Study Programme No. 8 **)

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

CONSIDERING :

*(a)* That Annex I to Recommendation No. 99 is a provisional partial reply to Question No. 3 (III) for stable conditions ;

*(b)* That there is a need for figures which take fading and field intensity fluctuation into account ;

*(c)* That it is not yet possible to give a full answer to Study Programme No. 8 ** ;

*(d)* That, however, the documents received relative to Question No. 52 and Study Programme No. 24 give some results from which can be derived provisional data on fading allowances ;

RECOMMENDS :

1. That the studies in connection with Recommendation No. 99 and Study Programme No. 45 (III) should be continued in conjunction with those of Study Programme No. 66 (VI), for the purpose of determining whether the provisional values given in the Annex may be accepted or should be modified ;

2. That, meanwhile, the values given in the Annex may be regarded as provisional total fading allowances (combined fading safety factors and intensity fluctuation factors) ;

3. That, meanwhile, these values may be used as a guide in conjunction with the values for signal-to-noise ratios required for stable conditions given in Recommendation No. 99, Ann. I, to estimate monthly median values of hourly median field intensity necessary for the various types and grades of service ; similarly, the fading allowances may be added to signal-to-interference ratios (for stable conditions) appropriate to the various services ;

### ANNEX

*Note 1.* — The allowance for day-to-day fluctuation (intensity fluctuation factor) for the signal, against steady noise, is 10 db, estimated to give protection for 90% of the days. The intensity fluctuation of atmospheric noise is also taken to be 10 db for 90% of the days. Assuming there is no correlation between the intensity fluctuations of noise and signal (the worst condition likely to exist), a good estimate of the combined signal and noise factor is :

$$\sqrt{10^2 + 10^2} = 14 \text{ db}$$

* This Recommendation replaces Recommendation No. 68.

** This Study Programme has become Study Programme No. 45 (III).

PROVISIONAL TOTAL FADING ALLOWANCES *

| Type of Service ** | For Protection of a Fading Signal Against: Atmospheric Noise Subject to Day-to-Day Intensity Fluctuation (Subtract 4 db for protection against steady noise or steady interfering signal) (See Note 1) | For Protection of a Fading Signal Against: Interfering Signal Subject to Fading and Day-to-Day Intensity Fluctuation (See Note 2) |
|---|---|---|
| | db Relative to Ratios of Monthly Median Values of Hourly Median Field Strength | |
| **A1 Telegraphy** | | |
| 8 baud, low grade (Note 3) | 21 | 17 |
| 24 baud (Note 4) | 25 | 20 |
| 120 baud recorder / 50 baud printer (Notes 5, 6) | 32 | 27 |
| **A2 Telegraphy** | | |
| 8 baud, low grade (Notes 3, 7) | 17 | 13 |
| 24 baud (Notes 4, 7) | 20 | 17 |
| **F1 Telegraphy** | | |
| 120 baud recorder / 50 baud printer (Notes 5, 6) | 32 | 27 |
| Facsimile (Note 8) | — | — |
| Hellschreiber (Note 9) | 23 | 20 |
| **A3 Telephony** | | |
| DSB just usable quality, operator to operator (Note 10) | 17 | 11 |
| DSB marginally commercial (Note 11) | 19 | 14 |
| DSB good commercial quality (Note 12) | 21 | 17 |
| SSB 1 channel / 2 channel / 3 channel / 4 channel (Note 12) | 21 | 17 |
| Broadcasting | 21 | 17 |

* Combined fading safety factor and intensity fluctuation allowances.
** From Annex I, Recommendation No. 99.

This figure has been added to the fading safety factor applied to each type of service to obtain the combined fading allowance in column 1. Subtraction of 4 db reduces the intensity fluctuation allowance to 10 db, which is the value for the signal alone ; the net allowance would then be appropriate to protection of a fading signal against steady (non-fluctuating) noise or steady (non-fading or fluctuating) interfering signal..

*Note 2.* — The probability distribution of the ratio of two signals fading independently has been used as given by London Doc. No. 443 : combined intensity fluctuation allowance for two signals, taken as 7 db, which represents a compromise between the 0 db allowance appropriate in the case of perfectly correlated intensity fluctuations of the two signals, and the 14 db allowance appropriate (see Note 1) for uncorrelated intensity fluctuations of the two signals.

*General Note.* — In calculating fading safety factor for rapid or short period fading, log-normal amplitude-distribution of the received fading signal (using 7 db for the ratio of median level to level exceeded for 10% or 90% of the time) have been used, except in the case of high-speed automatic telegraphy services, where protection has been calculated on the basis of Rayleigh distribution. The following notes refer to protection against rapid or short-period fading :

*Note 3.* — For protection 90% of the time.

*Note 4.* — For protection 98% of the time.

*Note 5.* — For protection 99.99% of the time.

*Note 6.* — Minimum of 2-element diversity assumed.

*Note 7.* — Total sideband power combined with keyed carrier assumed to give partial (two-element) diversity effect. 4 db allowed for the case of 90% protection (8 baud) and 6 db allowed for the case of 98% protection.

*Note 8.* — A figure, even provisional, for percentage protection, requires further study in conjunction with a review of the corresponding signal-to-noise ratio given in Ann. 1 of Recommendation No. 44 *.

*Note 9.* — Based on 95% protection.

*Note 10.* — Based on 70% protection.

*Note 11.* — Based on 80% protection.

*Note 12.* — Based on 90% protection.

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## RECOMMENDATION No. 106

## VOICE FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(Question No. 3 (III))

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

CONSIDERING :

*(a)* That diversity reception on radiotelegraphy circuits is not general practice ;

*(b)* That, in the case where voice frequency equipment is used on radio circuits at frequencies lower than about 30 Mc/s, the quality of these circuits will in general be insufficient when no means of diversity reception is provided ;

* This Recommendation has become Recommendation No. 99.

*(c)* That, in the presence of fading, space diversity or frequency diversity give comparable improvement to the quality of reception of telegraph signals transmitted on radio channels ;

*(d)* That for adequate frequency diversity it appears necessary that the frequencies which are used in combination to obtain this diversity should differ by at least 400 c/s ;

*(e)* That space diversity needs only half the bandwidth and less power for each telegraph channel when compared to the case of frequency diversity but, in general, requires more equipment ;

UNANIMOUSLY RECOMMENDS :

**1.** That, when voice frequency telegraphy systems are used on radio circuits at frequencies lower than about 30 Mc/s, diversity reception should be used on the individual voice frequency channels ;

**2.** That, whenever practicable, space diversity should be used in preference to frequency diversity ;

**3.** That, in the case of frequency diversity, the channel frequencies used in combination should have a separation of at least 400 c/s so that adequate diversity effects may be obtained.

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## RECOMMENDATION No. 107

### COMMUNICATION THEORY

(Question No. 44 (III))

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

CONSIDERING :

*(a)* That the study of both the practical and theoretical aspects of communication theory is of interest to the I.T.U. ;

*(b)* That the bibliography and documentation on this subject published by the Secretariat of the C.C.I.R. are useful for this study ;

UNANIMOUSLY RECOMMENDS :

**1.** That the C.C.I.R. should continue the study of the general question of communication theory ;

**2.** That it is very desirable that the U.R.S.I. should participate in the work, particularly on theoretical questions, and inform the C.C.I.R. of the results obtained, in order that they may be taken into account from the point of view of their practical application.

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## RECOMMENDATION No. 108

### PRESENTATION OF ANTENNA RADIATION DATA

(Question No. 49)

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

CONSIDERING :

*(a)* That the aims pursued by the I.T.U. require a knowledge of the radiation in all directions of the antennae used in international radiocommunication ;

*(b)* That antenna radiation is well represented by diagrams showing the field strength or the power radiated in every direction of space ;

*(c)* That, alternatively, the antenna radiation can be represented by the specific cymomotive force F measured in volts and defined as the product E.d of the electric field E, radiated by the antenna in the direction under consideration and measured at a distance d * from its centre, and the distance d * itself, the power radiated by the antenna being 1 kW ;

*(d)* That the radiated power and the cymomotive force are related by the equation

$$F^2 = 377 \text{ W}$$

where F is expressed in Volts and W is expressed in Watts per unit solid angle ;

*(e)* That the use of the concept of c.m.f. facilitates the assessment of the inverse distance field from the formula $E = \frac{F}{d}$ together with propagation curves giving the attenuation additional to the inverse distance loss. This permits the calculation of the field under practical conditions ;

RECOMMENDS :

**1.** That, in diagrams of antenna radiation, contours representing the radiation in all directions may usefully be labelled in terms of specific c.m.f. as well as in terms of relative radiated power or field strength, at least for frequencies below 30 Mc/s ;

**2.** That it would be useful to add to ground wave propagation curves the curve corresponding to a perfectly conducting ground and a flat earth so that the attenuation due to earth curvature and losses due to the imperfect transmission medium may be determined ;

**3.** That the possibility of using the concept of c.m.f. at frequencies greater than 30 Mc/s should be studied ** ;

**4.** That the Director of the C.C.I.R., when antenna diagrams are being drawn should take account of the above considerations.

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## RECOMMENDATION No. 109 ***

## GROUND-WAVE PROPAGATION OVER MIXED PATHS

(Question No. 6 (IV))

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

CONSIDERING :

*(a)* That the calculation of ground-wave field strengths and phases for propagation over mixed paths such as part land and part sea is a matter of great importance in determining the service areas of radio transmitters and in the use of medium and low frequencies for navigational aids ;

*(b)* That the calculations based on a rigid mathematical analysis are laborious, even in the case of a single boundary and a flat earth ;

*(c)* That, in many cases, the changes in the electrical constants of the ground with distance are gradual, ill defined or imperfectly known ;

* Distance d must be such that the field varies according to the inverse distance.

** In particular, in view of the practical use of curves such as those proposed in Resolution No. 11.

*** This Recommendation replaces Recommendation No. 51.

*(d)* That methods such as those described in the United Kingdom document (*Proc. I.E.E.*, Part III, **96**, 1944, p. 53) and in the Netherlands Doc. Nos. 243 and 348 (London) are found to give good agreement with experimental results ;

*(e)* That these methods are partly based on sound theoretical argument and make use of existing curves for propagation over a homogeneous earth ;

RECOMMENDS :

**1.** That such methods should be provisionally adopted for the calculation of ground-wave field strengths and phases where the propagation is over a path consisting of well defined sections of differing electrical constants, especially where the changes of amplitude and phase of the field with distance are required in detail ;

**2.** That where the changes of the electrical constants with distance are small or gradual and detailed variations in field strength and phase along the path are not required, a method based on a simple equivalent electrical constant of the kind described in London Doc. Nos. 140 (Japan) and 246 (Yugoslavia) may be adequate and preferable on account of its relative simplicity.

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## RECOMMENDATION No. 110

## PRESENTATION OF DATA IN STUDIES OF TROPOSPHERIC WAVE PROPAGATION

(Study Programmes Nos. 17 * and 18 *)

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

CONSIDERING :

*(a)* That there is an urgent need for guidance to be given to engineers in the planning of broadcasting, television and fixed link services in the frequency band 30-4000 Mc/s ;

*(b)* That it is important to determine how the field strength in this frequency band depends on meteorological conditions and upon the nature of the terrain at locations both within and beyond the horizon ;

*(c)* That to facilitate the comparison of results, it is desirable that administrations and operating agencies should present field strength data in a uniform manner ;

UNANIMOUSLY RECOMMENDS :

**1.** That field strength exceeded for 0.1%, 1%, 10%, 50%, 90%, 99% and 99.9% of the overall time should, whenever possible, be determined for all locations at which measurements are made ;

**2.** That in the case of broadcasting and television the median values of field strength exceeded at 10%, 50% and 90% of the locations should be determined ;

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* These Study Programmes have become respectively Study Programmes Nos. 55 (V) and 56 (V)

3. That the statistical results of field strength measurements should be displayed on probability paper. The field strength should be plotted along the ordinate and expressed in decibels relative to 1 microvolt per metre, the values of field strength increasing, moving up the ordinate. The percentage of total valid recording time, or percentage of locations should be plotted along the abscissa, with a scale following the Gaussian probability law, percentages increasing from left to right. An example of a log-normal distribution plotted on probability paper is given in Ann. II ;

4. That all measured values of field strength should be normalized to correspond to those that would be obtained with a vertical half-wave dipole, or with a similar horizontal dipole placed broadside to the direction of the receiving point, the dipole in each case being at least several wave-lengths above the ground and radiating 1 kW ;

5. That in the case of broadcasting and television, and whenever possible, all measurements should be referred to a receiving aerial 10 metres above the ground and this aerial should not be highly directive in the vertical plane ;

6. That Ann. I should be used as a guide by those working in this field.

## ANNEXE I

It should be noted that the recommendations given above refer particularly to the propagation of waves to long distances (especially in connection with interference problems in sound and television broadcasting) and also to propagation characteristics within the service areas of sound and television broadcasting stations. While in these cases the first interest lies in ascertaining those values of field strength exceeded for various percentages of the overall time at varying distances, for a more detailed analysis it might, however, be useful to analyse measurements within unit periods of 1 hour. This latter procedure would permit studies to be made of diurnal variations, while seasonal variations could similarly conveniently be studied by grouping the values obtained at specified hours of the day for a whole month and examining the change of field strength distributions from month to month. Presentation of the results in this form would, moreover, permit later correlation of radio measurements with meteorological data.

For the study of propagation over fixed optical links, in the VHF (metric), UHF (decimetric) or SHF (centimetric) bands, a more precise correlation between received field strength and prevailing atmospheric conditions might be required. For this and other reasons it is considered that results should be capable of being presented separately for each hour of the day of each month during which tests are being conducted. At the same time, overall distribution curves for periods of one month will be required to permit a study of seasonal variations ; overall distribution curves for even longer periods will also, no doubt, be required by the planning engineer. It is generally convenient to refer results to the free space value for the distance and other conditions concerned.

Although it will usually be necessary to preserve, for reference, the original charts upon which the field strength variations are recorded, it is essential that some much simpler and more conveniently accessible means of displaying the essential data be employed. One method is to plot the maximum, median and minimum field strengths for each hour on linear graph paper, the spread of results within the hour being shown by a vertical line. In addition, by determining the hourly median value or value over some other percentage of the time, it is possible to obtain for any given hour of the day, the statistical distribution of these values for a month (or any other desired period of time).

It is evident that much further data relating to micro-wave links is required, and is likely to become available in the relatively near future ; apart, however, from the foregoing general remarks, it is considered undesirable to lay down precise methods of presentation of data in a field which is rapidly growing, both in importance and in investigation techniques.

# ANNEX II

The Gaussian probability scale is defined by

$$P(x) = \frac{1}{\sqrt{2\pi}} \int_{x}^{\infty} e^{-\frac{1}{2}\xi^2} d\xi$$

For abscissae $x = 0$, $x \rightarrow \infty$ and $x \rightarrow -\infty$, the corresponding values of the probability P (x) are 50%, 0% and 100%.

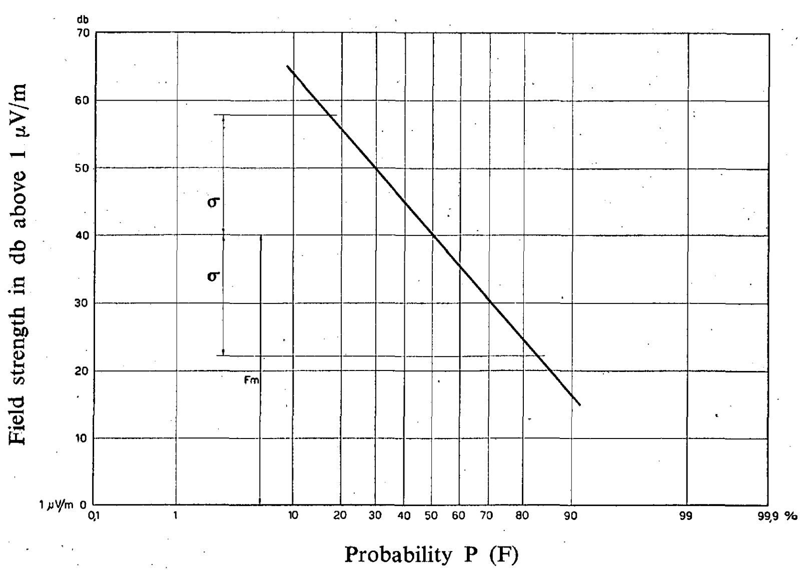
An amplitude Gaussian distribution for a field strength F measured in db (log-normal distribution) is given by :

$$P(F) = \frac{1}{\sigma\sqrt{2\pi}} \int_{F}^{\infty} e^{-\frac{1}{2}\left(\frac{f-F_m}{\sigma}\right)^2} df$$

P (F) is the probability (percentage of time or locations) that the field strength E expressed in db above 1 $\mu$V/m ($F = 20 \log E$) will exceed the level F. Fm is the median value of F, i.e. that which is exceeded for 50% of the time or locations. $\sigma$ is the standard deviation, so that $P(F_m - \sigma) \approx 84\%$ and $P(F_m + \sigma) \approx 16\%$.

It is often of interest to know the field strength exceeded for 1% or 10% of the time ; when the distribution is log-normal, the distribution curve is a straight line, the corresponding deviations are given by 2.32 $\sigma$ and 1.28 $\sigma$.

The accompanying graph illustrates the presentation of log-normal distribution.




GRAPH SHOWING LOG-NORMAL DISTRIBUTION OF FIELD STRENGTH MEASUREMENTS

# RECOMMENDATION No. 111 *

## TROPOSPHERIC WAVE PROPAGATION CURVES

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

CONSIDERING :

*(a)* That there is an urgent need to give a guide to engineers in the planning of services in the 30-300 Mc/s band, in particular for television and VHF (metric) broadcasting ;

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

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

RECOMMENDS :

That the revised curves given in Ann. II be adopted for use, *subject to the conditions stated in Ann. I.*

## ANNEX I

*(a)* The curves of Ann. II were prepared principally from data obtained in the United States of America and the United Kingdom, supplemented by data from other European countries ;

*(a)* Is is not known to what extent these curves will be applicable in other parts of the world ;

*(c)* For paths which lie wholly or mainly over the sea, the curves should be used with caution, as present experience suggests that, under these conditions, the field strengths may be considerably greater on the average than those given by the curves, particularly in areas having meteorological conditions such as are met with in the Mediterranean ;

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

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

*(f)* They are referred to a radiated power of 1 kW from a half-wave dipole several wavelengths at least, above the ground ;

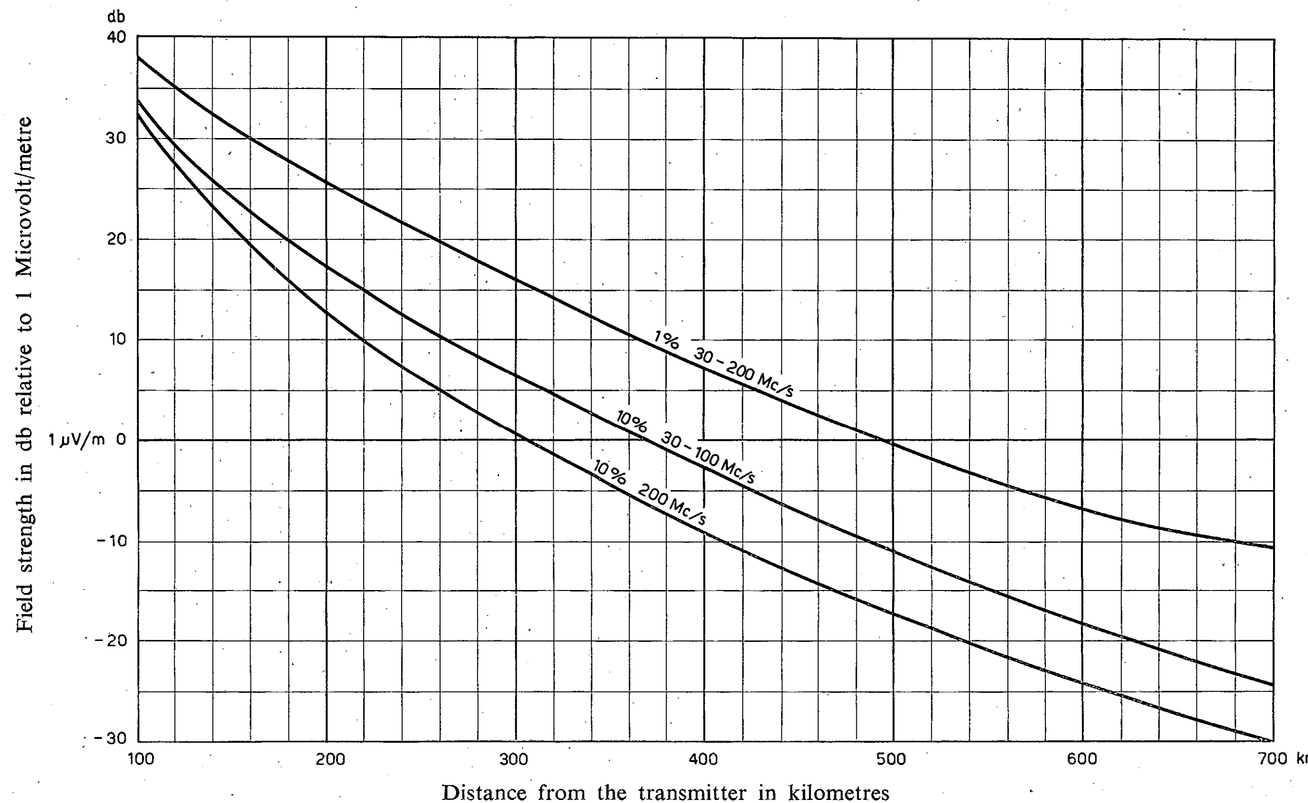
*(g)* They refer equally to horizontal and vertical polarization ;

*(h)* The observed field strength depends upon the nature of the terrain over which the transmission takes place and these curves represent median values with respect to locations in the geographical areas (United States of America and Europe) in which the data were obtained ;

* This Recommendation replaces Recommendation No. 55.

# ANNEX II

## Estimated tropospheric field strength exceeded for 1% and 10% of the time




*Frequency range 30-200 Mc/s.* 1 kW radiated from a half wavelength dipole, vertical or horizontal polarization. Receiving aerial height 10 m. above ground level, median values with respect to terrain.

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

*(j)* These curves take no account of ionospheric propagation.

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## RECOMMENDATION No. 112 *

## BEST METHODS FOR EXPRESSING FIELD STRENGTH FOR PULSE TRANSMISSIONS

(Question No. 8, § A.1c)

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

CONSIDERING :

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

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

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

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

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

UNANIMOUSLY RECOMMENDS :

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

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

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

**4.** That apparatus for measuring and determining pulse characteristics should be developed ;

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* This Recommendation replaces Recommendation No. 62.

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

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

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## RECOMMENDATION No. 113 *

## FIELD STRENGTH MEASUREMENT

### Types of wave collector and equipment for use in each frequency band

(Question No. 8, § A.3)

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

CONSIDERING :

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

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

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

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

UNANIMOUSLY RECOMMENDS :

1. That the following wave collectors should be used for measuring field strengths stronger than a few microvolts per metre ;
   — between 10 kc/s and 30 Mc/s, loop or stub-antennae (it is possible to use loops up to about 100 Mc/s) ;
   — above about 30 Mc/s, doublets, or stub-antennae, or loop antennae up to about 100 Mc/s ;
   — above about 300 Mc/s, more complex directional wave collectors, as may be desirable ;

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

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

*Note.* — It is to be noted that longer single-conductor antennae may be used effectively to measure weak field strength.

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* This Recommendation replaces Recommendation No. 64.

## RECOMMENDATION No. 114 *

## FIELD STRENGTH MEASUREMENT

### Influence of Local Conditions on Interpretation and Accuracy of Measurements of Field Strength

(Question No. 8, § A.5)

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

CONSIDERING :

*(a)* That local conditions affect the measured values of field strength to a variable extent ;

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

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

*(d)* That the nature of the soil in the neighbourhood of the measuring site will affect the value of field strength observed and that its influence depends on frequency, polarisation, type of antenna and angle of arrival of the waves ;

UNANIMOUSLY RECOMMENDS :

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

**2.** That measurements should be accompanied by :

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

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

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

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

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

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* This Recommendation replaces Recommendation No. 66.

## RECOMMENDATION No. 115 *

## STUDY OF ABSORPTION IN THE IONOSPHERE

(Recommendation No. 8)

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

CONSIDERING :

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

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

*(c)* That the necessary investigations would be greatly assisted if the facilities of existing high power transmitters could be made available at times for the studies ;

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

RECOMMENDS :

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

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

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

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## RECOMMENDATION No. 116 **

## PRESENTATION OF BASIC PROPAGATION PREDICTION CHARTS

(Recommendation No. 53)

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

CONSIDERING :

*(a)* That basic propagation prediction charts produced by different organizations are not of uniform presentation ;

*(b)* That the use of such charts for routine predictions, and their intercomparison, would be facilitated by the standardization of the scales employed ;

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* The text of this Recommendation, which has been approved by the VIIth Plenary Assembly of the C.C.I.R. (London, 1953), was added under the title " Note by the Director of the C.C.I.R. " to Vol. I of the documents of the VIth Plenary Assembly of the C.C.I.R. (Geneva, 1951).

** This Recommendation replaces Recommendation No. 53.

UNANIMOUSLY RECOMMENDS :

That, keeping their present form, the charts should be made with a uniform scale using a centimetre grid on which one centimetre represents 10 degrees of latitude and 15 degrees of longitude or one hour of time.

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## RECOMMENDATION No. 117 *

## PREDICTION OF SOLAR INDEX

(Recommendation No. 69)

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

CONSIDERING :

*(a)* That it is desirable to have an internationally agreed prediction of smoothed relative sunspot numbers for about 6 months in advance ;

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

*(c)* That the autocorrelation techniques referred to in Recommendation 69, § 2, are not immediately applicable in practice to the extrapolation of a finite time series ;

*(d)* That the Director of the C.C.I.R. has already made considerable progress in overcoming the difficulty referred to in *(c)* and that there is reasonable hope of finding a practical method of making the required predictions.

UNANIMOUSLY RECOMMENDS :

**1.** That the Director of the C.C.I.R. should continue the study of the application of autocorrelation or other suitable prediction techniques to finite time series and more particularly to the prediction of smoothed sunspot numbers ;

**2.** That the accuracy of the prediction obtained by such methods should be compared with that attainable by subjective methods ;

**3.** That, in the event of any satisfactory prediction method being found, these predictions should be published in the *Journal des Telecommunications* as they become available ;

**4.** That as soon as they are available these predictions should be made available monthly to all administrations and other interested parties by an inexpensive postcard subscription service utilizing air-mail ;

**5.** That, the Director of the C.C.I.R. and the various administrations should present to the next Plenary Assembly of the C.C.I.R. their comments on these predictions, stressing in particular :

— the usefulness of 12-month smoothed averages ;
— the usefulness of prediction six months in advance ;
— the applicability of the predictions to their communication problems.

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* This Recommendation replaces Recommendation No. 69.

## RECOMMENDATION No. 118

## PROTECTION OF FREQUENCIES USED FOR RADIO-ASTRONOMICAL MEASUREMENTS

(Recommendation No. 56)

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

CONSIDERING :

*(a)* That protection from interference in radio astronomical measurements is required ;

*(b)* That in general, for the purpose of these measurements, it is not practicable to use the frequencies listed in Recommendation No. 56 ;

*(c)* That a considerable degree of protection can be achieved by appropriate frequency assignments on a national rather than an international basis ;

*(d)* That, nevertheless, it may be impracticable to afford such protection in or near populous or industrial regions ;

UNANIMOUSLY RECOMMENDS :

**1.** That Geneva Recommendation No. 56 shall be considered no longer operative ;

**2.** That administrations should afford all practicable protection from interference to radio-astronomical measurements, particularly on frequencies around 1420 Mc/s.

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## RECOMMENDATION No. 119

## MEASUREMENT OF ATMOSPHERIC RADIO NOISE

(Study Programme No. 23 *)

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

CONSIDERING :

The need for measurement of atmospheric radio noise by objective and automatic means (§ 3 and 4 of Study Programme No. 23 *) ;

RECOMMENDS :

That administrations in a position to do so, should consider effective participation in the testing of the equipment referred to in the Annex, with a view to its adoption for a world-wide network of noise-measuring stations.

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* This Study Programme has become Study Programme No. 65 (VI).

## ANNEX

A prototype equipment for the objective measurement of atmospheric noise has been developed by the Central Radio Propagation Laboratory of the National Bureau of Standards.

It is planned that about 50 stations will be established in a network comprising one equatorial chain and four meridional chains, at longitudes 30° E, 130° E, 75° W and 160° W, approximately.

Administrations can assist in the programme by the provision of the following : sites or personnel or equipment. Additional information may be obtained from the National Bureau of Standards.

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## RECOMMENDATION No. 120

## REVISION OF ATMOSPHERIC RADIO NOISE DATA

(Study Programme No. 23 *)

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

CONSIDERING :

*(a)* That there is a need for revision and clarification in the presentation of existing atmospheric noise data ;

*(b)* That Study Programme No. 23 * has resulted in additional information becoming available ;

*(c)* That time will be required for the preparation of the data in suitable form ;

RECOMMENDS :

1. That revised charts and curves of atmospheric noise should be prepared, based on, and of similar form to those contained in the National Bureau of Standards Circular No. 462 (*Ionospheric Radio Propagation*, National Bureau of Standards Circular No. 462, 1948. United States Government Printing Office) ;

2. That Study Group No. VI should organize this revision by correspondence ;

3. That the fundamental quantity on which the curves are to be based should be the root mean square noise field strength as measured on a short vertical rod aerial, in a bandwidth of 1 kc/s, averaged over a period of a few minutes (here called the average r.m.s. noise) ;

4. That the curves should show the seasonal median value of the average r.m.s. noise as a function of season, time of day, frequency and geographical location ;

5. That information should be given regarding the short and long-term variations of the average r.m.s. noise ;

6. That information should be given regarding the variability of noise within a period of a few minutes ;

7. That the frequency range of the curves should be extended downwards to 10 kc/s ;

* This Study Programme has become Study Programme No. 65 (VI).

**8.** That in the period until the revised charts and curves are available :

— the seasonal median values of average r.m.s. noise in a bandwidth of 1 kc/s be assumed to be 32 db below the values plotted in Circular No. 462. This implies that the values to be used in conjunction with Ann. I of Geneva Recommendation No. 44 (which specifies a bandwidth of 6 kc/s), and with appropriate fading factors are 24 db below the values in Circular No. 462 ;

— in using these derived values of average r.m.s. noise no allowance should be made for noise variations in periods of less than one hour, and that in allowing for hour-to-hour and day-to-day variations, the upper decile values be assumed to be 10 db greater than the medians ;

— the average r.m.s. noise field strength in a 1 kc/s bandwidth from extra-terrestrial sources should be assumed to be 0.1 microvolt per metre (20 db below 1 microvolt per metre) at 50 Mc/sec and to vary inversely with frequency to the power 0.15 ;

**9.** That the attention of the U.R.S.I. should be drawn to the desirability of expressing the results of future noise measurements in such a way as to facilitate direct comparison with the proposed curves of average r.m.s. noise ;

**10.** That the attention of U.R.S.I. should be drawn to the urgent need for further information regarding atmospheric noise, with particular reference to variations with time, direction of arrival and the influence of sunspot activity ;

**11.** That the above recommendations should be deemed complementary to Recommendation No. 67.

*Notes:*

1. The curves in Circular No. 462 indicate the estimated carrier signal strengths required for satisfactory radio telephone communication 90 per cent of the time. The figure of 32 db quoted in Section 8 of the Recommendation is based on the assumption that for this service the required ratio of carrier signal to r.m.s. noise in a bandwidth of 6 kc/s is 9 db under steady conditions. A factor of 15 db has been applied to allow for time variations in both signal and noise, and a further factor of 8 db to allow for the change in bandwidth. This combination of factors is considered to be more specific and reliable than the overall figure of 15 db for signal to average noise ratio given in Circular No. 462.

2. Recent publications *, **, suggest that :

   *(a)* Values for midnight at 2.5 Mc/s may be 12 db lower than those indicated in Circular No. 462 ;

   *(b)* Values for midnight at 15 Mc/s may be 10 db higher than those indicated in Circular No. 462 ;

   *(c)* Values at very low frequencies in high latitudes may be considerably lower than those indicated in Circular No. 462.

These observations should be considered to replace those in Sections (i) and (vi) of Report No. 8.

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* " Measurements of Atmospheric Noise at High Frequencies ", by F. Horner. *Radio Research Special Report*, No. 26 1953, London, H.M.S.O., Code No. 47-29-26.

** " Noise Levels in the American Sub-Arctic " by N.C. Gerson, *Proc. I.R.E.*, 1950, **38**, 905-916.

## RECOMMENDATION No. 121

## LOCAL LIGHTNING FLASH COUNTERS

(Study Programme No. 23 *)

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

CONSIDERING :

*(a)* That several devices designed for counting local lightning flashes have been proposed ;

*(b)* That available performance data are insufficient to compare the merits of these devices ;

RECOMMENDS :

1. That direct comparisons should be made at several places, between various devices proposed for the counting of local lightning flashes ;
2. That steps should be taken by the Director of the C.C.I.R. and Study Group No. VI in collaboration with the World Meteorological Organization to arrange for direct comparison to be made between the several devices ;
3. That United States of America, France, India, Japan, the United Kingdom and the Union of South Africa should each be invited to propose a member to participate in this work and that the United Kingdom member should co-ordinate the work on behalf of the Chairman of Study Group No. VI.

*Notes.* — It is not possible to devise a simple radio device which will count all lightning flashes within a specified radius and none of those originating at greater distances.

It is considered that an instrument which responds to all major discharges will provide better indications of radio interference caused by storms than one which responds only to discharges to the ground.

It is considered that counters would provide a more satisfactory measure of thunderstorm activity if designed for a range greater than the 20 kilometres suggested in Study Programme No. 23 *.

It is considered that the most reliable indications of local thunderstorm activity are likely to be provided by instruments responding to a wide band of frequencies in the VLF (myriametric) band.

The standard or standards of reference to be used in the comparisons should be decided in close consultation with the Director of the C.C.I.R. and representatives of the World Meteorological Organization.

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## RECOMMENDATION No. 122 **

## STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Question No. 54 ***)

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

CONSIDERING :

*(a)* That the International Administrative Radio Conference, Atlantic City, 1947, allocated frequency bands 2.5 Mc/s $\pm$ 5 kc/s (2.5 Mc/s $\pm$ 2 kc/s in Region 1), 5 Mc/s $\pm$ 5 kc/s, 10 Mc/s $\pm$ 5 kc/s, 15 Mc/s $\pm$ 10 kc/s, 20 Mc/s $\pm$ 10 kc/s, and 25 Mc/s $\pm$ 10 kc/s, and that the Conference requested the C.C.I.R. to study the question of establishing and operating a world-wide standard frequency and time service ;

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* This Study Programme has become Study Programme No. 65 (VI).

** This Recommendation replaces Recommendation No. 70.

*** This Question has become Question No. 87 (VII).

*(b)* That experimental standard frequency stations have been put in operation and that a considerable amount of data on their performance have been collected (see Ann. I) ;

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

*(d)* That the present standard frequency service is experiencing interference from stations other than standard frequency stations ;

*(e)* That this service should permit reliable and accurate measurement to be made using simple receiving equipment ;

RECOMMENDS :

**1.** That a standard frequency transmission should comprise a standard carrier frequency, modulated by a time signal and, if desired, by one or more standard audio frequencies ;

**2.** That the standard audio frequencies should be chosen preferably from 440, 600 or 1000 c/s, and that the duration of the audio frequency modulation should be at least 4 minutes ;

**3.** That the time signals should consist of impulses repeated at intervals of one mean solar second, synchronized as precisely as possible with Universal Time ;

**4.** That these impulses should consist preferably of either 4 cycles of 800 c/s tone, or 5 cycles of 1000 c/s tone, or 6 cycles of 1200 c/s tone, or 7 cycles of 1400 c/s tone ;

**5.** That the first impulse of each minute be prolonged so as to be easily identified by means of simple receiving equipment ;

**6.** That preferably, the time signals should be transmitted without any other modulation during periods of at least 4 minutes ;

**7.** That the frequencies transmitted should be maintained within $\pm 2$ parts in $10^8$ of their nominal frequency (see Ann. II) ;

**8.** That the standards used for control should have a drift of less than 1 part in $10^8$ per week (see Ann. II) ;

**9.** That the time intervals transmitted should be maintained within $\pm 2$ parts in $10^8$ $\pm 1$ microsecond (see Ann. II) ;

**10.** That notice of any adjustments to the standard frequencies and time signals should be sent regularly by each Administration to the Secretariat of the C.C.I.R. in the uniform manner suggested in Ann. III, for collation and distribution ;

**11.** That the measured values of the frequencies and time signals should be sent regularly by each administration to the Secretariat of the C.C.I.R. in the uniform manner suggested in Form A of Ann. III, for collation and distribution ;

**12.** That co-operation with the B.I.H. and the U.R.S.I. should continue ;

**13.** That any experimental station operating within the framework of Study Programme No. 68 (VII) found to be causing harmful interference to the established services of permanent stations should take steps to eliminate such interference ;

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

**15.** That administrations should recognise that it is in the general interest that steps be taken to clear the allocated bands as soon as possible.

## ANNEX I

PRINCIPAL CHARACTERISTICS OF STANDARD-FREQUENCY AND TIME-SIGNAL STATIONS (1)
(September 1953)

| | | | HAWAI | RUGBY | TOKYO | TORINO | WASHINGTON | JOHANNESBURG (18) |
|---|---|---|---|---|---|---|---|---|
| 1 | STATIONS | | HAWAI | RUGBY | TOKYO | TORINO | WASHINGTON | JOHANNESBURG (18) |
| 2 | *Call-sign* | | WWVH | MSF | JJY | IBF | WWV | ZRE 21 |
| 3 | *Service* | | Experimental | Experimental | Experimental | Experimental | Regular | Experimental |
| 4 | *Carrier power* (kW) | | 2 (2) | 0.5 | 1 | 0.3 | 10 (2) | 0.1 |
| 5 | *Type of antenna* | | Vertical dipole | Vertical dipole | Vertical dipole | Horizontal dipole (14) | Vertical dipole | Inverted L |
| 6 | *Number of simultaneous transmissions* | | 3 | 3 | 1 | 1 | 6 | 1 |
| 7 | *Number of frequencies used* | | 3 | 3 | 3 | 1 | 6 | 1 |
| 8 | *Emissions* | *Days per week* | 7 | 7 | 3 (9) (10) (11) | 1 (15) | 7 | 7 |
| 9 | | *Hours per day* | 22 | 24 (6) | 24 | 6 (16) | 24 | 24 |
| 10 | *Standard frequencies used* | *Carriers* (Mc/s) | 5 10 15 | 2.5 5 10 (7) | 2.5 (9) 5 (10) 10 (11) (12) | 5 | All | 5 |
| 11 | | *Modulations* c/s) | 1 (3) 440 600 | 1 (3) 1000 | 1 (13) 1000 | 1 (3) 440 1000 | 1 (3) 440 600 | 1 (3) |
| 12 | *Duration of tone modulation in minutes* | | 4 in each 5 (4) | 5 in each 15 | 9 in each 20 | 5 in each 10 (17) | 4 in each 5 (4) | — |
| 13 | *Accuracy of frequencies in parts in* $10^8$ | | $\pm 2$ | $\pm 2$ | $\pm 2$ | $\pm 2$ | $\pm 2$ | $\pm 10$ (18) |
| 14 | *Maximum oscillator drift in parts in* $10^8$ *per month* | | $+2$ | $+0.5$ | $+1$ | $+4$ | $+1$ | $+5$ (18) |
| 15 | *Maximum value of steps of frequency adjustment in parts in* $10^8$ | | 1 | 2 | 2 | 2 | 1 | 5 (18) |
| 16 | *Duration of time-signals in minutes* | | continuous | 5 in each 15 | continuous | 5 in each 10 | continuous | continuous |
| 17 | *Accuracy of time intervals* | | $\pm 2 \times 10^{-8}$ $\pm 1$ micro-second | $\pm 2 \times 10^{-8}$ $\pm 1$ micro-second | $\pm 2 \times 10^{-8}$ $\pm 1$ micro-second | $\pm 2 \times 10^{-8}$ $\pm 1$ micro-second | $\pm 2 \times 10^{-8}$ $\pm 1$ micro-second | $\pm 10 \times 10^{-8}$ (18) $\pm 50$ micro-seconds |
| 18 | *Method of adjusting time signals* | | Steering (5) | By steps of 50 ms (8) | Adjusted to mean of time signals | Adjusted to mean of time signals | Steering (5) | Steering (5) |

For notes to the table see page 153.

## ANNEX II

To satisfy the requirements of § 7, 8 and 9, the control oscillator of a standard frequency station should be checked, and if necessary, adjusted at least once a day by reference to at least three quartz-crystal-controlled oscillators of high precision, which are in turn calibrated either :

— in terms of astronomical-observatory time signals, corrected if necessary, over periods of at least 20 days,
*or*
— in terms of time signals of a standard frequency station operated according to the above method over periods of at least 10 days.

In addition, frequency comparisons between the control oscillator and three or more high-precision reference oscillators should be continuously recorded, with a discrimination better than $\pm 2$ parts in $10^9$. Each oscillator should be stable to better than $\pm 2$ parts in $10^9$ over 24-hour intervals.

## ANNEX III

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

..............................................................................................................................................

.................................................... for the quarter ending .................................................. 19......

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

..............................................................................................................................................

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

..............................................................................................................................................

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*Notes to the table on page 152.*

(1) For details see documents :
WWVH-WWV : LC 1009 U.S.A. National Bureau of Standards (15 April 1952).
MSF : No. 304 C.C.I.R. London, or U.K. National Physical Laboratory leaflet : MSF : *New Programme of experimental standard frequency transmissions from the U.K.*, May, 1953.
IBF : No. 257 C.C.I.R., Geneva.
JJY : *Standard Frequency and Time Signals*, Radio Research Laboratories, Tokyo.

(2) These are maximum values ; on certain frequencies and on certain days reduced power is used.

(3) 5 cycles of 1000 c/s modulation pulses.

(4) 440 and 600 c/s tones alternately.

(5) No phase adjustment made to time signals.

(6) Total interruption of transmission from minute 15 to minute 20 of each hour.

(7) Transmissions are also made on 60 kc/s (see note 1).

(8) Adjustments made on first day of the month when necessary.

(9) Mondays.

(10) Wednesdays.

(11) Fridays.

(12) Transmissions are also made on 4 and 8 Mc/s (see note 1).

(13) 7 cycles of 1400 c/s modulation pulses.

(14) Maximum radiation in N.W. and S.E. directions.

(15) Tuesdays.

(16) From 0800 to 1100 h and from 1300 to 1600 h U.T.

(17) 440 and 1000 c/s tones alternately.

(18) The transmissions are made by the Union Observatory (Union of South Africa). The accuracy will be improved when new equipment becomes available.

3. Method of reporting :

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

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

| Date | Frequency, parts in $10^9$ | Time, milliseconds |
|---|---|---|
| | | |

Date of compilation :

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## RECOMMENDATION No. 123

## ACCURACY OF FIELD STRENGTH MEASUREMENTS BY MONITORING STATIONS

(Question No. 55)

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

CONSIDERING :

(a) That field intensity measurements are being made by monitoring stations in the frequency range from 15 kc/s to 300 Mc/s ;

(b) That the order of accuracy of such measurements would make them suitable for use in connection with the international registration and assignment of frequencies ;

(c) That the publication of such data by monitoring stations is therefore desirable ;

RECOMMENDS :

**1.** That, to obtain the accuracy specified in the table below, the field strength measuring equipment at monitoring stations should be installed, calibrated and operated in accordance with the terms contained in the Annex to this Recommendation ;

**2.** That, except where there are limitations due to receiver noise level, atmospheric noise or external interference, the accuracy to be expected in field strength measurements at intensities above 1 μV/m is as shown in the following table.

| Frequency Band | Accuracy of Measurement |
|---|---|
| Below 3000 kc/s . . . . . . | ±1.5 db |
| 3000 to 30 000 kc/s . . . . | ±2.0 db |
| 30 to 300 Mc/s . . . . . . | ±3.0 db |

The accuracy specified in the table is obtainable with apparatus either manually operated or used with automatic recorders, provided that the time constant of the combined equipment is 0.1 second or less, when measuring unmodulated carriers, modulated emissions of all types except A1, A2, P and emissions with suppressed or reduced carriers.

**3.** That when, because of interference, signal instability or for other reasons accuracy within these limits is not obtainable, the measurements should nevertheless receive due consideration if their accuracy is indicated ;

**4.** That studies of methods and equipment for field strength measurements at monitoring stations should be continued.

## ANNEX

### 1. Antenna Installation

(a) *Frequencies of 30 Mc/s and below.*

It is recommended that, for frequencies of 30 Mc/s and below, vertical antennae three-eighths wavelength or less in height should be used, with ground systems consisting of buried radial conductors at least half wavelength long or of an equivalent ground screen near the earth.

The radial conductors should be spaced 10 degrees or less apart. It is necessary to ensure that no significant distortion of the field being measured is caused by obstructions, buildings, buried pipes etc.

Vertical antennae as described above, are recommended as standard for field strength measurement by monitoring stations, for ionospheric signals on frequencies of 30 Mc/s and below for the following reasons :

1. It is generally accepted that random variations in polarization of ionospheric waves are such that the vertically polarized component is, in general, substantially equal to the horizontal component.

2. The effective height of a vertical stub-antenna is substantially independent of wavelength.

3. The disadvantage of using a horizontal antenna is that its gain depends on its elevation above the ground and on its orientation.

(b) *Frequencies above 30 Mc/s.*

Antennae for field strength measurement on frequencies above 30 Mc/s are recommended to conform to the following conditions :

1. The receiving antenna must have the same polarization as the transmitting antenna. For these frequencies stub-antennae, or half-wave dipoles can be used, as appropriate.

2. VHF (metric) antennae should be located at a standard height above ground, representative of average receiving conditions, and a height of 10 metres is recommended.

3. There should be a clearance of at least 100 feet (30 metres) from other structures.

(c) *Antenna factor.*

For frequencies below 30 Mc/s, the error in the determination of the antenna factor should be kept within $\pm 1$ db and for frequencies from 30 Mc/s to 300 Mc/s it should be within $\pm 2$ db. The antenna factor includes coupling or mismatch losses between antenna and receiver in the parts not common to the measuring and calibrating circuits.

### 2. Receiver

The receiver should have high inherent stability with respect to gain, frequency, bandwidth and attenuation calibrations. Particular attention is drawn to the desirability of using voltage regulators and crystal controlled oscillators to limit the effect of the receiver on the overall accuracy of field strength measurements. Nevertheless, the frequent use of a signal generator for calibration of the field strength measuring equipment is recommended. With current designs using recording equipment, calibration should be carried out at least daily.

### 3. Signal Generator

The attainable accuracy of standard signal generators in the voltage range above 1 $\mu$V is $\pm 1$ db.

This accuracy can be obtained using a bolometer secondary voltage standard or other recognised methods of comparable precision. However it should be noted that there is now available an improved device capable of greater accuracy, namely the micro-potentiometer.

The calibration of the signal generator should be checked frequently by means of such standards in order to maintain the desired accuracy of measurement.

*Bibliography.* — Selby, M. C., "Accurate R.F. Voltages". Communications and Electronics. *Trans. A.I.E.E.* No. 6, Page 158-164, May 1953.

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## RECOMMENDATION No. 124

# WATCH ON THE RADIO TELEPHONY DISTRESS FREQUENCY OF 2182 kc/s

(Question No. 56)

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

CONSIDERING :

*(a)* That, according to Atlantic City Radio Regulations No. 815, the frequency 2182 kc/s may be used for calls and replies, and is the frequency to be used for the distress call and traffic, as well as for urgency and safety signals and messages ;

*b)* That, there is, as yet, little experience of the world-wide use of a common frequency for calling and distress in the MF (hectometric) maritime radio-telephony service ;

*(c)* That in certain areas distress calls at times suffer interference from traffic calls and replies ;

*(d)* That certain countries use frequencies other than 2182 kc/s, especially working frequencies, for normal traffic calling and replies, in accordance with Radio Regulations No. 817 ;

*(e)* That, nevertheless, the exclusive use of the frequency of 2182 kc/s for distress purposes would militate against extensive watch-keeping on this frequency by ships ;

*(f)* That the use of an alarm signal with strongly distinctive characteristics would facilitate the reception of distress calls in ships and coast stations carrying out aural watch as well as in those stations fitted with automatic alarms ;

*(g)* That a loudspeaker distress watch in ships not fitted with automatic alarms would increase the efficiency of the distress watch ;

UNANIMOUSLY RECOMMENDS :

**1.** That an alarm signal of the type specified in Recommendation No. 71 should be adopted by all administrations and brought into use at an early date ;

**2.** That administrations should encourage the keeping of a loud speaker watch on the calling and distress frequency of 2182 kc/s on board those of their ship which are not fitted with automatic alarm receiving equipment for that frequency ; nevertheless the automatic or aural watch for the alarm signal on the distress frequency of 2182 kc/s need be encouraged only on ships not fitted with radiotelegraph equipment in the 500 kc/s band ;

**3.** That administrations should take special steps to enforce respect of the Radio Regulations (especially Nos. 815 and 816) regarding the use of the calling and distress frequency 2182 kc/s ;

**4.** That administrations should maintain observations over a sufficient period to determine whether there is a need to change the Radio Regulations regarding the use of the international calling and distress frequency 2182 kc/s ;

**5.** That the results of such observations should be submitted directly by administrations to an appropriate administrative conference.

*Note.* — This Recommendation concludes the study of Question No. 57.

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## RECOMMENDATION No. 125 *

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

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

CONSIDERING :

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

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

1. Provide reliable operation of automatic alarm equipment ;
2. Provide a distinctive signal which is readily recognized aurally when received on a loud-speaker or headphones ;

* This Recommendation concludes the study of Question No. 56 and of Study Programme No. 29.

3. be capable of being received through interference from speech transmissions, through other kinds of interference, and through noise ;
4. avoid false responses when received either aurally or by automatic means ;
5. be capable of being produced by a simple manual device, as well as by automatic means ;

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

*(d)* That to help in clearing the calling and distress frequency channel of emissions from other stations the alarm signal and detecting device should be effective beyond the range at which speech transmission is satisfactory ;

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

*(f)* That the results of the further examination of this problem by the administrations participating in Study Programme No. 29 (Geneva, 1951) are sufficiently conclusive to determine the essential characteristics of the signal including tolerances that should be recommended for international adoption ;

*(g)* That it is possible to specify the minimum performance standards for automatic alarm equipment, for both transmission and reception, to such an extent that future progress and development are not hampered ;

*(h)* That it is undesirable that the specification of performance standards for automatic alarm equipment should exceed in scope the requirements already established by international agreement for automatic alarm devices intended for the reception of the international alarm signal or the international distress signal in radio-telegraphy, normally transmitted on the frequency 500 kc/s (Art. 37, § 31, 32, 33, International Radio Regulations, Atlantic City, 1947 ; and Chap. IV, Regulation 11, Convention for Safety of Life at Sea, London, 1948) ;

UNANIMOUSLY RECOMMENDS :

**1.** That the alarm signal described below should be adopted internationally for use on the maritime radio-telephony calling and distress frequency of 2182 kc/s ;

1.1 The alarm signal shall consist of two substantially sinusoidal audio frequency tones, transmitted alternately for a minimum period of 6 seconds. One tone shall have a frequency of 2200 c/s and the other a frequency of 1300 c/s. The duration of each tone shall be 250 milliseconds ;

1.2 The tolerance of the frequency of each tone shall be $\pm 1.5\%$; the tolerance on the duration of each tone shall be $\pm 50$ milliseconds ; the interval between successive tones shall not exceed 50 milliseconds ; the ratio of the amplitude of the stronger tone to that of the weaker shall be within the range 1 to 1.2 ;

1.3 When generated by automatic means, the alarm signal shall be sent continuously for a period of at least 30 seconds but not exceeding one minute ; when generated by other means, the signal shall be sent as continuously as practicable over a period of approximately one minute ;

**2.** That the automatic devices intended for the reception of the alarm signal in question should fulfil the following conditions :

2.1 The frequencies of maximum reponse of the tuned circuits, and other tone-selecting devices, shall be subject to a tolerance of $\pm 1.5\%$ in each instance ; and the response shall not fall below $50\%$ of the maximum response for frequencies within $1.5\%$ of the frequency of maximum response ;

2.2 In the absence of noise and interference, the automatic receiving equipment shall be capable of operating from the alarm signal in a period of not less than four and not more than six seconds ;

2.3 The automatic receiving equipment shall respond to the alarm signal through intermittent interference caused by atmospherics and powerful signals other than the alarm signal, preferably without any manual adjustment being required during any period of watch maintained by the equipment ;

2.4 The equipment shall not be actuated by atmospherics or by strong signals other than the alarm signal ;

**3.** The automatic alarm equipments, for both transmission and reception on the calling and distress frequency of 2182 kc/s, shall fulfil the following conditions :

3.1 The equipment shall be effective beyond the range at which speech transmission is satisfactory ;

3.2 The equipments shall be capable of withstanding vibration, humidity, changes of temperature and variations in power supply voltage equivalent to the severe conditions experienced on board ships at sea, and shall continue to operate under such conditions ;

3.3 The equipment should as far as practicable give warning of faults that would prevent the apparatus from performing its normal functions during watch hours ;

**4.** That before any type of automatic alarm equipment for transmission and reception on the calling and distress frequency of 2182 kc/s is approved for use on ships, the administrations having jurisdiction over those ships should be satisfied by practical tests, made under operating conditions equivalent to those obtaining in practice, that the equipment complies with the provisions of § 1,2 and 3 of this Recommendation.

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## RECOMMENDATION No. 126 *

## PULSE TRANSMISSION FOR RADIO DIRECTION FINDING

(Question No. 61)

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

CONSIDERING :

*(a)* That certain studies, extending over many years, of the errors of direction finders show that, under ideal conditions of site, equipment and operation, the use of pulse transmissions offers only a slight improvement in accuracy over the use of continuous wave transmissions ;

*(b)* That, in practice, unavoidable departures from the ideal conditions referred to in *(a)* would tend to reduce this improvement in accuracy ;

*(c)* That, for reasons of interference, their wide bandwidths make the use of pulse transmissions on frequencies below 20 000 kc/s generally undesirable ;

RECOMMENDS :

**1.** That the foregoing considerations should be brought to the notice of the administrations and other organisations concerned.

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* This Recommendation completes the study of Question No. 61.

## ANNEX

The following errors in high-frequency direction finding can occur :

1. Observational errors introduced by the operator ;
2. Instrumental errors, including polarization errors and those due to deficiencies of the direction-finder site ;
3. Errors due to radiation scattered from topographical features many wavelengths distant from the direction finder ;
4. Errors due to lateral deviation in the ionosphere ;
5. Errors due to wave interference caused by convergence of rays and by different modes of propagation.

The advantage of a pulse emission over a continuous-wave emission lies in its ability to allow signals arriving over different paths to be separated, and so to reduce errors arising from sources 4. and 5. above.

The degree of accuracy to be expected from the use of pulse emissions for radio direction finding has been studied, and it is estimated that, in most favourable circumstances, for a frequency of about 8000 kc/s, the standard deviation of a single rapidly observed bearing might be about 3 degrees for a continuous-wave emission and about 2 degrees for a pulse emission. The corresponding figures for the mean of ten such bearings taken in a period of five minutes are : continuous-wave 2.5 degrees, pulse 1.7 degrees.

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## RECOMMENDATION No. 127 *

## STANDARDISATION OF PHOTOTELEGRAPH APPARATUS FOR USE ON COMBINED RADIO AND METALLIC CIRCUITS

(Question No. 58)

The C.C.I.R., (Stockholm, 1948 — London, 1953)

CONSIDERING :

*(a)* That in order to facilitate interworking it is desirable to standardise the characteristics of apparatus employed for photo-telegraph transmission over long distance HF (decametric) circuits ;

*(b)* That it is desirable to standardise certain characteristics of the apparatus in such a way as to make it equally suitable for transmission over metallic circuits ;

*(c)* That the transmission system using direct amplitude modulation is generally unsatisfactory over H.F. radio circuits because of the intolerable fading ratio usually encountered ;

*(d)* That the time modulation system gives insufficiently good definition ;

*(e)* That the system of direct frequency modulation of the radio frequency carrier is not yet widely adopted for the transmission of half-tone pictures owing to the high stability necessary in the frequencies representing the picture tones ;

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* The present Recommendation, in conjunction with Resolution No. 15 and Question No. 95 (IX) completes the study of Question No. 58.

*(f)* That the system of sub-carrier frequency modulation (i.e. in which a sub-carrier is frequency modulated and the resultant is used to modulate in amplitude a radio frequency carrier) has proved satisfactory but requires standardisation in respect of the sub-carrier and deviation frequencies, taking into account the values of picture modulation frequencies to be transmitted ;

*(g)* That, taking into account the degree of tolerable distortion, the effect of multipath echoes on long distance HF (decametric) radio circuits normally limits the maximum admissible picture modulation frequency to approximately 600 c/s ;

*(h)* That a Joint Study Group of the C.C.I.T. and the C.C.I.R., under the direction of the C.C.I.T., has been formed to study certain aspects of the subject of " Transmission of half-tone pictures over combined radio and metallic circuits " and, having met at the C.C.I.T. VIIth Plenary Assembly, Arnhem 1953, issued draft Recommendation No. D.4 (C.C.I.T. Doc. No. AP VII/95 refers) which was approved by the C.C.I.T. VIIth Plenary Assembly.

*(i)* That the C.C.I.F. has undertaken the study of the effects of land-line characteristics on the transmission of sub-carrier frequency modulation phototelegraph signals (see C.C.I.F. Question No. 12) ;

UNANIMOUSLY RECOMMENDS :

That in respect of transmission of half-tone pictures over combined radio and metallic circuits :

**1.** Over the radio path, the sub-carrier frequency modulation system should be used with the following characteristics :

*(a)* Sub-carrier frequency . . . . . 1900 c/s
White frequency . . . . . . . 1500 c/s (the 1500 c/s frequency is also used for the phasing frequency)
Black frequency . . . . . . . 2300 c/s

*(b)* Stability of frequencies such that the variations are less than :
Instantaneous . . . . . . . . . 8 c/s
During 15 minutes . . . . . . 16 c/s

**2.** For the present, the following alternative characteristics should be used :

| | | |
|---|---|---|
| Index of co-operation . . . . . . . | 352 | 264 |
| Speed of rotation of drum in r.p.m. | 60 | 90 45 (lower speed for use when radio propagation conditions demand it) |

**3.** Amplitude modulation shall be the normal method for the transmission of pictures over international metallic telephone circuits, and where metallic and radio paths are combined in a picture circuit the translation from amplitude to sub-carrier frequency modulation shall be carried out at the junction of the radio and metallic paths ;

**4.** Notwithstanding what is stated in § 3 above, it shall be allowable in special cases, and particularly where the service is permanently point-to-point and the line conditions permit, to employ the system of sub-carrier frequency modulation throughout the circuit ;

**5.** For the present it is desirable when using sub-carrier frequency modulation to use a frequency deviation which is a linear function of the brightness of the picture element transmitted ; moreover, at a point of conversion (from amplitude modulation to frequency modulation or vice versa) the converters should be given linear characteristics ;

6. That the C.C.I.T. recommendations concerning scanning helix, drum dimensions, stability of speed of rotation of the drum, and equalisation of drum speeds of the transmitter and receiver, contained in C.C.I.T. Recommendation No. D.1, should be employed.

*Note.* — The question of the minimum drum length eventually to be recommended is under study by the C.C.I.T. (see C.C.I.T. Question No. 48).

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## RECOMMENDATION No. 128

## WIDE-BAND RADIO SYSTEMS OPERATING IN THE VHF (METRIC), UHF (DECIMETRIC) AND SHF (CENTIMETRIC) BANDS

### Sub-control Stations

(Study Programme No. 28)

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

CONSIDERING :

*(a)* That it is normal practice in multi-channel telephony to divide high frequency cable systems for maintenance, supervision and monitoring purposes into line-regulated sections ;

*(b)* That the length of such sections (which may include several relays or repeaters) varies with circumstances but is generally of the order of 100 miles (160 km) ;

*(c)* That supervisory, control and pilot signals are extracted and reinserted at the end of such sections in stations called sub-control stations ;

UNANIMOUSLY RECOMMENDS :

That in all cases where there is a junction between a wide-band multi-channel telephony cable system and a radio system, and where each system contains at least one intermediate repeater station, this junction should be made a sub-control station (i.e. the junction of two regulated sections), not necessarily attended.

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## RECOMMENDATION No. 129

## METHODS OF SPECIFYING THE POWER SUPPLIED TO AN ANTENNA BY A RADIO TRANSMITTER

(Question No. 60)

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

CONSIDERING :

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

*(b)* That in some cases the power of the unmodulated carrier may be a preferable method of rating the power of a transmitter with regard to monitoring and interference producing capabilities ;

*(c)* That, although the two alternatives provided in the Radio Regulations may not always be adequate for all the uses made of transmitter power ratings, there is no satisfactory alternative form of specification immediately available ;

*(d)* That there is no good reason for not specifying the power of a radio transmitter in a number of ways simultaneously, as long as each way can be shown to be necessary ;

UNANIMOUSLY RECOMMENDS :

1. That, for the time being the provisions of the Radio Regulations, Atlantic City, 1947, Art. 1, Section IV, Nos. 60-64 need not be altered ;

2. That other methods of specifying and measuring the power of radio transmitters should be included when this is justified.

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## RECOMMENDATION No. 130 *

## POWER RELATIONSHIPS FOR MODULATED EMISSIONS

(Question No. 59)

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

CONSIDERING :

*(a)* That the modulated signals likely to be used for field strength measurements can be divided into two classes :

Class 1 : where the radiated power is wholly or largely independent of the degree of modulation ;

Class 2 : where the radiated power is largely dependent on the degree of modulation.

*(b)* That for modulation by speech, music or conversation, or by certain other forms of intelligence, the power relationships of the modulating signal are variable ;

UNANIMOUSLY RECOMMENDS :

1. That for signals of Class 1 it should suffice, for most field strength measurements, to specify the unmodulated carrier power ;

2. That for signals of Class 2, when it is necessary to make field strength measurements of high precision, it appears desirable for the two terminals to co-operate, either by recording the transmitter output power with an instrument having similar characteristics to those of the field strength recorder or by the transmission of special signals.

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* This Recommandation completes the study of Question No. 59.

## RECOMMENDATION No. 131

### INTERFERENCE TO RADIO SERVICES *

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

CONSIDERING :

*(a)* That the study of certain aspects of interference, affecting sound and television broadcasting, especially from industrial sources, is already entrusted to the Special International Committee of Radio Interference (C.I.S.P.R.) administered by the International Electrotechnical Commission (I.E.C.) ;

*(b)* That the C.C.I.R. in accordance with Recommendation No. 27 of the Vth Plenary Assembly (Stockholm, 1948) maintains regular contact with the C.I.S.P.R. ;

*(c)* That the harmonious co-existence of radio services with industrial installations producing radio oscillations involves close collaboration between organisations representing the manufacturers and users of these installations on the one hand, and the radio services on the other, for which the existing collaboration between the C.C.I.R. and the C.I.S.P.R. provides ;

*(d)* That the C.I.S.P.R. has already studied and is continuing to study extensively the permissible signal/interference ratios for sound and television broadcasting, but has not yet made equivalent studies for other radio services ;

RECOMMENDS :

**1.** That the existing collaboration between the C.C.I.R. and the C.I.S.P.R. should be actively maintained and extended ;

**2.** That in the course of such collaboration the C.C.I.R. should bring to the notice of the C.I.S.P.R. those aspects of the work that are of the greatest urgency, so far as the C.C.I.R. is concerned, so that the results of their work can be used in future by the C.C.I.R. ;

**3.** That the study of interference to radio services, required by Resolution No. 5 annexed to the International Telecommunication Convention, Buenos Aires, 1952, should be carried out by the C.C.I.R.'s continuing to study the maximum interference levels (including radiations from industrial scientific and medical equipment) tolerable in various radio systems, while avoiding duplication of the work already in progress in the C.I.S.P.R., and that the C.C.I.R. should transmit its findings to the C.I.S.P.R. to facilitate the latter's study of radio interference problems ;

**4.** That the C.C.I.R. should continue to take cognisance of those aspects of this work which relate specifically to the study and establishment of conditions necessary to ensure the avoidance of harmful interference between services whose operation is covered by the Radio Regulations.

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## RECOMMENDATION No. 132

### IDENTIFICATION OF RADIO STATIONS

(Question No. 17)

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

CONSIDERING :

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

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* See Buenos Aires Resolution No. 5.

(b) That in many types of radio systems the identification procedure used at present is satisfactory to both the operating agencies and the regulating administrations, as is the case for single channel low speed telegraphy ;

(c) That the Atlantic City Radio Regulations (Art. 13, Section V, § 10) set forth requirements for transmissions of radio call signs, and state that each radio station provided with a call sign from the international series must, unless the Atlantic City Radio Regulations provide otherwise, transmit this call sign during the course of their transmission as frequently as is practicable and reasonable ;

(d) That certain types of radio stations are exempted from the necessity of having an international call sign, for example, stations which are easily identified by other means and whose signals of identification, or characteristics of emission, are published in international documents ;

(e) That a satisfactory method for identifying multi-channel single-sideband transmissions has been evolved ;

(f) That the problem of accomplishing identification of multi-channel telephone and telegraph transmission, except for single-sideband systems, is particularly difficult without the use of costly special apparatus ;

(g) That the requirement of frequently transmitting a call sign may impose a difficult and costly hardship on the operating agencies, particularly where heavily loaded multi-channel or high speed machine operation is employed ;

(h) That, when a special call signal is transmitted simultaneously with traffic, it is desirable, for ease of identification, to transmit a signal preceding the call sign to indicate that the call sign which follows is superimposed on another emission ;

RECOMMENDS :

**1**.1 That each radio station required to have an identifying signal under the provisions of the Atlantic City Radio Regulations, Art. 19, should send its call sign at the beginning and the end of a transmission, and as often as practicable and reasonable during such transmissions ;

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

1.3 That, when a number of stations work simultaneously in a common circuit, either as relay stations, or in parallel on different frequencies, each station shall as far as is practicable and reasonable, transmit its own call sign ; alternatively, each station should transmit the call signs of all stations working as a group on a common circuit ;

**2.** That for the purpose of identification one of the following special call signal emissions should be used :

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

2.2 A call signal emission employing Five-Unit Code (International Telegraph Alphabet No. 2) using class A1, A2 or F1 emission, at a speed appropriate to single channel working and preferably at the standardised speed of 50 bauds ;

2.3 A call signal emission employing speech in clear ;

**3.** That the identification signal should be transmitted by one of the following methods :

3.1 For class F1 emissions, particularly for high speed or multi-channel working, the superposition of the call sign in Morse Code by amplitude keying ;

3.2 For single-sideband emissions, by amplitude keying of the reduced carrier or of some other pilot frequency ;

3.3 For facsimile transmission employing class A4 emissions, by Morse during the intervals of traffic, or alternatively, simultaneously with traffic, by amplitude modulation at a frequency below the lowest used for the facsimile modulation. Where single sideband transmission is used, amplitude keying as in 3.2 above may be used ;

3.4 For the transmission of a special call signal emission simultaneously with traffic, as covered in 3.1, 3.2 and 3.3 above or in other ways, the signal sent to indicate that the call signal that follows is superimposed on another transmission, should be sent in the same manner as the call signal, and the letters QTT should be used and incorporated in the International Q-Code (Radio Regulations Atlantic City 1947, App. 9) for this purpose ;

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

**5.** That, if the call signal cannot be transmitted frequently or continuously, it would facilitate the work of monitoring stations if the call signal were transmitted in the period from 10 minutes before, to 10 minutes after, the hour (G.M.T.) ;

**6.** That administrations be invited to specify the telephone and telegraph systems in which the frequent transmission of call signals for identification purposes constitutes a problem.

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## RECOMMENDATION No. 133 *

## STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Questions Nos. 42 and 63)

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

RECOMMENDS :

That the international exchange of recorded sound programmes between broadcasting organizations should be by means of lateral cut recording on disc and single track magnetic recording on tape, conforming to the technical standards given in

Recommendation No. 134 for disc

Recommendation No. 135 for tape.

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* The present Recommendation, in conjunction with Recommendations Nos. 134 and 135, replaces Recommendations Nos. 81 and 86.

# RECOMMENDATION No. 134 *

## STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

### Lateral Cut Recording on Discs

(Questions Nos. 42 and 63 — Recommendation No. 133)

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

RECOMMENDS :

That lateral cut recording on disc should be in accordance with the following technical standards :

1. *Type of Groove:*

   *(a)* Coarse Groove
   - Minimum Top Width : 0.004″ (0.1 mm),
   - Maximum Bottom Radius : 0.0015″ (0.038 mm),
   - Included Angle : 80° to 90° ;

   *(b)* Fine Groove
   - Minimum Top Width : 0.002″ (0.05 mm),
   - Maximum Bottom Radius : 0.0003″ (0.0076 mm),
   - Included Angle : 80° to 90°.

2. *Speed of Rotation:*

   $33^1/_3$ r.p.m. ± 0.5%,
   78 r.p.m. ± 0.7%.

3. *Direction of Rotation:*

   Clockwise.

4. *Direction of Cut:*

   Outside to inside.

5. *Type of Disc:*

   Lacquer coated or processed.

6. *Maximum Diameter of Disc:*
   - for $33^1/_3$ r.p.m. $16^1/_{16}$″ (408 mm),
   - for 78 r.p.m. $12^1/_{32}$″ (306 mm).

7. *Centre Hole Diameter:*

   $$0.285'' \begin{cases} +0.002'' \\ -0'' \end{cases} \left( 7.24\ \text{mm} \begin{cases} +0.05\ \text{mm} \\ -0\ \text{mm} \end{cases} \right)$$

8. *Minimum Diameter of Recorded Surface:*
   - for $33^1/_3$ r.p.m. Coarse Groove : $7^1/_2$″ (190 mm),
     Fine Groove : $4^3/_4$″ (120 mm),
   - for 78 r.p.m. $3^3/_4$″ ( 95 mm).

* This Recommendation, in conjunction with Recommendations Nos. 133 and 135, replaces Recommendations Nos. 81 and 86.

9. *Number of Plain Grooves:*

At Start : Minimum 2, Maximum 4,
At Finish : Minimum 2, Maximum 4.

10. *Minimum Information to be Stated on Label:*

— Broadcasting Organisation,
— Programme Title,
— Side Number,
— Total Number of Sides,
— Reference Number,
— Total Playing Time of Programme,
— Speed of Rotation in r.p.m.,
— Type of Groove.

(The last two items should be marked as prominently as possible.)

11. *Recording Characteristic:*

*(a)* Nominal Characteristic

With constant voltage applied to the input of the recording chain, the curve of recorded velocity * v. frequency should be that which results from the superposition of the two following curves :

— one rising with frequency in conformity with the admittance of a series combination of a capacity and a resistance having a time constant of 450 microseconds,
— the other rising with frequency in conformity with the admittance of a parallel combination of a capacitance and a resistance having a time constant of 50 microseconds.

This curve is shown in the attached figure and is defined by :

$$N\ (db) = 10 \log (1 + 4\pi^2 f^2 t_1^2) - 10 \log (1 + \frac{1}{4\pi^2 f^2 t_2^2})$$

where : $f$ = frequency in c/s,
$t_1 = 50 \times 10^{-6}$ seconds,
$t_2 = 450 \times 10^{-6}$ seconds.

*Note.* — This paragraph defines the relative velocities to be recorded on a disc ; but to ensure that the proper response is obtained on reproduction it is necessary to use a pickup with a suitable stylus and with working pressures low enough to avoid any appreciable deformation of the disc material.

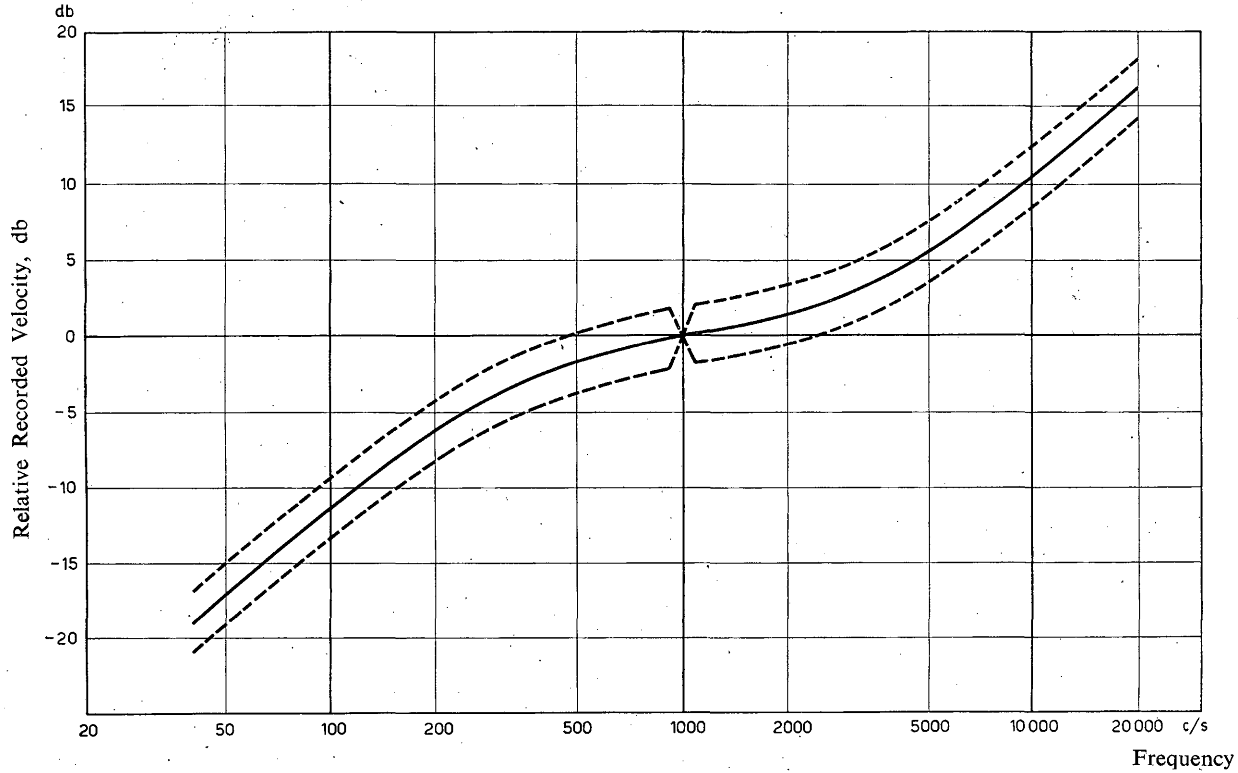
*(b)* Tolerance

Discs for international interchange of programmes should be recorded within $\pm 2$ db of the Nominal Characteristic, taking as reference point the value at 1000 c/s.

Any variation, for example that which results from the application of radius compensation, should be within the stated tolerance.

*Note on use of recording characteristic.* — Within the U.S.A. a different characteristic will be used for the interchange of programmes between broadcasting organisations but the C.C.I.R. characteristic will be used by the broadcasting of the U.S.A. for international exchange.

* The recorded velocity is defined as that determined by the Buchmann-Meyer Light Band Method.




C.C.I.R. Nominal Recording Characteristic for lateral cut discs and the tolerance within which discs should be recorded

# RECOMMENDATION No. 135 *

## STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

### Single track recording on magnetic tape

(Questions Nos. 42 and 63 — Recommendation No. 133)

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

RECOMMENDS :

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

1. *Speed of Tape*

| | | |
|---|---|---|
| Primary speed : | 15 inches/s ± 0.5% | (38.1 cm/s ± 0.5%) ; |
| Secondary speeds ** : | 30 inches/s ± 0.5% | (76.2 cm/s ± 0.5%), |
| | $7^1/_2$ inches/s ± 0.5% | (19.05 cm/s ± 0.5%). |

2. *Width of Tape:*

$$0.250 \text{ inches} \begin{cases} +0 \\ -0.006 \text{ inches} \end{cases} \quad \left(6.35 \text{ mm} \begin{cases} +0 \\ -0.15 \text{ mm} \end{cases}\right)$$

3. *Strength of Tape:*

The tape should be suitable for use on a machine exerting a maximum (transient) stress of 2.2 pounds (1 kg).

4. *Direction of Winding:*

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

5. *Tape Spools:*

Two types of hub are accepted for international programme exchange :

Fig. 1 gives the principal dimensions of the type more generally used in Europe ;
Fig. 2 gives the dimensions of the hub more generally used in the U.S.A. ;
Fig. 3 gives the dimensions of the flange used with the hub of Fig. 2 ;
Fig. 4 gives the main dimensions of a typical machine fitting to receive the hub of Fig. 1 ;
Fig. 5 shows the main dimensions of a typical adaptor to enable the European type of machine fitting to receive the hub of Fig. 2.

6. *Maximum Outside Diameter of the Reel of Tape:*

For hub of Fig. 1 : 11.4 inches (290 mm),
For hub of Fig. 2 : 10.5 inches (267 mm).

* In conjunction with Recommendations Nos. 133 and 134, this Recommendation replaces Recommendations Nos. 81 and 86.

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

7. *Tape Leader:*

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

*Note.* — It is desirable, wherever possible, that the non-recorded side of a tape should be identified by some form of marking continuous throughout the length of the tape.

8. *Programme Identification:*

A label giving the following information should accompany each reel :

— Broadcasting Organisation,
— 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 :

*(a)* Nominal Characteristic

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

For tape speeds of 15 in/s (38.1 cm/s) and 30 in/s (76.2 cm/s), the specified frequency response curve falls with increasing frequency in conformity with the impedance of a series combination of a capacitance and a resistance having a time constant of 35 μs. This curve is shown in Figure 6 ;

For a tape speed of 7½ in/s (19.05 cm/s) the specified frequency response curve falls with increasing frequency in conformity with the impedance of a series combination of a capacitance and a resistance having a time constant of 100 μs. This curve is shown in Figure 7.

*(b)* Tolerances

Tapes for international programme interchange should be recorded so that, when reproduced on a Standard Replay Chain the response falls between upper and lower limits defined as follows for tape speeds of 15 in/s (38.1 cm/s) and 30 in/s (76.2 cm/s) :

Upper Limit

| | | | | | | |
|---|---|---|---|---|---|---|
| — from | 50 | c/s to | 100 | c/s | Falling regularly by 1 db, |
| — from | 100 | c/s to | 5 000 | c/s | Flat, |
| — from | 5 000 | c/s to | 10 000 | c/s | Rising regularly by 1 db, |
| — from | 10 000 | c/s to | 15 000 | c/s | Flat ; |

Lower Limit

| | | | | | |
|---|---|---|---|---|---|
| — from | 50 | c/s to | 100 | c/s | Rising regularly by 3 db, |
| — from | 100 | c/s to | 7 500 | c/s | Flat, |
| — from | 7 500 | c/s to | 15 000 | c/s | Falling regularly by 3 db ; |

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

For a tape speed of 7½ in/s (19.05 cm/s), the response should fall within limits defined as follows :

Upper Limit

— from 50 c/s to 10 000 c/s Flat ;

Lower Limit

— from 50 c/s to 100 c/s Rising regularly by 3 db,
— from 100 c/s to 5 000 c/s Flat
— from 5 000 c/s to 10 000 c/s Falling regularly by 3 db ;

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

*Notes :*

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.

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

*Note on Use of Reproducing Characteristics :*

A different Standard Replay Chain has been adopted in the U.S.A. for 15 in/s (38.1 cm/s). The difference between the nominal characteristics of the Standard Replay Chain of the U.S.A. and that of the C.C.I.R. is less than the tolerance in § 9.

Furthermore a different characteristic is used in France for 30 in/s (76.2 cm/s).

## ANNEX

*Methods of measuring the magnetisation of a tape.*

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

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

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

2. By means of a magnetic reproducing device, which necessarily affects the surface induction of the tape in a manner dependent on recorded wavelength. In this category there are two ways in which conventional magnetic heads have been used, one method involving heads with a short gap, the other involving heads with a long gap. In both cases the gap in the reproducing head must be sufficiently accurate, magnetically, to give well-defined minima of reproduced level, one in the short gap method or several in the long gap method. In order to ensure that the same results will be obtained with both magnetic and non-magnetic reproducing devices, a coated high coercivity tape must be used.

*(a) The "Short Gap" Method:*

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

$$\frac{\sin \frac{\pi d}{\lambda}}{\frac{\pi d}{\lambda}}$$

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

*(b) The " Long Gap " Method:*

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

A curve through the successive maxima is a measure of the relative surface induction on the tape, when the necessary correction for the eddy current losses of the head has been made. This curve rises approximately 2 db/octave * compared with the curve of surface induction/frequency in air as determined by a non-magnetic reproducing device, or by a " short gap " head. This correction must therefore be applied.

The precise steps by which the procedures of 2 *(a)* and *(b)* may be applied in practice are outlined in the following.

*Standardisation by the Short Gap Magnetic Head.*

Using the Short Gap Method a recording equipment is set to the standard condition in the following way :

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

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* *Note by the Director, C.C.I.R.* — The wording of this paragraph is as approved during the VIIth Plenary Assembly of the C.C.I.R. As this volume goes to press the attention of the Director has been drawn by the Chairman and some members of Study Group No. X to an error which results from an oversight :

for : " This curve rises approximately 2 db/octave ",

read : " This curve falls approximately 4 db/octave ".

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

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

3. The frequency response of the reproducing chain is now adjusted to be that specified in § 9 *(a)* of this Recommendation together with the gap correction noted in 1. above and the compensation for frequency dependent losses noted in 2. above.

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

*Standardisation by the Long Gap Magnetic Head.*

Using the Long Gap Method a recording equipment is set to the standard condition in the following way :

1. The reproducing head used has a well-defined gap long enough to give successive maxima of response at intervals of 1 kc/s, or less, in the audio frequency range (with a tape speed of 30 in/sec (76.2 cms/sec) the gap length required would be about 800 microns). If the successive minima in the response curve are not equally well defined the head is not suitable for this measurement. A short preliminary experiment is carried out to determine the exact frequencies at which successive maxima occur at the relevant tape speed.

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

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

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

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

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

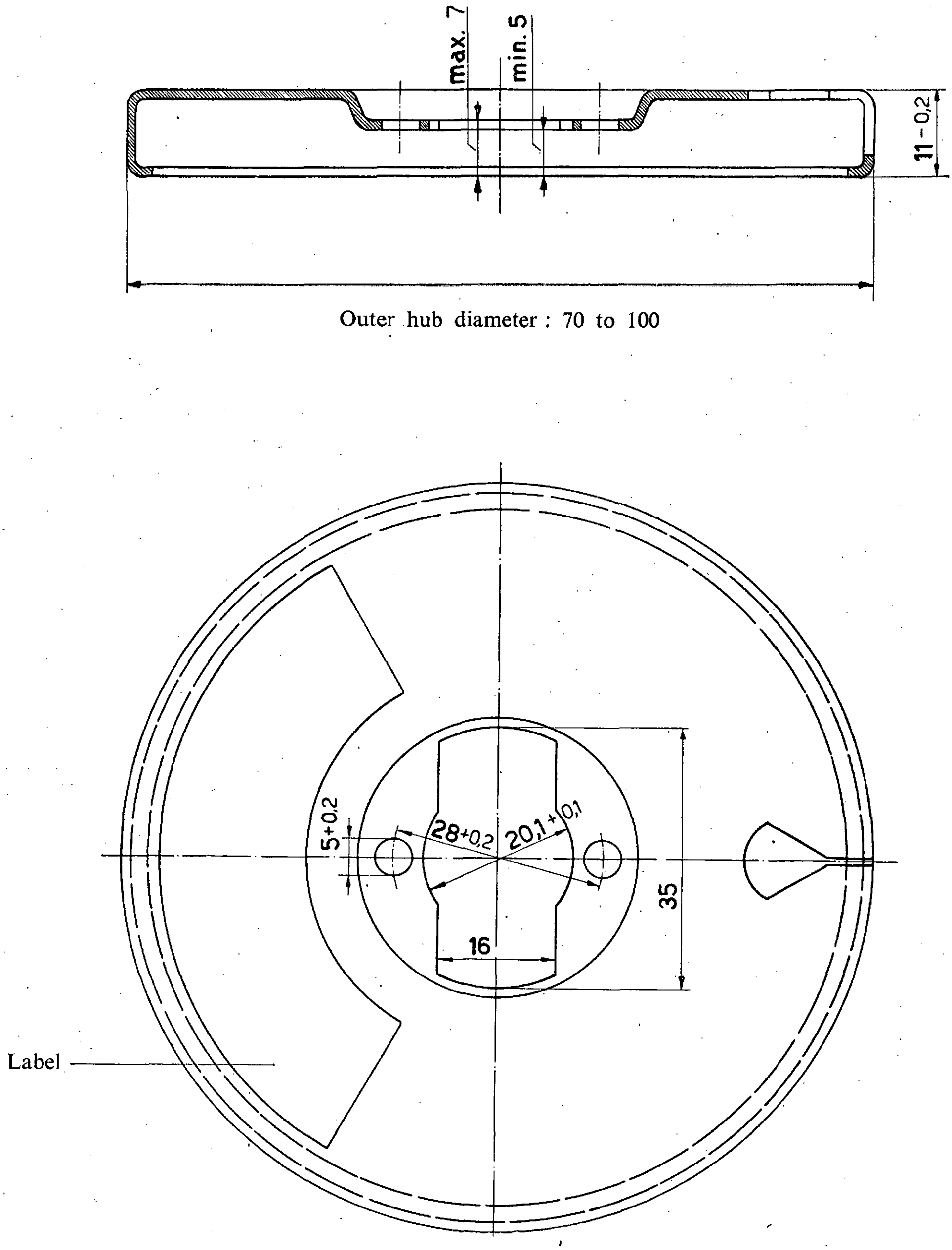
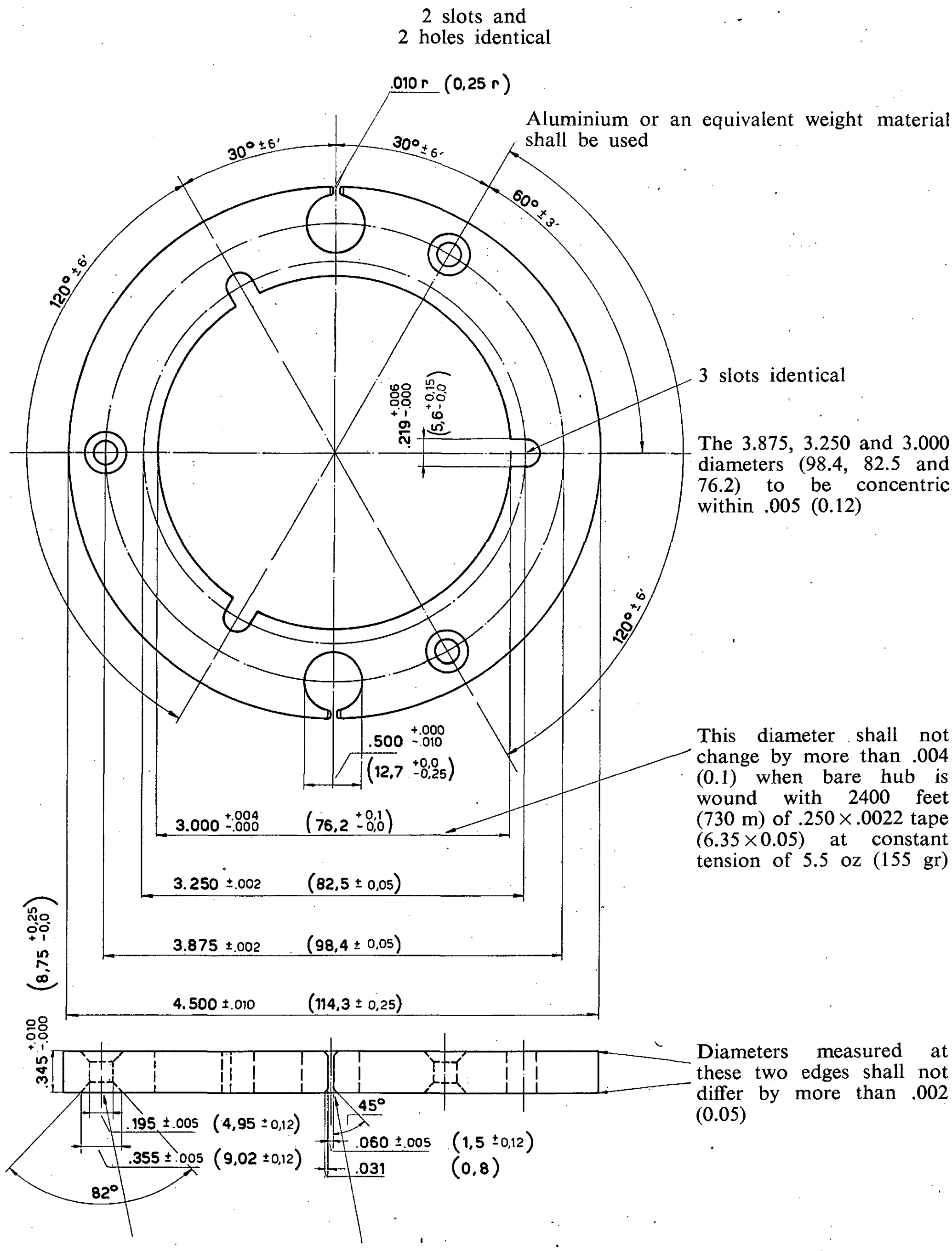



FIGURE 1

EUROPEAN STANDARDS

*Spool hub for magnetic tape recording*

*Note.* — The dimensions indicated are given in millimetres




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

FIGURE 2

U.S.A. STANDARDS

*Hub for magnetic tape reel*

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

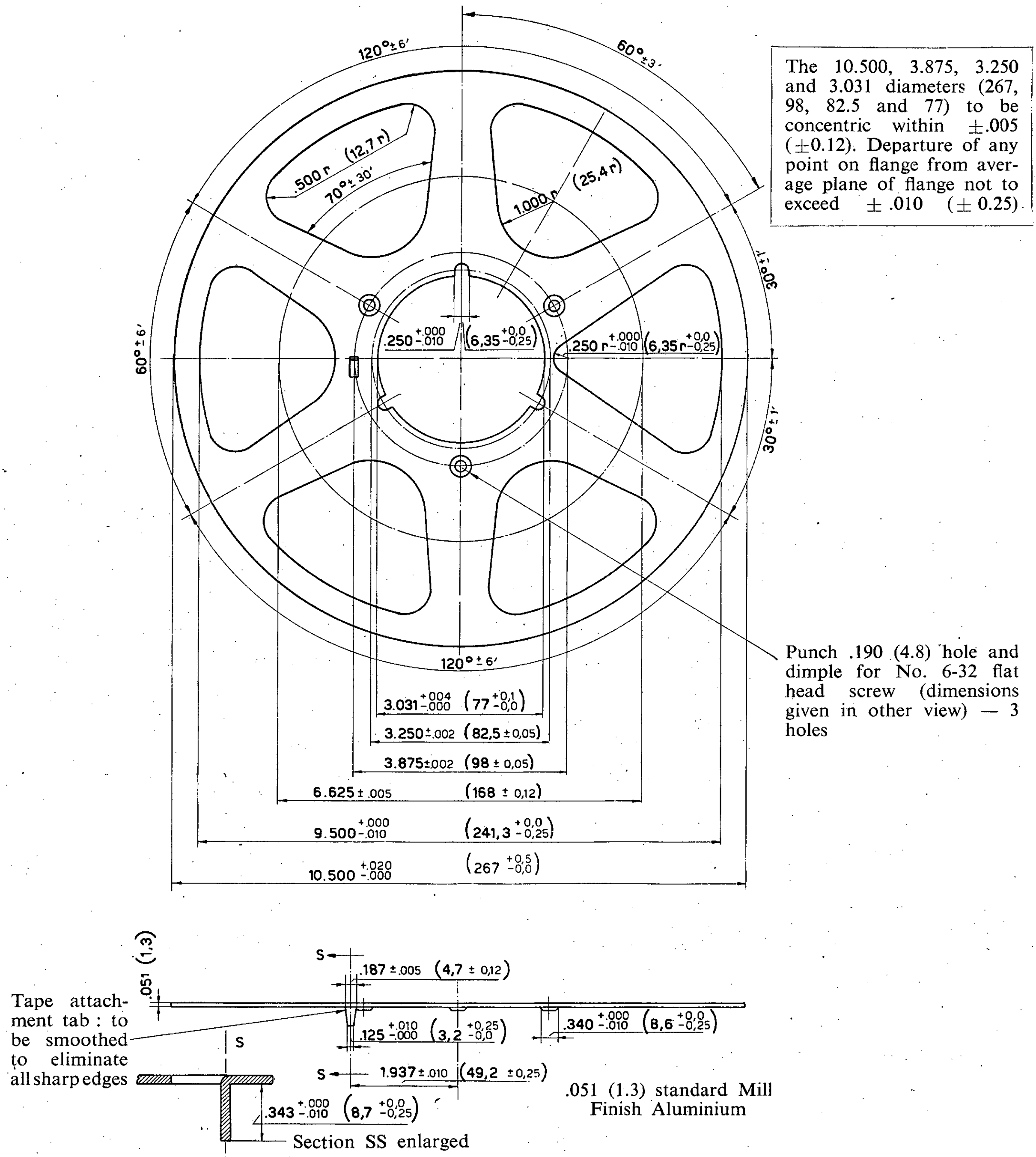



FIGURE 3

U.S.A. STANDARDS

*Flange for magnetic tape reel*

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

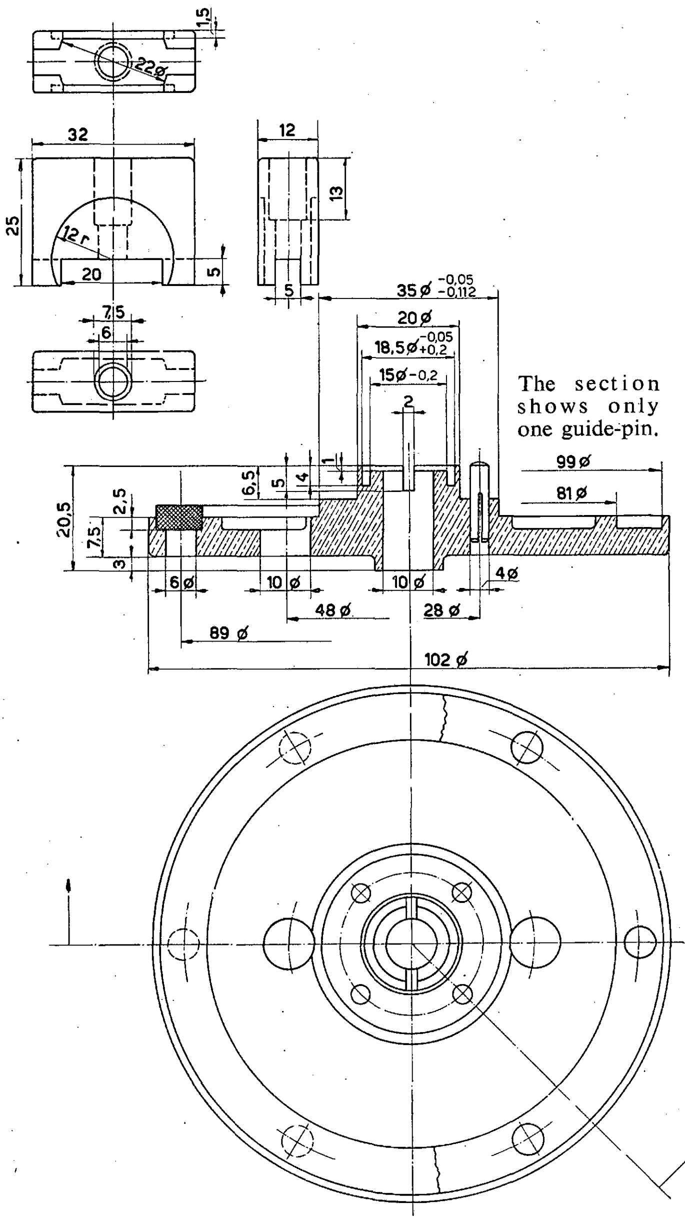



FIGURE 4

EUROPEAN STANDARDS

*Typical machine fitting to receive hub of Fig. 1*

*Note.* — The dimensions indicated are given in millimetres.

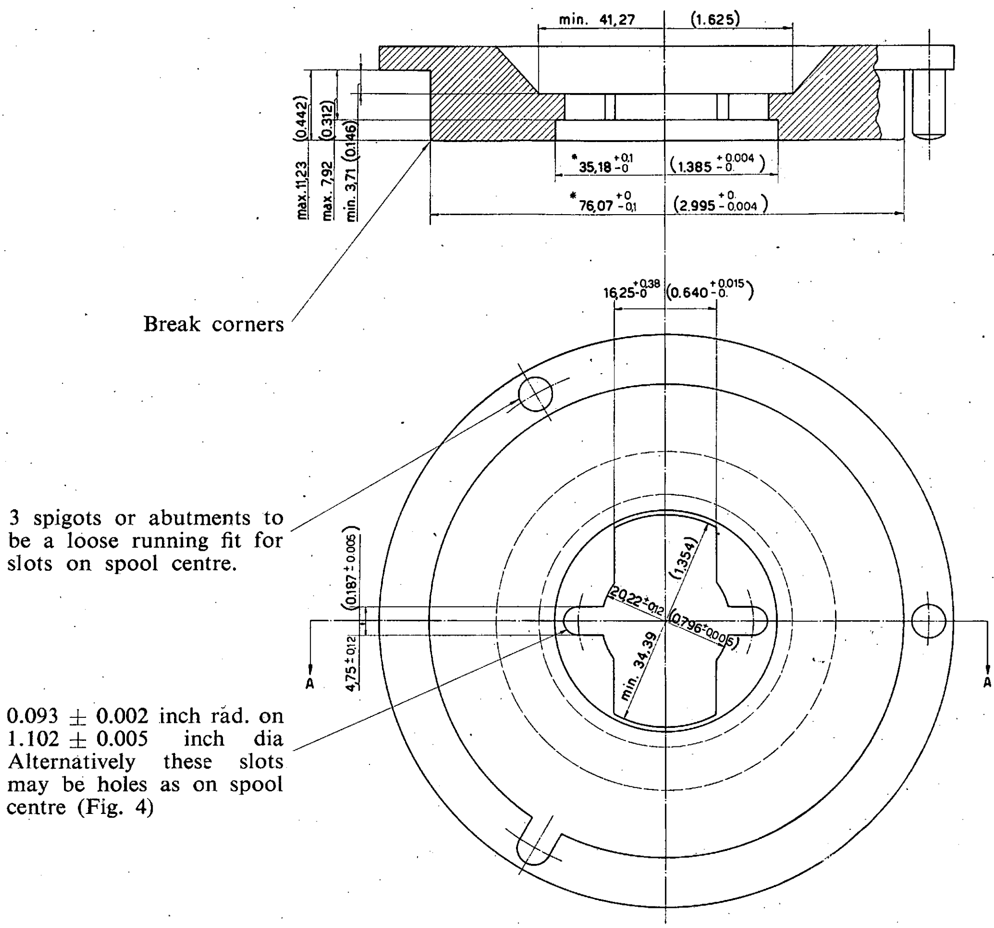



FIGURE 5

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

*Note.* — Diameters marked thus * to be concentric within 0.003″.

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

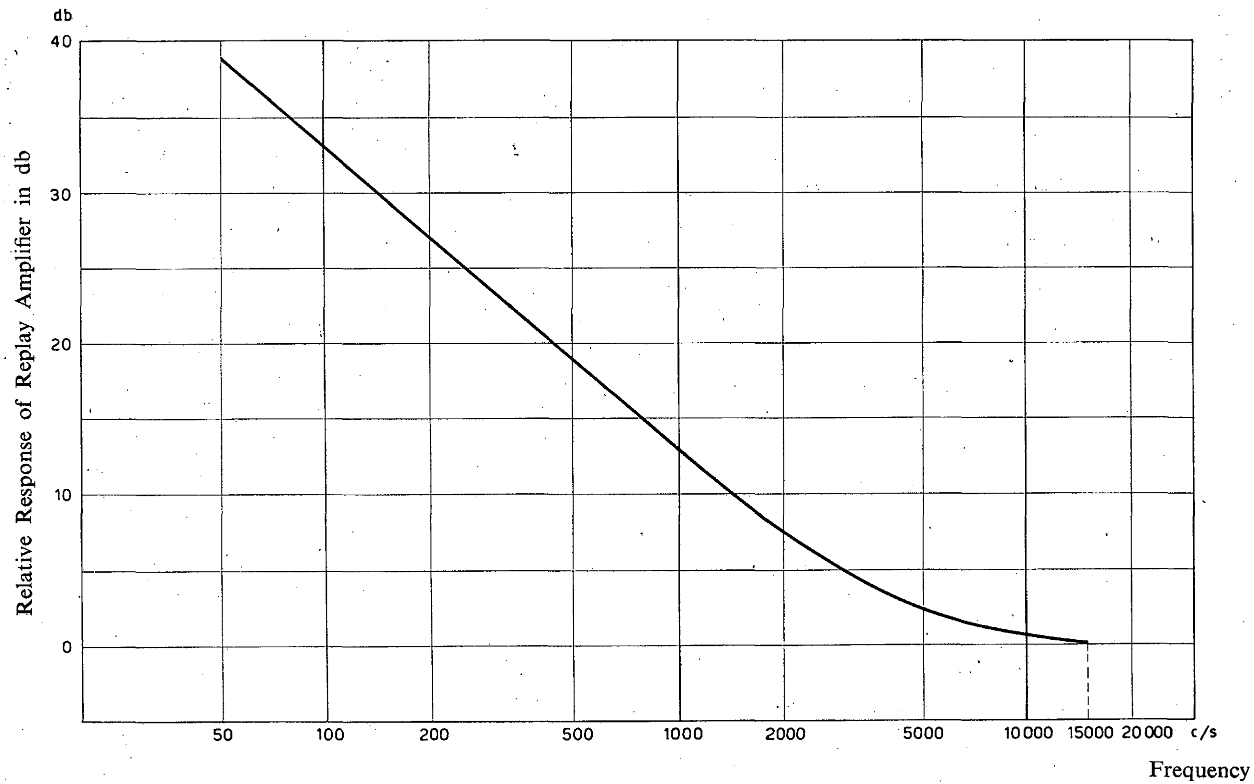



FIGURE 6

Nominal Reproducing Characteristic for Magnetic Tape at 15 in/s and 30 in/s

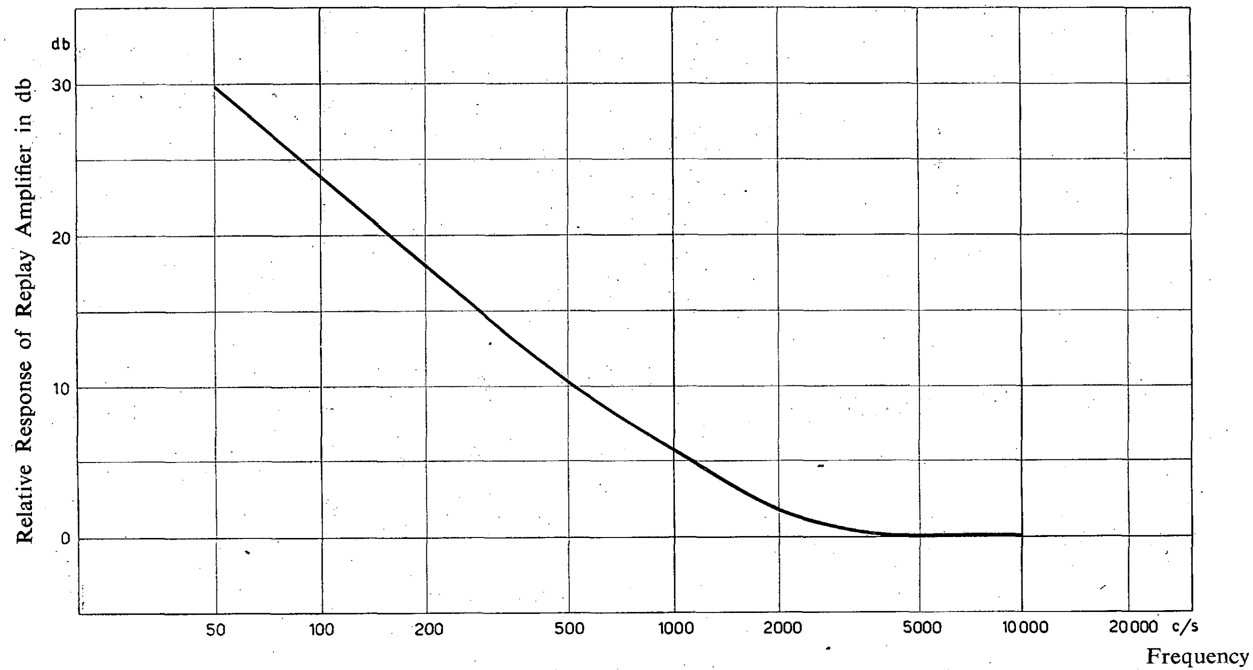



FIGURE 7

Nominal Reproducing Characteristic for Magnetic Tape at $7^1/_2$ in/s

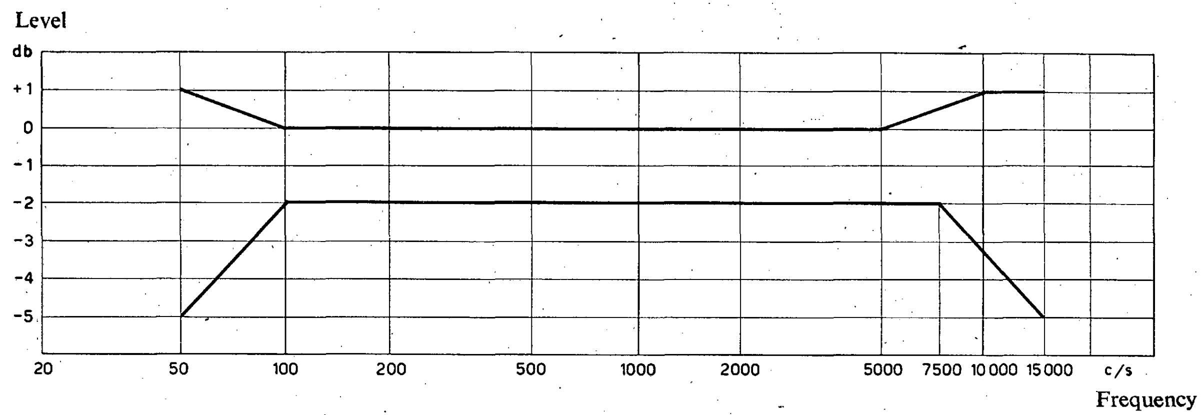



FIGURE 8

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

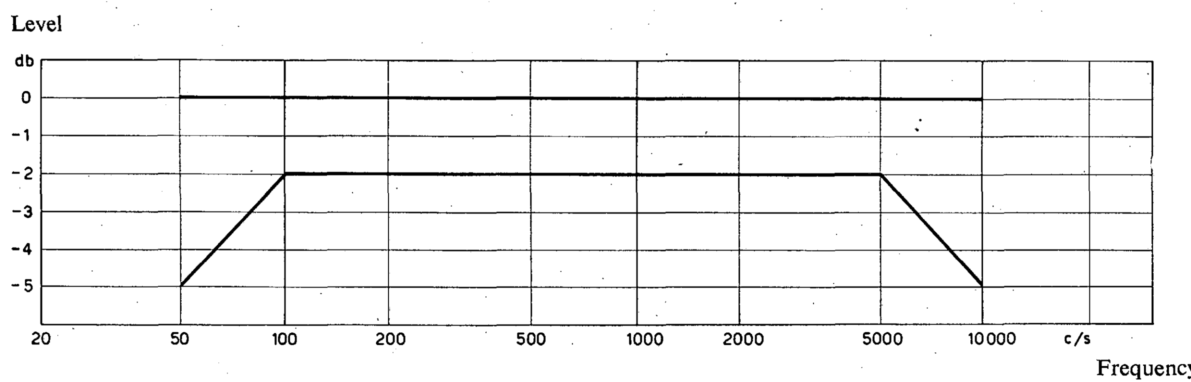



FIGURE 9

Recording tolerance for the speed of $7^1/_2$ in/s. Limits within which the response should lie when reproduction is carried out on the Standard Replay Chain.

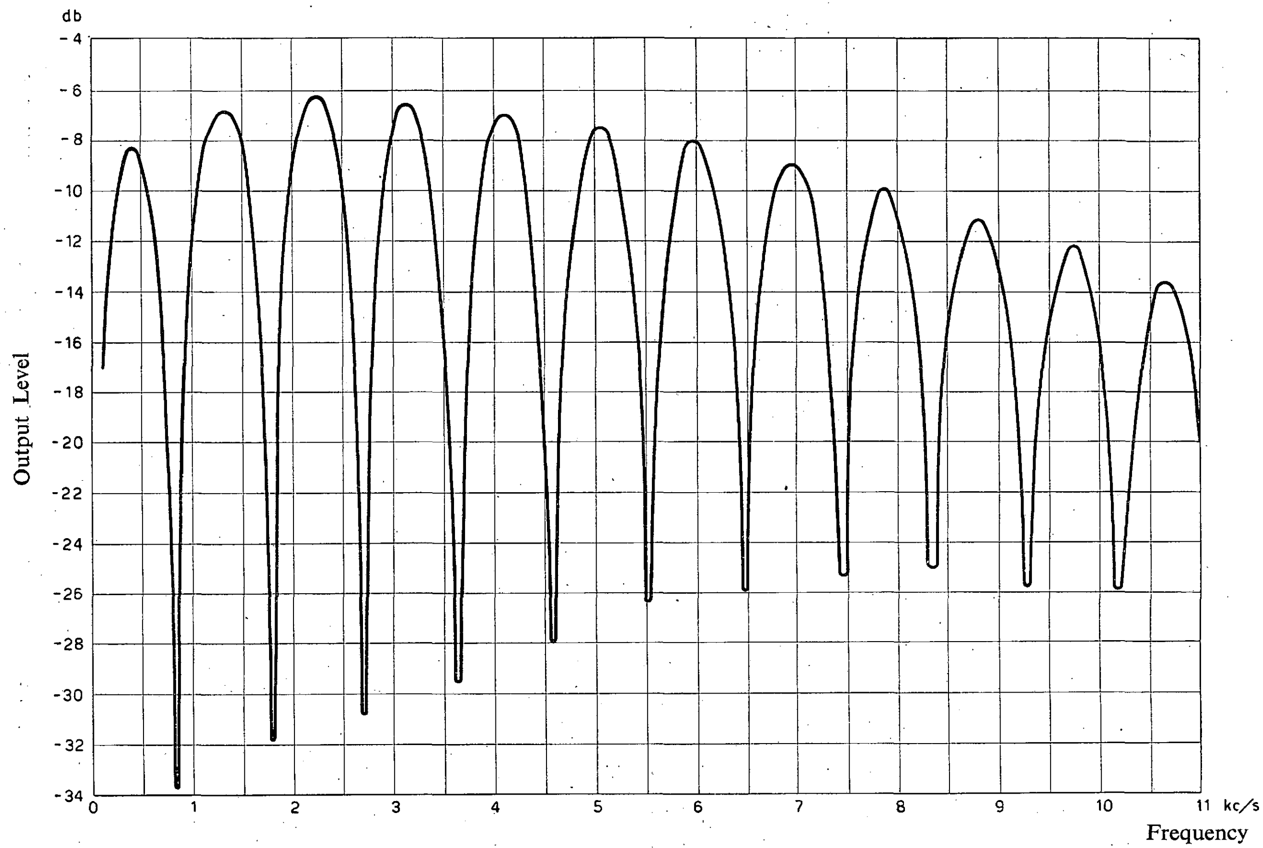



FIGURE 10

Typical Response curve of a "Long Gap" Reproducing head

## RECOMMENDATION No. 136

## SINGLE SIDEBAND SOUND BROADCASTING

(Question No. 62)

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

CONSIDERING :

*(a)* That the results of a series of laboratory experiments (see London Doc. No. 305) on the use of SSB or ASB transmissions for HF (decametric) broadcasting indicate that :

- with present types of HF (decametric) broadcast receivers no economy in the radio 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 ;
- 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 be accepted as a conclusive answer to Question No. 62.

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## RECOMMENDATION No. 137

## USE OF SYNCHRONIZED TRANSMITTERS IN HF BROADCASTING

(Study Programme No. 30)

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

UNANIMOUSLY RECOMMENDS :

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

- for non-overlapping service areas,
- for overlapping service areas at distances not more than about 1500 km.

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## RECOMMENDATION No. 138 *

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

(Question No. 4 **)

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

CONSIDERING :

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

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

*(c)* That, in the absence of sufficient information concerning noise values in various parts of the tropical zone, it is difficult to state a value of minimum field to which the minimum permissible protection ratio should be maintained ; however, this minimum field strength should provide satisfactory reception at the limit of the broadcast station service area as provided by Art. 9, No. 243, Radio Regulations, 1947 ;

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 : Mexico City 1948/49, Doc. No. 635, § 13) *** ;

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

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

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

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* This Recommendation replaces Recommendation No. 50.

** This Question has become Question No. 102 (XII).

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

**** Practical consideration of the frequency separation of adjacent channels requires the use of an audio frequency cut-off of 5 kc/s in the measurement in preference to 6.4 kc/s, appropriate corrections being applied, if considered necessary, to correspond to an audio frequency cut-off of 6.4 kc/s.

## RECOMMENDATION No. 139

# DESIGN OF TRANSMITTING AERIALS FOR TROPICAL BROADCASTING

(Question No. 70, § 1)

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

CONSIDERING :

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

*(b)* That the aerials should be economical in design and simple in operation ;

*(c)* That Report No. 36 gives the principles on which aerials for tropical broadcasting should be designed and constructed ;

*(d)* That it is desirable to obtain as much operational data as possible on tropical broadcasting using aerials designed on these principles ;

RECOMMENDS :

**1.** That administrations and organisations operating tropical broadcasting services should use aerial systems so designed that :

— the power radiated is as large as possible at 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 organisations should forward to the C.C.I.R. reports on the operation of such aerials so that an addendum can be issued to Report No. 36 giving practical operational data concerning these aerials. The data and information should be forwarded in the following form :

— type of aerial 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 aerial ;
— siting of the aerial with respect to the geographical configuration of the area to be served and the orientation of the aerial 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 aerial with respect to the magnetic meridian ;
— ground conductivity in the vicinity of the aerial system ;
— any other information considered useful in respect of this Recommendation.

## RECOMMENDATION No. 140

## DESIGN OF RECEIVING AERIALS FOR TROPICAL BROADCASTING

(Question No. 70, § 3)

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

CONSIDERING :

*(a)* That for the great majority of domestic tropical broadcast listeners, only simple aerials are practicable ;

*(b)* That the aerial has to be both cheap and simple to install and it has to be used on a number of frequencies with fields at varying angles of incidence ;

RECOMMENDS :

**1.** That the directivity of receiving aerials cannot be relied upon to improve the signal/noise ratio ;

**2.** That it appears reasonable to assume that the aerial of the average listener cannot be better than that given in the Report of the Geneva Planning Committee (1948) and this consisted of an " L " type aerial with horizontal and vertical limbs, each 16 feet in length (4.80 metres).

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## RECOMMENDATION No. 141 *

## ADDITION TO APPENDIX 9 OF THE RADIO REGULATIONS

(Question No. 28)

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

CONSIDERING :

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

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

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

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

*(e)* That the FRAME and RAFISBENQO codes have been used for a long time but :

— the SINPO code gives a more accurate description of the transmission quality than the FRAME code and is easier to use ;

— the SINPFEMO code is derived from the SINPO code by adding three letters relating to special features of telephone transmissions and is easier to use than the RAFISBENQO or RISAFMONE code ;

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* This Recommendation replaces Recommendation No. 85.

## ANNEX

### SINPO Signal Reporting Code

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

### SINPFEMO Signal Reporting Code

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

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

UNANIMOUSLY RECOMMENDS :

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

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

*Special remarks.*

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

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

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

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

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

(*e*) The overall rating for telephony shall be interpreted as follows :

| | OPERATING CONDITION | QUALITY |
|---|---|---|
| 5 Excellent | Signal quality unaffected | Commercial |
| 4 Good | Signal quality slightly affected | Commercial |
| 3 Fair | Signal quality seriously affected. Channel usable by operators or by experienced subscribers | Marginally commercial |
| 2 Poor | Channel just usable by operators | Not commercial |
| 1 Unusable | Channel unusable by operators | Not commercial |

## RECOMMENDATION No. 142

## NOMENCLATURE OF THE FREQUENCY AND WAVELENGTH BANDS USED IN RADIOCOMMUNICATION

(Question No. 73)

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

CONSIDERING :

*(a)* That it is appropriate to retain the subdivision of frequencies and of wavelengths adopted by the International Radio Conference of Atlantic City (Radio Regulations, Chap. II, Art. 2, No. 85, § 10), which has been shown to be of considerable practical value, since it is in fair agreement with the criterion of grouping together frequencies with common physical and propagation properties as well as a uniform equipment constructional technique ;

*(b)* That, however, frequency band denomination by means of adjectives, superlatives and adverbs is inconvenient, ambiguous and not readily extended to the ever widening bands employed in radiocommunication ;

UNANIMOUSLY RECOMMENDS :

That, by doing away with all frequency band denomination by means of ambiguous terms such as : adjectives, superlatives, etc., it is proper to characterise bands by means of progressive whole numbers in accordance with the following table, intended to be substituted, at a later conference of the I.T.U., for that of the Radio Regulations of Atlantic City (Chap. II, Art. 2, No. 85, § 10).

| Band Number | Frequency Range (lower limit exclusive, upper limit inclusive) | Metric subdivision |
|---|---|---|
| 4 | 3 to 30 kc/s | Myriametric waves |
| 5 | 30 to 300 kc/s | Kilometirc waves |
| 6 | 300 to 3 000 kc/s | Hectometric waves |
| 7 | 3 000 to 30 000 kc/s | Decametric waves |
| 8 | 30 to 300 Mc/s | Metric waves |
| 9 | 300 to 3 000 Mc/s | Decimetric waves |
| 10 | 3 000 to 30 000 Mc/s | Centimetric waves |
| 11 | 30 000 to 300 000 Mc/s | Millimetric waves |
| 12 | 300 000 to 3 000 000 Mc/s | Deci-millimetric waves |

*Note.* — " Band N " extends from $0.3 \times 10^N$ to $3 \times 10^N$ c/s.

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## RECOMMENDATION No. 143

## UNIT SYSTEMS

(Resolution No. 6)

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

CONSIDERING :

That the use of the rationalized M.K.S. system (also known as the rationalized Giorgi system) has been recommended by the International Electrotechnical Commission (Technical Committee No. 24 meeting, held in Paris on 17th and 18th July, 1950) and that it is now very widely used by radio engineers and by the authors of radio publications ;

RECOMMENDS :

That administrations and private operating agencies should be encouraged gradually to adopt, in their relations with the I.T.U. and its permanent organs, the rationalized M.K.S. system (also known as the rationalized Giorgi system).

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## RECOMMENDATION No. 144

### MEANS OF EXPRESSION TERMS, DEFINITIONS, GRAPHICAL AND LETTER SYMBOLS AND THEIR CONVENTIONAL USAGE

(Resolution No. 5)

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

CONSIDERING :

*(a)* That it is of importance for the ease and efficiency of the work of the C.C.I.s that means of expression of all kinds (terms, symbols, etc.) and the conditions of their use be rendered and maintained as uniform as possible ;

*(b)* That the C.C.I.F. has finished its Draft List of Definitions of Essential Telephone Terms, that the C.C.I.T. has made considerable progress in its work of terminology and that a procedure for coordinating the vocabulary work of the three C.C.I.s is outlined in Resolution No. 283 of the I.T.U. Administrative Council ;

*(c)* That the desired unification means avoiding, unless imperatively necessary, contradictions between the conventions accepted by the C.C.I.R. and those used by other qualified organizations, especially the International Electrotechnical Commission (I.E.C.) and that efficient cooperation must be secured for this purpose, not only in the final stage of the work but also in the preparatory stages, i.e. at the level of each of the participating countries ;

*(d)* That the I.E.C. has on its part sought means of cooperation with the C.C.I.R. ;

*(e)* That the Australian Administration has submitted to the C.C.I.R. (London Doc. No. 269) a proposal to the effect that the unification of graphical means of expression should not be restricted to elementary symbols but should be extended to circuit diagram lay-out, making them of greater practical utility to the engineer by giving each of the sub-circuits an appearance characteristic of the function it fulfils;

UNANIMOUSLY RECOMMENDS :

1. That lists of the various categories of means of expression suitable for the work of the C.C.I.R. (terms, definitions, graphical and letter symbols) and the conventions for putting these means of expression to the best use should be prepared as soon as possible and kept up to date as constantly as possible, this permanent task being entrusted to the Study Group No. XIV specially set up for this purpose by the C.C.I.R. ;

2. That each administration wishing to cooperate effectively in this work should nominate to the Study Group concerned a "*national correspondent*", and that the Study Groups of the C.C.I.R. should appoint "*representatives*" whose technical qualifications are required for the efficient performance of this work ;

3. That the Study Group concerned should take all appropriate action for coordination and cooperation with the organizations active in this sphere, so as to avoid useless duplication

of work already begun and harmful divergences in results, this being particularly important with reference to the C.C.I.F. and the C.C.I.T. on the one hand, and the International Electrotechnical Commission on the other ;

**4.** That priority should be given to the preparation of that part of the I.T.U. vocabulary dealing with radiocommunication, so as to ensure as soon as possible the publication of the complete vocabulary, for which the work done by the C.C.I.F. and the C.C.I.T. is much more advanced ; and for this purpose :

4.1 That the I.T.U. vocabulary should be published in separate sections so as to avoid, both for the edition at present in preparation and for any future revised editions, delay in the publication of certain sections not yet ready, merely because of delays in other sections ; that consequently a section should be devoted to each of the following subjects : telegraphy, telephony, radiocommunication, terms common to all three branches of telecommunication ;

4.2 That the initial document intended to serve as a basis for the " radiocommunication " section of the I.T.U. vocabulary, which was drawn up during the VIIth Plenary Assembly under the heading " *Preparatory list of terms and definitions used by the C.C.I.R.* " should be communicated to the Director of the C.C.I.R. for issue and distribution to the " *national correspondents* " and " *representatives* " referred to in point 2 above, so that they may examine it ;

4.3 That replies to this first consultation be sent direct to the Chairman of the relevant Study Group (No. XIV) ; that comments should be made and amendments suggested bearing in mind the fact that the published section will in principle contain only the terminology peculiar to the work of the C.C.I.R. and not the terminology formally adopted by the I.E.C. for its vocabulary ; so that for this common terminology only major objections to the corresponding terms or their definitions need be mentioned ;

4.4 That the Chairman of the Study Group concerned should carry out in the most suitable manner an analysis of the results of this first enquiry ; that he should then entrust the three " national correspondents "—of the U.S.A., United Kingdom and France—with the necessary translation work for the bilingual text (taking into account differences in American and British terminology) required to draw up a " *provisional list of terms and definitions peculiar to the work of the C.C.I.R.* " ; that he should then request the Director of the C.C.I.R. to issue this document and to send it for study to all the Study Groups and the administrations participating in the work on terminology ;

4.5 That replies to this second enquiry should be sent to the Director of the C.C.I.R. ; that the Chairman of the Study Group concerned should carry out in the most appropriate manner an analysis of these replies ; that, with the assistance of the Study Group, the final text of the (bilingual) " *List of terms and definitions peculiar to the work of the C.C.I.R.* " should then be drawn up, which would then constitute the draft sections to be placed before the joint Study Group of the three C.C.I.s provided for by the Administrative Council of the I.T.U. ;

**5.** That work should also be started on means of expression other than those in the vocabulary, so long as work on the latter is not thereby held up, and using a procedure based on the experience acquired.

# REPORTS

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# REPORT No. 3

## REVIEW OF PUBLICATIONS ON PROPAGATION

(Recommendation No. 14)
(Study Groups Nos. IV, V and VI) *

(Geneva, 1951)

Recommendation No. 14 served to focus attention on the extraordinary amount of effort which is being expended in learning the facts of radio propagation and in applying them to radio operations and to international control and adjustment of the various radio services. This great field of effort is illustrated by the reviews prepared by eleven members in response to Recommendation No. 14, which appear as Annexes ** to Doc. No. 115 of Washington. These reviews in most cases report on the period 1938 to 1948 inclusive. The field of radio propagation was summarized under C.C.I.R. auspices in 1937, covering progress up to that time. The results were given in " Report of Committee on Radio Wave Propagation ", which was distributed by the Bureau of the International Telecommunication Union before the 1938 Cairo Conference, and was published in *Proceedings, Institute of Radio Engineers,* **26**, pp. 1193-1234, (October, 1938).

Since 1937, work on radio propagation has been exceedingly active and extensive. The phenomena of the ionosphere have been intensively studied and the results increasingly applied to the practical determination of optimum frequencies for long-distance transmission over any transmission path at any time. Propagation via the troposphere has been vigorously explored and much has been learned, particularly regarding propagation at VHF and higher frequencies. Microwave propagation has been pioneered. Ground-wave propagation has been reduced to quantitative calculation.

The publications on radio propagation are scattered through many scientific and engineering periodicals and books. References to these papers are given monthly in the lists of "Abstracts and References " published in *Wireless Engineer* and *Proc. I.R.E.* Annual summaries of the work are given in the *Proc. I.R.E.*, entitled " Radio Progress during 19.. ", published usually in the March or April issue each year. Each of these reviews has a section on radio propagation. The reviews for 1938-1948 give references to 1025 published papers on radio propagation. These annual reviews of work on radio propagation in *Proc. I.R.E.* constitute a useful summary of the work done arranged in chronological order.

It is thus clear that a vast amount of work on radio propagation has been going on and is continuing. This field is now recognized as fundamental to radio operations and engineering. The work in progress is undertaken for a variety of motives and objectives. Some of it is on basic physical phenomena, some directed closely to specific engineering applications, and all of it is of interest.

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* Study Group No. IV for ground wave propagation.
Study Group No. V for tropospheric propagation.
Study Group No. VI for ionospheric propagation.

** The reviews of radio propagation work submitted by various countries appear as the following Annexes to Doc. No. 115 of Washington :

| | | | |
|---|---|---|---|
| Annex " A " | Belgium | Annex " G " | Sweden |
| Annex " B " | U.S.A. | Annex " H " | Switzerland |
| Annex " C " | France | Annex " I " | Union of South Africa |
| Annex " D " | Italy | Annex " K " | Netherlands |
| Annex " E " | New Zealand | Annex " L " | Canada |
| Annex " F " | United Kingdom | | |

The extent and value of the work on radio propagation is further illustrated by its extensive use in recent international conferences. Many compilations of methods of using ionospheric propagation data and an extraordinary number of charts have been prepared for and by recent international conferences. These have been indispensable in the conference work and will be needed even more in the future. As they were prepared hurriedly to meet specific needs, a valuable service could be rendered by reviewing them and, if found necessary, supplementing them.

It is believed that no other worth-while specific guidance "regarding desirable future work" could be given in any overall manner by the C.C.I.R. or any other body. On the other hand, the questions established and the studies made by the C.C.I.R. do provide incentives and objectives which are taken into account by the administrations, companies, research institutes and individuals engaged in radio propagation work. The effect of the C.C.I.R. work as a whole upon the various programmes of radio propagation work will therefore provide the real answers to Recommendation No. 14. The means by which the C.C.I.R. enables the various people in this field to work together is a valuable means of furthering and co-ordinating the work.

The C.C.I.R. Secretariat may be requested to distribute to Study Group chairmen contributions which, in the view of an administration, may be of interest to other administrations on the subject of radio propagation and which may be sent to the C.C.I.R. Secretariat for that purpose.

The choice of new Questions and other acts of future Plenary Assemblies will in fact be the " regular recommendations " envisaged in Section B 7 of Recommendation No. 1 adopted by the International Radio Conference, Atlantic City, 1947.

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REPORT No. 4 *

# METHODS OF MEASURING FIELD STRENGTH

(Question No. 8)

(Study Group No. V)

(Geneva, 1951)

In the following considerations of Question No. 8 of the C.C.I.R., particular attention is given to the ultimate purpose for which radio field strength measurements are made. Usually they are to serve one of two purposes, as follows :

1. To provide an index of the serviceability of the radio signal for a given service ;
2. To provide an index of its interference-producing capabilities.

To provide a serviceable signal at a given point, a radio station must produce a radio field at that point such that the ratio of the radio field strength to the interference field strength is sufficiently large for a given percentage of time. Under such conditions the signal-to-interference ratio at the receiver output will exceed a given minimum value during the specified percentage of time. Specification of this minimum signal-to-interference ratio will determine the grade of service obtained. The minimum ratio will, in general, vary with the type of service.

To determine the transmitter power output needed to maintain the prescribed signal-to-interference ratio at the receiving point will require taking account of both the radio noise field strength measurements and wave propagation data. The determination is complicated by the fact that there is a variation with time of the intensity of the signal field as well as of the interference field.

In some cases, a much more direct approach to the problem may be made which does not require separate measurements of the field intensity of either the desired station or of the interference, nor interpretation of wave propagation phenomena. In this approach, only signal-to-

* This Report was adopted unanimously.

interference ratio measurements are made at the output of the receiver, with constant transmitter power. With this method, the power required for various grades of service may be directly determined.

Field strength measurements have not only the fundamental use indicated in the foregoing, but also the following uses : study of radio wave propagation ; study of the efficiency, radiation patterns, and other characteristics of radio antennae ; study of tropospheric and ionospheric phenomena ; and measurements of the electrical properties of the ground.

The following three paragraphs taken from the 1948 Report of the U.R.S.I. Commission on standards and measurements, summarize current thought with regard to field strength measurements :

> " In recent years little improvement in field strength measurements up to 30 Mc/s has taken place. Accuracies of ±20% are achieved. Considerable advances have taken place in the higher frequency range up to 10 000 Mc/s. Between 30 Mc/s and 600 Mc/s the equipment is usually calibrated by establishing a known radiation field from a local source ; while above 600 Mc/s a comparison is made between the power radiated and the power received at a fixed distance. Identical antenna systems of the waveguide horn type are used at both stations. Such field strength measurements depend upon reference standards of current, voltage or power and the resulting precision is based upon these standards.
>
> Facilities for radio field strength measurements are needed for many operations. Atmospheric and radio noise studies are becoming more important. This requirement, together with the need for field strength measurements from radar signals and unwanted electrical system interference, has been met in the United Kingdom by development of equipment suitable for pulse modulated fields between 20 Mc/s and 650 Mc/s for a wide range of pulse widths and recurrence frequencies.
>
> Many of the foregoing problems are of an international character and an exchange of knowledge of progress is desirable. There should also be an arrangement for the inter-comparison of methods used by different countries. A method for the exchange of reference apparatus would be valuable and would result in an improvement of the international consistency of standards."

Response to most of the points of Question No. 8 are given in separate Recommendations and Reports of the VIth Plenary Assembly of the C.C.I.R.

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## REPORT No. 5 *

## MEASUREMENT OF FIELD STRENGTH

### Respective Merits of the two Main Types of Equipment Now in Use

(Question No. 8, § A.6)
(Study Group No. V)

(Geneva, 1951)

The two main types given in Question No. 8 of the C.C.I.R. are :

*(a)* that in which the locally generated signal is injected directly into the receiving circuit ;

*(b)* that in which a locally generated field is applied to the wave collector of the measuring equipment.

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* This Report was adopted unanimously.

It is believed that the same degree of accuracy of field strength measurements may be obtained by either method, provided that equipment of suitable design is used and that careful installation and operating procedures are employed.

The current state of measurement technique generally dictates the particular arrangement and type of measuring equipment employed in a particular frequency range. Methods employing direct injection of a locally generated signal into the receiver or the receiver-antenna circuit are most applicable for mobile measurements. Methods employing either a locally generated field or direct injection of a locally-generated signal into the antenna are most applicable for primary calibration purposes.

The locally-generated field may be produced by the use of a loop antenna or dipole, the measurements being made close enough to the antenna so that the induction field constitutes an appreciable or a predominant portion of the total field. Alternatively, the use of a standard field produced by a transmitting antenna at distances sufficiently large so that the field is primarily a radiation field is generally preferred for calibration of a receiving equipment by the substitution method. In this method the use of horizontal polarization, rather than vertical polarization, is to be preferred where feasible. The method can, however, be more subject to site irregularities, and thereby give erroneous indications on waves arriving from a distance.

Equipment also exists in which the reference voltage is introduced into the antenna, even when this antenna is distant from the rest of the equipment. This method eliminates errors due to mismatching and possible attenuation in the transmission line between the antenna and the receiver. It also avoids possible errors due to site irregularities.

Finally, it is noted that it is often necessary to take into consideration, in choosing a method, the convenience and availability of equipment.

It is believed that the methods now in use may be better described as follows :

*(a)* those in which the locally-generated signal is applied directly to the receiver ;

*(b)* those in which the locally-generated signal is applied to the antenna of the receiver ;

*(c)* those in which use is made of a locally-generated standard radiation field.

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## REPORT No. 7 *

## LONG DISTANCE PROPAGATION OF WAVES OF 30 TO 300 Mc/s BY WAY OF IONIZATION IN THE E AND F REGIONS OF THE IONOSPHERE

(Question No. 7, Section 3)
(Study Group No. VI)

(Geneva, 1951)

I. *Introduction.*

Question No. 7 of the C.C.I.R. asked that a study be made for the frequency band indicated above :

1. For ground-wave transmission
2. For transmission through the troposphere, and
3. For transmission to long distances by way of ionozation in the E and F regions of the ionosphere.

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* This Report was adopted unanimously.

This study has now been made, in so far as section 3 is concerned, and this Report, together with Doc. No. 124 of Washington and Doc. No. 72 of Geneva, form an answer to this part of the Question.

This Report summarizes the information, contained in Doc. No. 124 of Washington and in Doc. No. 72 of Geneva, as to long-distance propagation of waves of 30 to 300 Mc/s, and as to their interfering potentialities at considerable distances. These two documents contain the detailed information obtained from studies made in the United States of America and in the United Kingdom respectively. This Report also embodies information from Doc. No. 136 of Geneva, compiled by the U.R.S.I., and may therefore be regarded as a summary of the information contained in all three of the above documents.

II. *Survey of problems.*

A survey of the problems presented is given in Section II of Doc. No. 124 of Washington and they are also generally surveyed in pages 2 to 12 of Doc. No. 72 of Geneva. They fall under six headings :

1. Transmission by way of regular E-layer ionization
2. Transmission by way of regular F1-layer ionization
3. Transmission by way of regular F2-layer ionization
4. Transmission by way of sporadic E ionization
5. Transmission by way of meteoric ionization
6. Transmission by way of anomalous and irregular ionization of other kinds.

It is not intended in the present Report to go into the details of the nature of the problems presented, but rather to summarize the results obtained. For detailed information as to the nature of the problems, reference should be made to those sections of the documents already quoted. A summary of the results of the studies now follows, appropriate references to the documents being given.

III. *Summary of results.*

1. *Transmission by way of regular E-layer ionization.*

A study of regularly made vertical incidence measurements indicates that it is unlikely that transmission of waves of 30 to 300 Mc/s would ever occur by way of the regular E-layer.

2. *Transmission by way of regular F1-layer ionization.*

A study of the vertical incidence measurements indicates that it is unlikely that transmission of waves of 30 to 300 Mc/s would ever occur by way of the regular F1-layer, except near noon at maximum solar activity in tropical regions only. Since the F2-layer MUF's would, under the same conditions, exceed those for the F1-layer, this fact is of little importance.

3. *Transmission by way of regular F2-layer ionization.*

A study has been made of the vertical incidence measurements for a number of widely distributed ionospheric stations and, in addition, a considerable amount of observational evidence has been collected from actual transmissions, both in the United States and the United Kingdom. These data relate mainly to the years 1946-1948, when solar activity was high. They indicate that during certain seasons of the year long-distance transmission by way of the regular F2-layer ionization can occur in temperate latitudes on waves of up to about 50 Mc/s, although the percentage of the total time during which such transmission is possible is small, being, for example, of the order of 4.5 % on 50 Mc/s over the London-New York circuit during the most favourable month of the year at sunspot maximum. In the tropics, however, such transmission can occur on waves of up to 60 Mc/s, with almost regular transmission on waves of 30 to 40 Mc/s. The field strengths observed on these waves are very variable, ranging from values exceeding the inverse-distance value to these near or below the receiver noise level, over very short periods of time. However, since the radio noise fields on these waves are also very low, reception is often continuous for long periods of time and serious interference may result to services which are designed to provide communication at relatively low field strengths.

It is clear that, for several years around the solar maximum, intolerable long-range interference may be expected on frequencies below about 50 Mc/s during daylight hours in the equinox and winter seasons. The lowest frequency at which such interference becomes so infrequent as to be inappreciable is about 50 Mc/s for stations in temperate latitudes, and about 60 Mc/s for stations in the tropics.

World-wide predictions of F2-layer MUF's are given in monthly charts published by the C.R.P.L. in the U.S.A., by the D.S.I.R. in the U.K. and by other authorities.

4. *Transmission by way of sporadic E ionization.*

Because of the nature of sporadic E ionization, implicit in its name, transmission by way of it is ordinarily confined to a single hop and is thus limited to a maximum distance of about 2300 km. Since, in the most intense form of sporadic E ionization, the skip-distance is about 650 km., the transmission range is, in practice, restricted to distances between about 650 and 2300 km.

It exists in different forms in different latitudes, the most clearly distinguished types being the auroral-zone type and that occurring at temperate and low latitudes. The auroral-zone type occurs most frequently at night and the studies indicate that transmission by way of it may occur on frequencies up to about 90 Mc/s and, infrequently, even higher. The temperate and low latitude type can occur at any time of day, but has a broad peak around midday and a subsidiary peak around sunset.

The studies indicate that transmission may occur by way of it on frequencies up to about 80 Mc/s and, infrequently, up to 100 Mc/s.

It is to be noted that this type of sporadic E exhibits a marked seasonal variation, which is especially prevalent during the months of May to September inclusive (in the Northern Hemisphere) and of relatively small importance during the remaining months. Doc. No. 124 of Washington contains some evidence that there is a variation in its occurrence over the sunspot cycle, suggesting that a maximum of sporadic E may occur at sunspot minimum, and vice-versa, but this evidence can hardly be regarded as conclusive.

During the months of May to September inclusive and during the hours of 0700-2000 L.T. (period during which temperate and low latitude sporadic E is most prevalent) the studies indicate that transmission at 2300 km may occur in accordance with the following frequency/time distribution :

| Frequency | Percentage of Total Time |
|---|---|
| 30 Mc/s | 28.0% |
| 40 Mc/s | 6.0% |
| 50 Mc/s | 1.5% |
| 60-80 Mc/s | $<1.0\%$ |

This frequency/time distribution is given in the graph in Fig. 3 of Doc. No. 72 of Geneva.

Field strengths for transmission by way of sporadic E may be high, and Doc. No. 124 of Washington indicates that the peak fields would occur at distances between about 1600 and 1800 km.

The expected world distribution of sporadic E is indicated in world charts published monthly by the C.R.P.L., in the U.S.A. and by other authorities.

5. *Transmissions by way of meteoric ionization.*

A study has been made both in the United States and the United Kingdom of the reflections which occur from meteor trails. On 30 Mc/s such reflections have been found at times to occur as often as one per minute, and on 70 Mc/s at a rate of about two per hour. They were found to last from a fraction of a second to about 10 seconds. The field strength of the signals obtained from the meteoric ionization was found to be very low. Because of these facts these reflections are considered to be of negligible importance from the interference point of view, such interference being generally limited to scanty occasional bursts of signal from stations normally out of range.

6. *Transmission by way of anomalous and irregular ionization of other kinds.*

The studies indicate that there may at times occur bodies of ionization at virtual heights different from those of any of the recognized ionospheric layers. Such ionization patches may occasionally give rise to reflections of waves in the 30 to 300 Mc/s range, the principal case being that of reflection from the edges or sides of such patches which occur within or near the auroral zone. It is not considered, however, that such reflections would constitute a serious source of interference to stations working on waves of 30 to 300 Mc/s.

IV. *Summary.*

A tabular summary of the main causes of interference to stations working on waves 30 Mc/s to 300 Mc/s is given below.

| Type of interference | Zone | Period of maximum effect | Highest frequency with severe interference, and range of distances affected | Lowest frequency with slight interference |
|---|---|---|---|---|
| Regular F2 layer reflection | Temperate latitude | Midday period<br>Equinox-winter<br>Solar cycle maximum | 45-50 Mc/s<br>3200-4800 km E/W<br>3200-9600 km N/S | 50 Mc/s |
| Regular F2 layer reflection | Tropics | Midday period<br>Equinox-winter<br>Solar cycle maximum | 50-55 Mc/s<br>3200-4800 km E/W<br>3200-9600 km N/S | 60 Mc/s |
| Sporadic E auroral type | High magnetic latitude | Night (associated with local magnetic disturbances) | Night 80 Mc/s<br>Day 45-50 Mc/s<br>650-2300 km | Night 90-100 Mc/s<br>Day 50 Mc/s |
| Sporadic E temperate type | Temperate latitude | May-Sept. inclusive<br>Day | 55 Mc/s<br>650-2300 km | 80-100 Mc/s |
| Meteoric ionization | | During meteoric showers | Seldom severe<br>650-2300 km | Varies with power used |

V. *Bibliography.*

An extensive bibliography concerning the matter is given at the ends of Doc. Nos. 124 of Washington and 72 of Geneva.

# REPORT No. 9

## INTERFERENCE TO RADIO RECEPTION AT SEA DUE TO ATMOSPHERIC CAUSES

(Question No. 36)
(Study Group No. VI)

(Geneva, 1951)

The question of interference to radio reception at sea due to atmospheric causes has been studied. Although only a limited amount of basic information is available on the subject, the following reference material will be useful in estimating the radio noise levels to be expected at sea :

1. Statements of K.A. NORTON, R. BATEMAN and C.A. ELLERT before the Federal Communications Commission at the Ship Power Hearing, November 14, 1938.

2. H.V. COTTONY, *Memorandum report on observations of atmospheric radio noise in Arctic regions*, National Bureau of Standards, Central Radio Propagation Laboratory, January 15, 1948.

3. *Minimum required field intensities for intelligible reception of radiotelephony in presence of atmospherics or receiving set noise.* Report No. 5, Radio Propagation Unit, Baltimore Signal Depot, October 1949.

4. BUREAU and BARRÉ, *Variations à grande échelle de l'activtié des atmosphériques au cours de la croisière antarctique du Commandant Charcot*, Comptes rendus, Académie des Sciences, Paris, **229**, p. 626, 26 September 1949.

Reference 1 contains measurements of atmospheric noise on 250 and 540 kc/s made on shipboard during several ocean voyages in the summer of 1938. In this report the noise levels are presented both diurnally and in cumulative time distributions. Table IV on page 43 of the statements shows the distribution of noise with latitude. This table can be used in estimating world-wide noise levels since they appear to be substantially independent of longitude.

Reference 2 contains atmospheric noise measurements over a wide range of frequencies made on shipboard during the summer of 1947. These measurements were made primarily at arctic latitudes ; however, some of the measurements extend to latitudes as low as 22° North.

Reference 3 gives predictions of world-wide noise levels to be expected for various frequencies, seasons and times of day. Although it is subject to some error (see C.C.I.R. Report No. 8 *), it is considered to be the most complete overall treatment of noise levels.

In making estimates of noise levels over ocean areas, Reference 1 is provisionally recommended where applicable, i.e., as to frequency and season. In view of the fact that in the 2000 kc/s range, noise levels are lower than in the 500 kc/s range, it may be desirable to use higher frequencies than those dealt with in Reference 1. References 2 and 3 will then be useful in estimating noise levels on these higher frequencies.

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* This Report has not been maintained.

# REPORT No. 13

## THE MINIMUM NUMBER OF FREQUENCIES NECESSARY FOR THE TRANSMISSION OF A HIGH FREQUENCY BROADCASTING PROGRAMME

(Question No. 37 (X))
(Study Group No. X)

(Geneva, 1951)

The C.C.I.R. has studied the technical data contained in Doc. No. 635 of Mexico, and agrees that it is essential to secure the greatest possible economy in the use of radio frequencies and that to this end, as a general rule, only one frequency should be used for the transmission of one programme to one reception area. It is, however, of the opinion that technical conditions do exist which would justify the use of more than one transmission frequency to assure the continuous reception of one programme in one reception area (i.e. the area to which the programme is directed) at certain times and over certain paths.

Wave propagation conditions over certain paths may be difficult to forecast (e.g. very long paths or paths passing through the auroral zones) or the rate of change of FOT may be high (e.g. at sunrise or sunset). Listeners to broadcasting cannot advise the transmitter of an unexpected deterioration in reception conditions as may be the case in radio services other than broadcasting.

The existence of these conditions could justify the simultaneous use of more than one frequency, each in a different band, to cover such periods and paths. In addition there may be cases where the depth of the area extending outward from the transmitter is too great to be served by a single frequency and more than one frequency may be needed.

The use of directional antennae is essential in most cases to ensure a satisfactory signal to noise ratio, as recommended by the Mexico City High Frequency Broadcasting Conference, and this limits the geographical area covered by each transmitter and its associated antenna to an extent differing with each particular case. Because of this, it may be necessary to use more than one transmitter and associated antenna to cover a given reception area. By synchronising transmitters, the number of frequencies in the same band may be reduced to not more than two. At the present time there is insufficient evidence to determine whether one frequency only would give satisfactory reception. Further study should be carried out.

The angle subtended by the reception area at the transmitter, its mean distance from the transmitter and its depth, may differ greatly from one case to another. This limits the value of adopting defined geometric reception areas as it would give rise to insufficient coverage in some cases and a wasteful use of frequencies in others. Thus it would seem that defining the above factors could not produce a useful criterion for the justification on technical grounds of the use of more than one frequency for transmitting one programme to a reception area, but that each case must be considered on its merits taking these factors into account.

# REPORT No. 14 *

## HIGH FREQUENCY BROADCASTING RECEPTION

(Question No. 38 (X))
(Study Group No. X)

(Geneva, 1951)

This report has been prepared utilizing the available results of past research regarding the short and long term variability of high frequency broadcasting signals, atmospheric noise and industrial noise intensities, together with the results of subjective tests of the acceptable ratios of steady desired to undesired signals and of steady signal to atmospheric and industrial noises.

Although it is believed that further theoretical and empirical work should be carried out in this field, it is felt that available material makes it possible to supplement provisionally the existing information and to estimate allowances which should be made to take into account the short and long term variability of signal and atmospheric noise intensities, in order to provide acceptable service for any specified percentage of the time.

Table I sets forth, for purposes of information, the fading safety factors which are necessary to assure a specified signal-to-interference ratio for particular percentages of the time **.

Consideration has not been given to the allowances to be made when there is more than one interfering signal or a combination of interfering signals and noise. This is known to be an exceedingly complex problem, and, although some theoretical investigations have been performed, there is no available information on the subjective aspect involved.

*Table I*

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Desired signal to undesired signal . . . . . . . . | 10 db | 13 db | 23 db | 16 db |
| Desired signal to atmospheric noise . . . . . . . | 6 db | 16 db | 22 db | 17 db |
| Desired signal to industrial noise . . . . . . . . | 6 db | 10 db | 16 db | 12 db |

*Column 1* This is the short-term fading allowance which must be made to ensure that the steady state ratio is achieved for 90% of any given hour.

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

*Column 3* By adding the values in Columns 1 and 2, this is the overall variability allowance which must be made to ensure that the steady state ratio is achieved for 90% of any hour in 90% of the hours in any month at a particular time of day and in 90% of the cases. This represents an assured steady state ratio for 96% of the overall time.

*Column 4* By taking the square root of the sum of the squares of the values in Columns 1 and 2, this is the overall variability allowance which must be made to ensure that the steady state ratio is achieved for 90% of the overall time.

* This Report was adopted unanimously.

** Refer to Doc. Nos. 43 and 66 of Washington, and Doc. Nos. 160, 178 and 215 of Geneva.

The figures in Table I relating to the time availability of service were selected on a theoretical basis and on experience derived principally from medium wave broadcasting. Some doubt exists as to the practicability of achieving these percentages, since recent calculations of the transmitter power required, in order to provide this time availability at presently accepted steady state conditions, have produced quite unrealistic results.

The C.C.I.R. is of the opinion that Question No. 39 should remain on the agenda, and that further theoretical and empirical work should be carried out on this question. These studies should include the gathering of data on the time availability versus signal-to-interference ratio for services which are regarded as being normally acceptable under actual operating conditions.

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# REPORT No. 16 *

## TELEGRAPHIC DISTORTION

(Question No. 18 (I))
(Study Group No. I)

(London, 1953)

Following the Seventh Plenary Assembly of the C.C.I.T. (Arnhem, 1953), the Director ad interim of the C.C.I.T. communicated findings of that Meeting to the C.C.I.R., as follows :

" *Telegraph distortion*

*(a)* The VIIth Plenary Assembly of the C.C.I.T. issued a recommendation on this matter, intended to replace Recommendation No. 301 provisionally numbered 1/1 but which, in the new series of C.C.I.T. recommendations will be numbered B.1. ;

*(b)* The C.C.I.T. has decided that new questions relating to telegraph distortion should be set for study and that the study of questions relative to this subject already under way should be continued.

It felt that the collaboration of the C.C.I.R. would be valuable in the study of the following questions :

" *Question 1/5 (provisional number)* **

What method should be recommended to determine the distribution law of the various degrees of distortion relative to a prolonged modulation (or restitution) :

*(a)* isochronous ?

*(b)* start-stop ?

*(c)* when the distortion considered is individual distortion ?

"*Notes :*

1. This question should be studied in collaboration with the C.C.I.R.
2. Some indications with regard to this question may be found on page 8 of Doc. AP VII/4.

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* This Report was adopted unanimously.

** This Question has become Question No. 6 of C.C.I.T.

" *Question 1/7 (provisional number)* *

Study Group No. I has, in co-operation with representatives of the C.C.I.R., included in the new Draft Resolution definitions which might be of assistance in any further study of the question, i.e. definitions of " defective modulation or restitution ", " efficiency factor of a telegraph communication ", " quality index " (in the general sense for telegraphists), and with reference to a given telegraph operation, a definition of the " quality index of a modulation or restitution ". It has however found it necessary to pursue the study of the problem with the following question :

How can the notions of " efficiency factor of a telegraph communication ", " quality index of a telegraph operation ", " quality index of a modulation or restitution ", be applied to qualify a radiotelegraph communication ?

What method should be adopted to attain this objective ?

" *Note.* — The following documents may be consulted for the study of this question :

C.C.I.T. Doc. AP VII/4, Ann. 2, 3 and 4.

Ann. No. 8 to Doc. AP VII/4, page 41 and following pages : Contribution of Italian rapporteurs to the study of C.C.I.R. Question No. 18."

The above questions arise from Question No. 18 and should be pursued with a view to establishing complete definitions and methods of measurement which are applicable to radiotelegraphy.

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## REPORT No. 17 **

## HARMONICS AND PARASITIC EMISSIONS

(Question No. 1.b (I) — Study Programme No. 2 (I))
(Study Group No. I)

(London, 1951)

After consideration of the various documents supplied to the C.C.I.R. on this question :

| | |
|---|---|
| Doc. 65 | United States of America |
| Doc. 80 | United States of America |
| Doc. 101 | Report from the Chairman of S.G. No. 1 |
| Doc. 124 | Belgium |
| Doc. 130 | Japan |
| Doc. 340 | U.S.S.R., |

the VIIth Plenary Assembly of the C.C.I.R. considers that insufficient information has been received to permit revision of App. No. 4 of the Radio Regulations (Atlantic City, 1947). However, the discussions and the documentation received show that the tolerances given in that App. No. 4 can be met in practice.

A study of several approaches to the problem of measurement of harmonic and parasitic emissions indicates that the problem can be attacked by two methods :

1. Tests on the transmitters in respect of the power of harmonic or parasitic frequencies delivered to the load ;
2. Field intensity measurements at a distance from the transmitter to determine the interfering possibilities of the complete installation.

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* This Question has become Question No. 5 of C.C.I.T.

** This Report was adopted unanimously.

The first method would generally precede operation on normal traffic and is a laboratory method based on power measurements. The power measurements may be by the substitution method, direct power measurement, or other methods. The field intensity measurement at a distance will provide a practical means of determining the overall effect and expressing the intensity of interfering signals due to harmonic parasitic radiations.

The direct power measurement method as described in London Doc. No. 130 can be used while the transmitter is in operation even when it is one of a group of transmitters operating simultaneously. The method used is based on the measurement of the current, voltage and phase of each harmonic.

When necessary, an improvement in the reduction of harmonics may be obtained by the use of filters at the output of the transmitter. One specific type of filter is described in London Doc. No. 340 which provides a reduction of 32 db of the level of the harmonics. The effectiveness of the filter is assessed by comparing the harmonic field intensity at a distance of over 100 metres from the transmitter aerial with and without the filter.

Another type of filter, mentioned in London Doc. No. 124, makes it possible to obtain harmonic levels of 70 or 75 db with respect to the fundamental for high power MF (hectometric) transmitters. These results were obtained by the substitution method. Attention must be given to proper screening of the transmitter in order to prevent direct radiation of harmonic and parasitic emissions.

As regards the combination frequencies produced by interaction between high power MF (hectometric) transmitters situated in the same transmitting centre, attenuation of 45 to 50 db has been obtained by high-quality series rejector filters (London Doc. No. 124).

With respect to the particular harmonics falling within television channels, information is given in London Doc. No. 65 which indicates the present limitation of harmonic and parasitic radiations applied in U.S.A. for the various services.

The study of the measurement and reduction of harmonics and parasitic emissions should be continued.

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## REPORT No. 18 *

## FREQUENCY STABILISATION OF TRANSMITTERS

(Question No. 1.c (I) — Study Programme No. 3 (I))
(Study Group No. I)

(London, 1953)

*Introduction.*

At the VIth Plenary at Geneva, 1951, the C.C.I.R. requested, in Study Programme No. 3 (I) that a study should be made of improved methods of attaining high accuracy and stability of the frequency of radio emissions, consistent with economic and design requirements.

*Summary of documentation*

*Doc. 81 (United States of America).*

In this document, information is given concerning frequency stability commercially obtainable in the U.S.A. for transmitters operating in bands between 150 kc/s and 8000 Mc/s.

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* This Report was adopted unanimously.

*Doc. 131 (Japan).*

This document describes crystal oscillators and thermostats giving a frequency stability of $3 \times 10^{-6}$.

*Doc. 193 (Netherlands).*

This document describes the circuits of a number of stable oscillators and gives details of their performance in tabular form. It is concluded that in the frequency range 10 kc/s to 30 Mc/s a stability of the order of $3 \times 10^{-6}$ is easily and cheaply obtainable without needing a special device for frequency adjustment.

*Doc. 288 (Japan).*

This document describes the application of statistical analysis to the results of frequency measurements on oscillators and concludes that the frequency stability of the oscillator described is $4 \times 10^{-6}$.

*Doc. 331 (Federal German Republic).*

This document describes three types of master-oscillators continuously variable in frequency having a 24-hour frequency stability of 1 to $2 \times 10^{-6}$ and suitable for transmitters operating in the band 4 to 30 Mc/s. The first of these oscillators described uses inductance and capacitance control elements and the remainder use indirect crystal control.

*Doc. 367 (Netherlands).*

This document proposes a limitation of frequency tolerance to $3 \times 10^{-6}$ for all those services subject under the Radio Regulations (Atlantic City, 1947) to tolerances of $3 \times 10^{-5}$ and $5 \times 10^{-5}$.

*Doc. 372 (Union of South Africa).*

This document describes studies of continuously adjustable frequency oscillators using the principle of frequency synthesis.

*General conclusion:*

The general conclusion reached is that the technique of frequency stabilisation of transmitters—particularly for fixed services operating on frequencies below 30 Mc/s—is now such that degrees of frequency stability considerably in excess of those laid down in the Radio Regulations (Atlantic City, 1947) can be obtained by using either direct crystal control master-oscillators or by using continuously adjustable master oscillators with indirect crystal control.

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## REPORT No. 19 *

## VOICE FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(Question No. 43 (III))
(Study Group No. III)

(London, 1953)

The C.C.I.R. in answer to Question No. 43 (III) has carried out certain studies concerning voice-frequency telegraphy on radio circuits.

These studies have shown that it is not yet possible to give a complete answer to the question. However, as regards radio circuits using frequencies below 30 Mc/s, a recommendation has been

* This Report was adopted unanimously.

made dealing with diversity reception. Moreover, the C.C.I.R. would draw the attention of the C.C.I.T. to the following points in respect of reception below 30 Mc/s.

1. The voice-frequency system which radiates one frequency for one signalling condition and suppresses the radiation for the other signalling condition does not give satisfactory results when applied to radio circuits.

2. Systems which radiate one frequency for one signalling condition and a different frequency for the other signalling condition (using two oscillators or one frequency-shift oscillator) have in general to be modified for this special use. For instance :
   — the range of linear amplification of the audio amplifier common to all channels in the receiving equipment has to be much greater than is necessary on land line circuits because of the large changes in amplitude of the received signals due to fading ;
   — for the same reason the limiter preceding each channel discriminator should operate over a large range of input signal amplitudes ;
   — many filters used in equipment designed for land line circuits do not have suitable characteristics ;
   — to obtain good diversity results it is not sufficient merely to connect the outputs of separate channels of standard voice-frequency equipment in series or in parallel, but special provisions have to be made.

3. Notwithstanding all precautions taken, it should be realised that the use of voice-frequency equipment on radio circuits may become impossible when reception conditions are poor.

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REPORT No. 20 *

## TEMPORAL VARIATION OF GROUND-WAVE FIELD STRENGTHS

(Question No. 6 (IV))
(Study Group No. IV)

(London, 1953)

1. Contributions relating to Study Programme No. 12 have been received from Switzerland (Doc. No. 335) and from the United Kingdom (Doc. No. 96 and Addendum 1 to Doc. No. 96), and have advanced the knowledge on this subject in the frequency range 500-1500 kc/s.

2. The study of this subject has now reached a stage where the following statement can be made :
   — the temporal variation of ground-wave field strengths correlates inversely with the influence of temperature,
   — such variations are not due to tropospheric refraction,
   — the large variations are due, in most cases, to the change in conductivity of the sap in trees and plants, brought about by changes in temperature,
   — it is not certain that the foregoing reason explains all the effects that occur.

It will therefore be necessary to continue the study of this phenomenon as suggested in Study Programme No. 52 (IV) in order to consider, in particular, the effects of temperature on the electrical constants of the ground. It would, for instance, be useful to make measurements in the frequency range 1-30 Mc/s.

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* This Report was adopted unanimously.

# REPORT No. 21 *

## GROUND-WAVE PROPAGATION OVER IRREGULAR TERRAIN

(Question No. 6 (IV))
(Study Group No. IV)

(Geneva, 1951 — London, 1953)

In addition to the documents submitted at the VIth Assembly at Geneva in 1951, further contributions relating to Question 6 (IV), items 2, 3, 4 and 5 have been received from the Chairman of the Study Group (Doc. No. 104), from Austria (Doc. No. 379), Japan (Docs. Nos. 139 and 160), the Netherlands (Doc. No. 242), the United Kingdom (Docs. Nos. 95 and 154) and from the United States (Docs. Nos. 10 and 11). The study of this subject has now reached a stage where the following statements can be made :

1. *Question No. 6 (IV), § 2.*

Effects of hills and other obstacles in diffracting the waves in either the horizontal or vertical plane.

1.1 *Single obstacles of definite shape.*

*(a)* Bare hills of approximately knife-edge shape.

When the terminal points are well removed from the obstacle, it is adequate to apply the classical Fresnel treatment for optical diffraction at a knife-edge profile, but when they are on or near the obstacle, a more rigid approach is necessary. The hill is regarded as a sharp edge at which the direct and ground reflected waves comprising the incident radiation are diffracted. The diffracted field at the receiver can be similarly resolved into the direct and ground reflected components.

A number of experiments have shown that small irregularities of the ground before and behind the obstacles may give rise to multiple transmission paths and can have a particularly favourable influence upon the field-strength at the receiving site if the components are in phase.

It appears that where Fresnel diffraction theory is applicable, there is no distinction in behaviour between horizontal and vertical polarization.

*(b)* Bare hills of approximately cylindrical shape.

When the transmitter and receiver are placed close to and on opposite sides of the obstacle, the theory of diffraction around a cylindrical or spherical surface is applicable.

When the transmitter and receiver are not very distant from the obstacle, the joint method of reflection and diffraction may be used. The diffraction around the obstacle between the tangents from the transmitter and the receiver is calculated as the associated exponential attenuation given by the diffraction formula.

When the two terminal points are very remote from the obstacle, the two treatments described in *(a)* and *(b)* give approximately the same answer, since the effect of the obstacle in any case becomes small under these conditions.

The cases of propagation along and across valleys have not yet been analysed to the same extent and they are therefore, together with the most general case of very irregular terrain, recommended for further theoretical and experimental investigation in Study Programme No. 53 (IV).

* This Report was adopted unanimously. It replaces Report No. 2.

1.2 *Multiple obstacles.*

In the case of transmission over a path containing multiple obstacles, e.g. undulating country or mountain ranges, the field strength varies considerably with change of path length and direction. Experiments have shown that small movements of receiving location also give rise to marked changes of the received field strength.

For these reasons the variation of field strength has to be considered by statistical methods.

2. *Question No. 6 (IV), § 3.*

*The siting of aerials for very high frequencies.*

The problem of the siting of aerials is closely connected with the question of obstacles discussed above. It is advantageous to raise the aerials where possible, e.g. by placing them on hill tops, in order to reduce the effect of an intervening obstacle and to increase the visibility. Where the receiver is to be located on a hill top, a greater received signal may often be obtained by siting the aerial on the forward face rather than at the highest point of the hill. In simple cases it is useful to study the ground profile with regard to the avoidance of unwanted reflections ; in such cases it may be possible to place the receiving aerial so that it is screened from such reflections. Unfortunately in most practical cases conditions are exceedingly varied and complex and the experimental results cannot easily be explained. At this stage, therefore, the most appropriate method for siting a VHF aerial is usually the empirical one of trying it in various positions and at different heights on the desired receiving site.

3. *Question No. 6 (IV) § 4.*

*The relative effects obtained with horizontal and vertical polarization.*

The question of the relative merits of vertical and horizontal polarization is closely connected with the siting of the aerials in relation to irregularities of the terrain. Here again there is, except in the simplest cases, a similar lack of reliable experimental data. Therefore in this case also no precise general rules can be given, and it is best to adopt an empirical method of choosing the type of polarization.

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## REPORT No. 22 *

## FIELD STRENGTH MEASUREMENTS

### Merits of a standard noise generator as the source of the locally generated signal

(Question No. 8, § A.7)
(Study Group No. V)

(Geneva, 1951 — London, 1953)

The major advantage of a standard noise generator as a calibrator for a field-strength meter is its simplicity of operation. The generator needs no tuning ; therefore, there are no tracking problems.

The response of a receiver to a noise signal is a function of the receiver bandwidth, the gain, the overload characteristic, and its transient response. Care must therefore be exercised in using a standard noise generator as a field strength meter calibrator. If the bandwidth is governed by

* This Report was adopted unanimously. It replaces Report No. 6.

the intermediate frequency amplifier over the entire frequency range of the receiver, the ratio of the response of the receiver to a sine wave to its response to a noise signal may be established for a single frequency, and the standard noise generator may be used to standardize the gain at all other frequencies.

The use of a standard noise generator as a calibrator is not recommended for field strength meters in the following cases :

— if for some reason the bandwidth of the receiver is not likely to remain constant over the entire frequency range ;
— if the receiver has any significant spurious responses (e.g. image-frequency response) ;
— if the receiver response is to any degree non-linear or has an unsuitable transient response.

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REPORT No. 23 *

# PRACTICAL USES AND RELIABILITY OF IONOSPHERIC PROPAGATION DATA

(Question No. 50)

(Study Group No. VI)

(London, 1953)

## A. *Practical uses*

1. *Introduction.*

Propagation in the band 3 to 30 Mc/s over any but the shortest distances is practicable mainly because of the possibility of obtaining ionospheric reflections which suffer only small attenuation. Satisfactory communication on a given circuit can generally be obtained, however, if the operating frequency lies between a lower and an upper frequency limit (LUF and median MUF respectively) determined by ionospheric characteristics. Since only a limited range of frequencies can be used it is desirable to have, as far in advance as possible, information on the probable values of these upper and lower limits.

In recent years many administrations operating services in the H.F. band have tended to place greater reliance on ionospheric forecasts and less on past experience. This is due to the realization that it is essential to make the most economical use of the limited resources both in equipment and frequency channels. It is clear from the documents submitted to Study Group No. VI at Stockholm (1952) and London (1953) that many operators are making great use of ionospheric forecasts either prepared in their own countries or obtained from abroad.

2. *Long-term forecasts.*

Organizations in several countries now make forecasts of ionospheric conditions up to 6 months in advance ; the following are known to exist :

| | | | |
|---|---|---|---|
| *(a)* | C.R.P.L. | Washington, U.S.A. | Central Radio Propagation Laboratory |
| *(b)* | I.P.S. | Sydney, Australia | Ionospheric Prediction Service |
| *(c)* | R.R.L. | Tokyo, Japan | Radio Research Laboratory |

* This Report was adopted unanimously.

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|---|---|---|---|
| *(d)* | R.R.S. | Slough, England | Radio Research Station |
| *(e)* | Gea Method | Madrid, Spain | |
| *(f)* | S.P.I.M. | Paris, France | Service de prévision ionosphérique militaire |
| *(g)* | F.T.Z. | Darmstadt, Germany | Fernmeldeltechnische Zentralamt |
| *(h)* | T.R.L. | Johannesburg, Union of South Africa | Telecommunication Research Laboratory |

Except in the case of *(e)* these forecasts are based on an estimated level of solar activity for a specific month and the seasonal characteristics of the ionosphere are allowed for in detail. The usual applications of these forecasts are :

*(a)* Allocations, in advance, to specific circuits of the most suitable of the available frequency assignments, for the time of day, season and level of solar activity ;

*(b)* Choice of times of frequency changes during day and night ;

*(c)* Selection of times for maximum traffic density on difficult circuits ;

*(d)* Selection of suitable equipment and frequency for circuits in temporary use for special purposes, including the operation of relays ;

*(e)* Monitoring of spectrum usage.

3. *Short-term forecasts of disturbances.*

As far as is known the following sources of short-term forecasts exist :

| | |
|---|---|
| Australia | Mt. Stromlo Observatory |
| France | Warnings radiated from Pontoise |
| Japan | Warnings radiated from JJY |
| U.S.A. | Warnings radiated from WWV and WWVH |
| U.S.A. | C.R.P.L. Series J |
| U.S.A. | R.C.A. Inc. |
| New Zealand | Carter Observatory |
| India | Kodaikanal Observatory |
| Germany | Darmstadt (F.T.Z.) |

Both long and medium term forecasts are intended to refer to normal ionospheric conditions. The occurrence of ionospheric disturbances may considerably modify the frequency range within which satisfactory operation can be maintained on a particular circuit. Under these circumstances reliable notification of impending ionospheric disturbances may be of considerable value, as follows :

*(a)* Making temporary adjustments to operating frequencies or transmitter powers ;

*(b)* Arrangements for the use of relay stations ;

*(c)* Re-routing of priority traffic ;

*(d)* Assessment of direction-finder fixes ;

*(e)* Investigation of reasons for interference

*(f)* Deployment of operating staff.

4. *Propagation calculations for long-term planning.*

The following sources of computed values of MUF, FOT, and field strength are available :

P.F.B. (Geneva) Charts and Tables produced by C.R.P.L. at the request of the Atlantic City conference (1947).

I.H.F.B.C. (Mexico City) Graphs (1949).

Australian I.P.S. Contour Maps (1947, also 1951 edition).

During previous conferences the basic propagation data were used for the preparation of international frequency assignment plans. Other uses within certain administrations for such data are :

*(a)* Fixing of frequency range and power output of new equipment for specific circuits ;

*(b)* Design of aerials ;

*(c)* Selection of location of terminal and relay stations ;

*(d)* Assessment of field-strengths in connection with interference problems.

As the above mentioned data were produced some years ago when there was less basic understanding of the physical properties of the ionosphere, their accuracy is, of course, less than that of the current long term forecasts. Discretion should therefore be exercised in their further use.

B. *Reliability of forecast ionospheric data*

1. *Introduction.*

The following C.C.I.R. documents and published data have been examined and provide most of the information on which this survey of the reliability of ionospheric forecasts is based.

| | |
|---|---|
| Stockholm Documents (1952) | Nos. 20 (United Kingdom), 21 (Sweden), 41 revised (Provisional Report). |
| London Documents (1953) | Nos. 25 and 26 (New Zealand), 144 (Japan), 224 (United States of America), 231 (Japan), 233 (Spain), 248 (Switzerland), 257 (Australia), 280 and 281 (Spain), 303 (Switzerland), 309 (France) and 345 (Italy). |
| Wilkins and Minnis | Proceedings of the Institute of Electrical Engineers (I.E.E.), May 1951. |
| Mlle G. Pillet | Note préliminaire du Laboratoire National de Radioélectricité, No. 166, 1953. |

Some of these sources refer to the accuracy of the forecasts over fairly short periods when applied to circuits ; others deal with what may be called typical samples of all possible circuits over fairly long periods. When drawing conclusions on the accuracy of predictions from information obtained from operational sources, it is necessary to ensure that the signals were in fact propagated substantially over the great circle path assumed in making the prediction and not by scattering.

2. *Median MUF.*

It seems fair to say that, when a sufficiently representative sample of circuits is examined, the differences between the observed and forecast values of the median MUF tend to be spread fairly evenly on either side of zero. Any bias which may exist appears to be in the direction which makes the forecast median MUF less than the observed one. On the other hand, examination of reports on individual circuits for particular periods suggests that at certain times, and for circuits in certain parts of the world, rather large errors can exist. For example, circuits between Europe and the Far East have a median MUF in summer which is higher than that forecast assuming that only F2 propagation is effective.

It is well known that in the preparation of the charts of basic forecasts from which the median MUF curves used by operating organisations are drawn, numerous sources of possible error exist. Some of these are due to errors made by the forecaster in estimating the future value of the sunspot number ; such errors will give rise to differences between the forecast and observed values of median MUF of the same sign in all parts of the world. Another major source of error lies in the use of the existing system of dividing the F2 region into three zones. This leads to positive or negative errors depending on the geographical location of the control points, and also on the way in which the forecaster has chosen the "typical" values for foF2 in each of the zones.

With the exception of one or two administrations, it is usual for operating agencies to compute the median MUF for long distance circuits assuming propagation via the F2 layer only. It seems likely that, at certain seasons in some parts of the world, propagation may be controlled, not by the F2 region, but by some mechanism within the E region. This form of propagation will tend to increase the median MUF to a value higher than that forecast when taking into account only F2 layer propagation and may account for part of the discrepancies observed in summer on circuits between Europe and the Far East.

The conversion of vertical incidence critical frequencies to MUF's at oblique incidence is achieved by the use of the MUF factor calculated on the assumption of a simple relation between electron density and height of the F2 layer. Oblique incidence soundings show that in many cases this assumption is not correct ; further, there is some experimental evidence which, though limited at present, suggests that the MUF factor as measured directly is in disagreement with the calculated value.

It is clear therefore that there are a sufficient number of known causes of error in forecast median MUF's to account for the discrepancies which have been reported even under conditions of correct solar predictions. An estimate of the relative importance of these errors suggests that the following are the major contributory factors :

— oversimplified picture of the modes of propagation,
— use of the present zonal system,
— inadequate coverage both in location and number of ionosphere sounding stations.

So far as is known the contribution from errors in calculating MUF factors is of secondary importance.

Assuming that the considerations outlined above are correct, it follows that, in general, the accuracy of median MUF forecasts cannot be much improved by removing any single source of error but rather that a simultaneous attack needs to be made in an effort to reduce them all. Where, in specific cases, it is known that observed errors are predominantly due to a particular cause then, of course, appropriate steps may be taken to deal with this ; however, in the majority of cases it seems possible that the error source responsible may not be easily identifiable. Pending the development of better methods of making median MUF forecasts, the desirability of making temporary empirical corrections has been recognised. This has been partially successful, for example, on the London-Australia circuit where the I.P.S. has introduced an empirical factor. A second example occurs in the Tasman Sea area where an empirical correction to the MUF factor appears to be required.

3. *Gea method.*

The foregoing discussion refers to the generally accepted method of forecasting the median MUF from which the FOT may be deduced. The Gea method however takes no account of the changes in solar activity which are known to play a predominant role in determining ionospheric characteristics ; further it implies a constant value for foF2 at sunrise and sunset, and also a constant rate of change of foF2 with time. In practice measured values of these parameters are found to vary over wide limits depending on geographical location. In consequence of these facts it is difficult to see how this method can be relied on to give accurate results for other than a few specific circuits at certain times.

4. *LUF.*

The main methods of forecasting the lower limiting frequency are those employed by C.R.P.L. and S.P.I.M. Insufficient work has been published on the use in practice of these methods to allow any worth while assessment to be made of their reliability.

There also exists the Absorption Limiting Frequency (A.L.F.) produced by the I.P.S. of Australia ; as this method takes no account of such obviously important factors as noise, transmitter powers or gains of aerials it can be considered to be a first approximation only.

5. *Short-term forecasts.*

Short-term forecasts of ionospheric disturbance are made in a number of countries. Near sunspot minimum these appear to be fairly accurate on account of the strongly developed recurrence tendency of disturbances ; during high solar activity the reliability is considerably less. The problem of assessing the value of disturbance forecasts is bound up with the nuisance caused by false alarms which at present are inevitable. In spite of this, several organizations consider such services to be worth while.

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## REPORT No. 24 *

## QUESTIONS SUBMITTED BY THE I.F.R.B.**

(Study Group No. VI)

(London, 1953)

The C.C.I.R. is not yet in a position to supply direct and unequivocal replies to the three questions submitted by the I.F.R.B.

In connection with question *(a)*, the reasons for this are made clear in the Study Programme No. 60 (VI) which replaces Question No. 50.

In connection with question *(b)*, the reasons for this are made clear in Recommendation No. 115.

In connection with question *(c)*, the C.C.I.R. considers that although the general mechanism of propagation of waves of medium-, low- and very low-frequency through the ionosphere is understood, our detailed knowledge is far from complete, especially the knowledge of the variation of the signal strength with time of day, season, latitude and phase of the solar cycle.

The C.C.I.R. is in a position now to recommend the use, on a provisional basis only, of the long and medium wave night propagation curves adopted in Cairo 1938, taking into account modifications made by the European Broadcasting Conference in Copenhagen.

Question *(c)* is included in Study Programme No. 64 (VI).

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* This Report was adopted unanimously.

** See Resolution No. 10.

## ANNEX

### Questions submitted by the I.F.R.B.

*Ionospheric propagation*

*Question (a) :*

What modification, if any, should be made to the master FOT curves used by the Mexico City High Frequency Broadcasting Conference in order to take into account experience acquired in subsequent years ?

*Question (b) :*

What is the best method of calculating field strength produced by a transmitter working on frequencies above 1500 kc/s by means of ionospheric propagation (distances up to 25 000 km) ?

*Note.* — In studying this question the material already submitted to the C.C.I.R. in answer to :

*(a)* C.C.I.R. Question No. 50 (Practical uses of radio propagation data) ;

*(b)* C.C.I.R. Question No. 69 (Best method for calculating the field strength produced by a tropical broadcasting transmitter) ;

*(c)* The draft recommendation (green sheet) * in C.C.I.R. Vol. I should be taken into account.

*Question (c) :*

What modification, if any, should be made to the C.C.I.R. long and medium wave night propagation curves adopted at Cairo in 1938 ? In particular they appear to need extension :

i) as a function of magnetic latitude,

ii) as a function of season,

iii) as a function of solar activity.

*Note :*

1. In revising and extending these curves attention should be paid to the shorter distances below 500 km (to allow, for example, for the evaluation of the effect of special vertical transmitting aerials designed to reduce fading in the outer part of the service area) and to distances beyond 2000 km (to allow for the evaluation of interference between regions).

2. While a long term study will be necessary for part *iii)*, information regarding i) and *ii)* might possibly be available in order to allow an early answer being given to this urgent question.

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* This draft Recommend tion has become Recommendation No. 115.

# REPORT No. 25 *

## CHOICE OF A BASIC INDEX FOR IONOSPHERIC PROPAGATION

(Question No. 53)
(Study Group No. VI)

(London, 1953)

1. *What are the desirable characteristics of a solar index which renders it most applicable to ionospheric propagation ?*

A satisfactory index based on solar measurements must be related simply to some index of ionospheric ionisation from which seasonal and diurnal cyclic effects have been removed. It is also desirable that the correlation coefficient between corresponding pairs of the solar and ionospheric indexes should be high.

In addition, it is desirable that the solar index should permit short term forecast of changes in propagation conditions to be made.

The index should preferably refer to a property of the sun, such as radiation flux, which has direct physical relationship to the ionosphere.

The index should be measurable objectively.

As far as short term variations are concerned, it should be borne in mind that some of the short period variations in ionospheric conditions are the result of complicated dynamical phenomena taking place in the upper atmosphere. A solar index, therefore, which can only reflect conditions taking place in the sun itself cannot portray quantitatively variations of ionospheric conditions over periods shorter than the minimum over which these dynamical effects are averaged out.

2. *What solar phenomena which can be observed in sufficiently objective manner, will provide a more useful index of activity for application to ionospheric propagation than relative sunspot numbers* ?

Solar phenomena which are useful as indexes of activity for application to ionospheric propagation, may be divided into two groups :

*(a)* Solar phenomena which can be observed by optical methods ;

*(b)* Solar phenomena which can be observed on radio frequencies.

For group *(a)* the total area of hydrogen or calcium flocculi or the total intensities of H $\alpha$ or other emission lines can be measured objectively. The total area of hydrogen or calcium flocculi appear to be slightly better correlated with ionospheric conditions than the sunspot number. On the other hand, such spectroscopic observations require better conditions of visibility than sunspot observations. This limits to some extent the availability of up-to-date data.

The total intensity of emission lines has not yet provided a useful index.

As far as is known at present, none of the solar phenomena mentioned above can be used as an index of short term variations of ionospheric propagation conditions.

* This Report was adopted unanimously.

As far as group *(b)* is concerned, an index of solar activity based on radio frequency observations, although it has been the object of several important researches, cannot be considered as perfectly defined at present. However, it has been shown recently that the intensity of solar radiation on 3000 Mc/s is a linear function closely linked with the area of spots visible on the sun and that a close correlation exists between the intensity of solar radiation on metric waves and the appearance of groups of active sunspots.

3. *What ionospheric characteristics which can be determined in a sufficiently objective manner, whenever observed, may be usefully employed as a basic index for ionospheric propagation?*

No agreement has yet been reached as to what ionospheric characteristic might be most usefully employed as a basic index for ionospheric propagation. There is hope, however, that even where it is not possible to construct an index based on an exact knowledge of the mechanism of formation of the ionospheric layers, it may still be possible to derive an index based on empirical relations.

Until further knowledge is available one of the following might be considered for use as an ionospheric index :

*(a)* Region character figure of the E and F1 layer respectively :

$$A_E = \frac{(foE)^4}{\cos \chi} \text{ is proportional to } \frac{I_E}{\alpha_E}$$

$$A_{F1} = \frac{(foF1)^4}{\cos \chi} \text{ is proportional to } \frac{I_{F1}}{\alpha_{F1}}$$

where :

$A$ = region character figure
fo = critical frequency
$\chi$ = zenith angle of the sun
$I$ = intrinsic intensity of ionising radiation
$\alpha$ = effective recombination coefficient of E and F1 layer respectively.

*(b)* Smoothed values of the critical frequency of F2 layer.

Changes in foF2 cannot be simply related to cos $\chi$ as for foE and foF1. For various reasons it is desirable to use noon values of foF2, or the mean of a group of hours centred on noon, and to averaged out daily fluctuations by computing the monthly mean. Having eliminated daily changes in this way, the removal of seasonal changes may be achieved by several methods :

b.1 The simplest procedure is to compute the 12-month running mean of the monthly values. This not only removes the annual cycle but also smoothes out any short-period changes in the true monthly value of the index, and this may not always be desirable. A further disadvantage of 12-month running means is that the most recent available value at any time always refers to a date six months earlier.

b.2 An index depending only on individual months can be derived by a method due to Allen (1) (2) who first deduced for a given observatory the monthly mean values of noon foF2 for zero sunspot number. The index for any actual month is then obtained by dividing the mean for foF2 for that month by the value for the corresponding month for zero sunspot number. The agreement between indexes of this kind calculated for a series of observatories was found to be good. There are, however, certain complementary features in the behaviour of the indexes in the N and S hemispheres. Consequently it would be advisable to combine the indexes from a suitably selected group of observatories to form a reliable index completely free from any seasonal effects. Also, in view of the anomalous behaviour of foF2 at Huancayo, discussed by Ratcliffe (3), care would be necessary in using data from equatorial observations in constructing an index intended to reflect the general level of solar activity.

b.3 When an observatory has been in operation for a complete solar cycle or longer, it is possible to deduce the relation between a monthly mean foF2 and some solar index such as sunspot number. Once this relation has been determined, it can then be used in reverse to convert an observed value of foF2 into an ionospheric sunspot number or, more correctly, an ionospheric index.

As to the choice of the ionospheric layer on which to base an index, two factors are relevant : the sensitivity of the critical frequency to change in solar activity, and the magnitude of irregular fluctuations in the critical frequency. Expressions given by Allen (2) allow the sensitivities of the three principal layers to be compared. Table I gives values $\frac{100}{f}\frac{df}{dR}$ where f = critical frequency, and R = sunspot number for each layer.

*Table I*

Sensitivity of critical frequency (f)
to change of sunspot number (R)

| Layer | R | |
|---|---|---|
| | 0 | 100 |
| E | 0.24 | 0.12 |
| F1 | 0.31 | 0.14 |
| F2 | 1.0 | 0.33 |

In the F2 layer the critical frequencies are two or three times more sensitive than those of the E and F1 layers to change in sunspot number and, therefore, in solar activity. This advantage must be balanced against the greater irregularity of foF2 particularly during disturbed conditions ; nevertheless, it seems likely that in spite of this defect, the F2 layer would provide a better index than either of the others.

A further reason for choosing the F2 layer would be that long distance communications depend mainly on the F2 layer ; an index based on this layer rather than the E layer would therefore be most likely to be capable of accurately defining ionospheric conditions on long communication circuits.

## BIBLIOGRAPHY

(1) Allen, C.W., *Terr. Mag.*, **51**, 1, 1946.

(2) Allen, C.W., *Terr. Mag.*, **53**, 433, 1948.

(3) Ratcliffe, J., *J. Geophys.*, **56**, 463, 1951.

# REPORT No. 26 *

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

(Recommendation No. 59)
(Study Group No. VI)

(London, 1953)

In pursuance of the measures recommended by the C.C.I.R. (Recommendation No. 59, Geneva, 1951) and U.R.S.I. (Sydney, 1952) for the rapid exchange of geophysical and solar information required for radio propagation disturbance forecasts, a first step in Ursigram centralization and in the unification of the codes used was taken on 1st July, 1952, with the inauguration of European Ursigram broadcasts from the French station of Pontoise. The information transmitted daily by that station emanates from French, German and Dutch scientific organizations.

The following messages are furnished by France and Germany : CHROM (solar chromosphere), CORON (solar corona), MAGNE (terrestrial magnetism), FODEU (F2 critical frequency) and ESFRE (Es critical frequency). SOLER messages (solar radio noise) are supplied by France and the Netherlands and CORAY (cosmic rays) by Germany.

In accordance with the recommendation of U.R.S.I., Pontoise has been broadcasting, several times per day since 1st January, 1953, daily European Ursigram programmes.

The Ursigram codes, times of transmission, and frequencies employed may be obtained from :

Bureau Ionosphérique Français
196, rue de Paris
Bagneux (Seine)

The second stage in the centralization process envisaged by U.R.S.I. is the transmission to Paris by electrical means, for subsequent incorporation in the Pontoise Ursigrams, of U.S.A. geophysical and solar data assembled in Washington, usable within 48 hours for short-term forecasting.

It is highly desirable that as many countries as possible should participate in carrying out the initial plan for Ursigram broadcasts on the international scale.

In France, ionospheric perturbation announcements are at present given in plain language after the Ursigram messages. They are also communicated by telephone to the main operating services.

In other countries the steps taken in compliance with Recommendation No. 59 are a follows :

(a) *United States of America.*

The basic data are sent by electrical means to the C.R.P.L. where the forecasts are prepared and then transmitted from WWV or WWVH depending on whether the forecast is applicable to the Northern Atlantic or Northern Pacific areas.

Details of times of transmission and frequencies used may be obtained from :

Central Radio Propagation Laboratory
National Bureau of Standards
Washington 25, D.C., U.S.A.

* This Report was adopted unanimously.

(b) *Federal German Republic.*

The basic data are sent by electrical means to the Fernmeldetechnisches Zentralamt at Darmstadt where the forecasts are prepared and sent by electrical means to transmitting and receiving centres operated by the Deutsche Bundespost and to other organizations in the Federal German Republic.

(c) *Japan.*

The basic data for both short-term forecasts and Ursigrams are sent by electrical means to the R.R.L. at Tokyo where the forecasts and Ursigrams are prepared. The short-term forecasts are broadcast from JJY and the Ursigrams from JJD. Details concerning times of transmission and frequencies in use may be obtained from :

Radio Research Laboratory,
Kokubunji P.O.,
Kitatama Gun,
Tokyo, Japan

(d) *New Zealand.*

The basic data are assembled by the Carter Observatory, Wellington where the forecasts are issued to the various transmitting and receiving centres operated by the Government agencies within New Zealand.

(e) *Netherlands.*

The basic data are assembled by the P.T.T. receiving station at Nederhorst-den-Berg (" Nera ") and distributed by telex to Darmstadt F.T.Z. and Paris B.I.F.

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REPORT No. 27

## FADING OF HF (DECAMETRIC) AND MF (HECTOMETRIC) SIGNALS PROPAGATED BY THE IONOSPHERE

(Questions Nos. 51 and 52 — Study Programme No. 24)
(Study Group No. VI)

(London, 1953)

I. *Scope of Report.*

As formulated in Geneva, Questions Nos. 51 and 52 and Study Programme No. 24, seek theoretical and experimental data on fading phenomena encountered in ionospheric propagation of waves of frequencies up to about 30 Mc/s, and engineering recommendations which allow account to be taken of fading in estimating the performance of radio circuits. Broadly, information has been sought on *(a)* the statistical representation of the variability of received signal strength, and *(b)* additional protection factors appropriate to the various classes of service (e.g. telephony, telegraphy, etc.) for preservation of a specified quality of service from the effects of a fading signal, when the required signal-to-noise or signal-to-interference ratios are known for stable (non-fading) signals. The latter aspect *(b)* concerning protection allowances has, during the course of the VIIth Plenary Assembly, been referred for separate consideration under Study Programme No. 8 (Study Group No. III) ; the present report deals with results concerning :

— the rapidity, severity and amplitude/time distribution of rapid or short-period variations of field strength, and the modification of this distribution by diversity systems ;
— the amplitude/time distribution of day-to-day variations of hourly median field strength.

II. *Summary of available data.*

Contributions (documents submitted) to the VIIth Plenary Assembly (References 1-6 incl.), earlier C.C.I.R. documents (References 7-14 incl.), and contemporary technical literature (References 15-27 incl.) warrant a report of results. A summary of information contained in documents of the VIIth C.C.I.R. follows :

*Doc. Nos. 22, 23, 24 (Federal German Republic).*

Observation of the variation of field strengths of HF (decametric) waves were conducted over a period of approximately one and a half months, using equipment which measures the length of time that the amplitude of a received signal lies within each of ten bounded ranges (although the documents report only results obtained over one and a half months, the measurements have continued over one year, and the results summarized below take advantage of new data available from the entire programme). WWV transmissions on 10, 15 and 20 Mc/s were received at Darmstadt using a rhombic antenna. The recording period for each set of observations was 30 minutes. The following results were obtained :

1. Fading observed over an interval of 30 minutes gives a log-normal amplitude distribution of the received field strength. This is considered, for further analysis, to represent the hourly distribution.* The hourly deviation $\sigma$ 10%, or ratio of the amplitude exceeded 10% of the time to the median value, $F_m$, has a mean value of 7 db, for the propagation path and frequencies considered. Thus, according to the log-normal distribution, the hourly ratio of the amplitudes exceeded 90% and 10% of the time is $2 \times 7 = 14$ db. The deviation is nearly independent of the time of day, date of reception, and nearly independent of frequency over the range considered.

2. To account for daily variations of the median value $F_m$, $\sigma_{Fm}$ is used to indicate (for any given hour of the day) the monthly deviation of the hourly median values. An average value of 11 db is obtained for $\sigma_{Fm}$ observed at 10, 15 and 20 Mc/s ; the figure may have some dependence on frequency, but information so far obtained is considered inadequate for reliable conclusions to be drawn. To what extent $\sigma_{Fm}$ can be considered constant from month to month depends on the results of further measurements.

3. The apparatus used for recording also counts the number of times a given level (roughly the amplitude exceeded 90% of the time) is exceeded and hence gives a measure of the rapidity of fading. Distribution curves were obtained for the number of times per minute, D, that the reference level is exceeded for the three frequencies investigated. Approximately Gaussian distribution is obtained for log. D. The results can be summarized as follows :

| Frequency | Median value of D | D exceeds the value given in this column in 10% of the cases |
|---|---|---|
| 10 Mc/s | 28.0 | 80 |
| 15 Mc/s | 12.0 | 50 |
| 20 Mc/s | 9.2 | 23 |

* Measurements taken over an interval longer than half an hour, particularly near the times of sunset and sunrise, tend to include systematic diurnal changes in field strength, as well as fading.

*Doc. No. 306 (France).*

Additional statistical analyses have been made of field fluctuations recorded at Bagneux (reported in Doc. No. 274, Geneva) for the following transmitters :

| | | |
|---|---|---|
| WWV | 20 Mc/s, | 6000 km path |
| Leipzig | 9.732 Mc/s, | 760 km path |
| Allouis | 6.2 Mc/s, | 180 km path |
| Wavre | 4.13 Mc/s, | 260 km path |
| Limoges | 0.710 Mc/s, | 330 km path |

Each recording was first analyzed in intervals of a few minutes, usually five minutes, with the exception of Limoges for which the fluctuations were sufficiently slow for the analysis to be made in sections of one hour. Because different conclusions have been reached in statistical analysis of field fluctuations on HF (decametric) waves by authors who considered fading over longer time intervals, of the order of an hour, the field recordings were further analyzed, over intervals of about 30 minutes.

The distribution approximates Rayleigh's law for time intervals of a few minutes, and the log-normal law for intervals of half an hour. The longer time interval is observed to contain slow fluctuations of the field on H.F. (decametric) waves superimposed on the rapid fluctuations resulting in a modification of the statistical distribution. On WWV recordings for example, such intervals cover both rapid fading and slow fluctuations of about fifteen minutes duration.

It is concluded that field fluctuation on HF (decametric) waves involves at least two different principal phenomena :

*(a)* interference between waves traversing different paths, giving rise to rapid fading showing a Rayleigh distribution ;

*(b)* the variability of ionospheric absorption within an interval of the order of half an hour or longer is shown by the slower fluctuation of the field and may be represented statistically by the log-normal distribution.

It is recommended that further studies should consider these phenomena separately and should also take into account the type and dimensions of the receiving antenna by making measurements with a small antenna, as well as with various regular communication antennae.

*Doc. Nos. 145, 146 (Japan).*

Two studies have been reported on.

The first is a theoretical analysis of fading phenomena in HF (decametric) propagation, as related to the mechanism of the interference of multiple modes reflected from a turbulent ionosphere (References 23, 24). Using experimentally observed amplitude distribution and rapidity of fading (obtained from field strength recordings of JJY on 4 and 8 Mc/s, carried out for one or two weeks every season since 1948) and assuming the average values, and distribution of fluctuation of atmospheric density and electron density of the ionosphere, it is shown that the mean square path difference

$$\frac{\overline{\Delta p^2}}{\lambda^2}$$

can be calculated and considered a useful parameter for the determination of fading factors.

The second report analyses experimental results on fading observed at night on medium frequencies (in the range 540-1600 kc/s) transmitted by seven broadcasting stations located at distances ranging from 300 to 1000 km from the Tokyo receiving station, over twelve months starting in November 1951. Each period of measurement was 20 minutes, and about seventy sets of measurements were used for each station and antenna. At the receiver either a loop or a vertical antenna was used, and the time constant of the recorder was 0.05 sec. For all observations the median value of D, i.e. the ratio between the quasi-maximum (level exceeded 5% of the time) and the median value, is 6.4 db. It is almost independent of frequency, distance, season, and type of receiving antenna, under the conditions of the experiment. The individual values of D fluctuate from 4 to 10 db, with a tendency, at long distances, for the values to become slightly less. Concerning the rapidity of fading, N (the number of times per minute the median value of field strength is exceeded), shows variation with frequency, path length (including the effect of varying angle of incidence at the ionosphere), and season. The median values of N, for a given season, path and frequency, lie in the range from 0.4 to a little less than 3.0. Within this range, N increases with increasing frequency, decreases with increasing path length, is a maximum in summer and a minimum in winter. Individual values of N fluctuate from about $^1/_3$ to 3 times the yearly median value.

*It is concluded:*

*(a)* that D probably keeps its characteristic value expected from the Rayleigh distribution ;

*(b)* that N changes to a comparatively great extent ;

*(c)* that both D and N show some influence from the radiation characteristics of the antennae, unless the waves arrive by a single hop.

*Doc. No. 27 (New Zealand).*

Based on day-to-day operational experience on point-to-point circuits, and on high frequency broadcast data, 6 db as an allowance for variation from hour to hour (Part 2, Question No. 52) is considered to be a reasonable value.

As regards Part 4 of Question No. 52, work is proceeding in New Zealand on the measurement of ionospheric winds in the E and F layers using the Mitra (Cavendish Laboratory) method. From the recorded data of this work much information can be deduced on the rapid, hourly and possibly the daily variations of fading.

*Doc. No. 443 (United States of America).*

References are given to earlier and current C.C.I.R. documents and contemporary technical literature, and it is concluded that :

*(a)* the Rayleigh distribution adequately represents the rapid fading amplitude distribution of a received ionosphere-reflected high-frequency signal, when rapid fading is considered over a five minute period ;

*(b)* that the amplitude distribution of short-period fading (fifteen minutes to about one hour) is represented by the log-normal distribution, the ratio of the field exceeded 10% of the time to the field exceeded 90% of the time being approximately 14 db ;

*(c)* that for periods from five to fifteen minutes, the average amplitude distribution is between a Rayleigh and a log-normal distribution. In general, the longer the interval, the higher the frequency, and the higher the latitude of the path, the more nearly the average fading approaches log-normal distribution.

Other results reported in the U.S. Document, such as the ratios of two signals each fading independently and the values for the fading safety factor with and without diversity operation, are considered appropriate to the question of allowance for fading applicable to the various classes of service separately dealt with by Study Group No. III.

*Doc. No. 286 (Permanent Secretariat of the C.C.I.R.).*

*Diversity systems.*

The improvement obtained by the use of diversity systems, with respect to the percentage of the time the signal falls below a specified value, can be calculated by a simple mathematical method which is the same for *space diversity*, *frequency diversity*, and *polarization diversity* ; the only requirement is that the fading of the individual signals be uncorrelated.

When $\overline{f_n}$ (F) is the distribution curve for the amplitude of the signal received in the $n^{th}$ element of a diversity system, $\overline{f_n}$ meaning that the level F *is exceeded* for $\overline{f_n}$% of the time, then $f_n$ (F), the percentage of time for which the signal falls *below* F, is obviously $100 - \overline{f_n}$ (F).

The percentage of the time, $f_o$ (F), for which n signals will simultaneously fall below F is :

$$f_o (F) = f_1 (F) \cdot f_2 (F) \cdot f_3 (F) \ldots\ldots f_k \ldots\ldots f_n (F)$$

and when each of the n signals has the same probability distribution :

$$f_o (F) = f^n (F)$$

In the special case of Rayleigh distribution, and for n = 1, 2, 3, 4 and 9 diversity elements, the following table shows the percentage of time during which n signals fall simultaneously below 1/20, 1/10, 2/10, 3/10 and 10/10 of the median value $F_m$ of the signal for any one receiver.

PERCENTAGE OF TIME n SIGNALS FALL SIMULTANEOUSLY BELOW A GIVEN LEVEL

| Amplitude relative to median level | db relative to median level | Number of diversity elements | | | | |
|---|---|---|---|---|---|---|
| | | n = 1 | n = 2 | n = 3 | n = 4 | n = 9 |
| 1/20 $F_m$ | −26.0 db | 0.12 % | 0.0003 % | — % | — % | — % |
| 1/10 $F_m$ | −20.0 | 0.70 | 0.005 | — | — | — |
| 2/10 $F_m$ | −14.0 | 2.8 | 0.08 | — | — | — |
| 3/10 $F_m$ | −10.5 | 6.2 | 0.39 | 0.02 | — | — |
| 10/10 $F_m$ | 0 | 50.0 | 25.0 | 12.5 | 6.2 | 0.20 |

III. *Conclusions.*

Final results have not been obtained in respect to Study Programme No. 24, nor answers to Questions Nos. 51 and 52. There remains a need for further studies of fading in ionospheric propagation, in respect of rapidity, depth and amplitude/time distribution of rapid or short-period fading, as well as on day-to-day variations, and the dependence of these factors on frequency, path length, geography, and level of solar activity. With respect to diversity systems the theoretical calculations have been based on the assumption of random correlation between signals received in all pairs of elements of a diversity system.

Further experimental data are needed regarding the extent to which this condition is achieved in practice, as a function of spacing of antennae or frequencies, as well perhaps, as the realizability of a certain degree of negative correlation.

Under the conditions of the experiments (and from theoretical calculations for diversity reception) reported above, it has been found that :

*(a)* The amplitude distribution of rapid-fading (observed over a period of about five minutes or less) ionosphere-reflected signals follow the Rayleigh distribution *. The amplitude distribution of all fading observed over a period from about fifteen minutes to an hour, excluding systematic diurnal trend of the median level, follows a log-normal distribution ** for which the deviation, or ratio of the level exceeded 10% of the time to the median level, is 7 db. For periods of from about five to fifteen minutes, the amplitude distribution is between Rayleigh and log-normal. In general, the longer the interval, the higher the frequency and the higher the latitude, the more nearly the average fading approaches the log-normal. For intervals up to as long as 20 minutes, night-time fading of medium frequencies has shown a Rayleigh distribution. All of the foregoing applies to single frequency, single antenna transmission and reception. The results do not apply directly to fading of total power in the sidebands of radiotelephone transmission, or other systems where a diversity effect occurs ;

*(b)* A 10 db allowance is reasonable for day-to-day variations, in a given month, of the hourly median field strength for any given hour throughout the day ; this figure represents, for a given hour, an average ratio of the hourly median exceeded 10% of the days to the monthly median ;

*(c)* To obtain the probability that n signals received in a diversity system will fall simultaneously below a given level, the cumulative probability function characterizing the distribution of one signal should be raised to the nth power.

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* The distribution curve following *Rayleigh's law* is given by

$$P(E) = e^{-0.693\ (E/E_m)^2}$$

where :

P (E) is the probability (fraction of the time) that the level of field strength E will be exceeded.
$E_m$ is the median value of field strength.

The Rayleigh distribution is uniquely determined by the choice of the value $E_m$. In order to decide whether a measured distribution curve corresponds to a Rayleigh distribution, it is useful to plot the curve on special coordinates, in which the Rayleigh distribution is shown as a straight line (Log P (E) is the ordinate, $(E/E_m)^2$ the abscissa).

** The log-normal distribution curve following the Gaussian law is given by :

$$P(F) = \frac{1}{\sigma\sqrt{2\pi}} \int_F^{\infty} e^{-\frac{1}{2}\left(\frac{f-F_m}{\sigma}\right)^2} df$$

where :

P (F) is the probability (fraction of the time) that the field strength F (in db above 1 μV/m) will be exceeded.
$F_m$ (in db) is the median value of field strength.
$\sigma$ is the standard deviation in db, so that :

$$P(F_m - \sigma) \sim 84\%$$
$$P(F_m + \sigma) \sim 16\%$$

The log-normal distribution is uniquely determined by the choice of two parameters $F_m$ and $\sigma$. The deviation is expressed in practice for probabilities other than the value of 84% associated with the standard deviation. The 10% and 1% deviations are, for example,

$$\sigma_{10\%} = F(10\%) - F(50\%)$$
$$\sigma_{1\%} = F(1\%) - F(50\%)$$

The two deviations are related to the standard deviation according to :

$$\sigma_{10\%} = 1.28\ \sigma$$
$$\text{and} \quad \sigma_{1\%} = 2.32\ \sigma$$

When it can be assumed that a measured distribution corresponds to a log-normal distribution, it is convenient to plot the distribution on probability paper, having a system of coordinates with a scale taking account of the Gaussian law. The field strength should be plotted along the ordinate and expressed in db relative to 1 μV/m. If the percentage of time, or cumulative probability, plotted along the abscissa follows the Gaussian probability law, the logarithmic normal distribution gives a straight line.

*Note by the Director. — The term " distribution " refers here to the integral of the probability density.*

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## REPORT No. 28 *

## CENTRALISING AGENCIES FOR THE RAPID EXCHANGE OF INFORMATION ON PROPAGATION

(Recommendation No. 11, § 1)
(Study Group No. VI)

(Geneva, 1951 — London, 1953)

The following have been designated by their respective countries as the official agencies for the reception, co-ordination, liaison and exchange of information relating to radio propagation.

* This Report was adopted unanimously. It replaces Report No. 10.

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Dirección General de Correos y Telecomunicación
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Note : All messages should begin with the word " Ionosphere ".

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# REPORT No. 29 *

## STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Question No. 54)
(Study Group No. VII)

(London, 1953)

The Atlantic City Radio Conference (1947) charged the C.C.I.R. with the task of studying the establishment and operation of a world-wide standard-frequency and time service. This study raises many problems that can only be solved by practical experience with experimental transmissions from many points, this being a long term process. The progress of the work is to some extent apparent from the Study Programmes and Recommendations produced by successive C.C.I.R. meetings **. This report gives a connected account of the work done so far and the plans for its continuation in the future, and it includes important information that does not appear in the formal Recommendations and Study Programmes.

At the time of the Vth C.C.I.R. Plenary Assembly, Stockholm 1948, there was only one standard frequency station, WWV Washington, U.S.A., in operation and it was broadcasting continuously on all the standard frequencies assigned at Atlantic City. By the time of the VIth C.C.I.R. Plenary Assembly, Geneva 1951, WWV had been joined by experimental stations in Hawaii (WWVH), Rugby, England (MSF), and Torino, Italy, the first with a substantially continuous service on three frequencies (5, 10 and 15 Mc/s), the others with comparatively short daily or weekly broadcasts. In addition JJY, Tokyo, Japan, was broadcasting continuously on 4 and 8 Mc/s. Between the VIth (Geneva 1951) and VIIth (London 1953) C.C.I.R. Plenary Assemblies, MSF went into continuous service on three frequencies (2.5, 5 and 10 Mc/s) and JJY commenced weekly experimental transmissions on each of the same three frequencies. Continuous transmissions were started on 5 Mc/s from the Union Observatory, Johannesburg, South Africa, call sign ZRE 21. A low power (20 Watt) transmission was also started from the observatory at Uccle, Belgium. Associated with these developments in transmissions there has been ample evidence of the ever-increasing demand for and use of standard frequency broadcasts, particularly the time signals.

At the London meeting plans were announced for continuous transmissions on 2.5, 5 and 10 Mc/s from station JJY, the precise arrangements for the 10 Mc/s and transmissions being dependent on the degree of mutual interference between JJY and WWVH ; some time-sharing arrangement may prove to be necessary. It was also announced that preparations were in hand for daily (1600-1700 hrs. U.T.) transmissions on 5 Mc/s from Torino, now with the call sign IBF, in addition to the existing Tuesday transmissions.

The ultimate objective of the work is the establishment of a continuously available world-wide standard-frequency and time service in the frequency bands allocated by the Atlantic City Radio Conference and, from evidence presented to the London meeting, it appears that, by suitable choice of the frequency by the user, a service is available at all hours over North America, much of the Pacific Ocean, and much of Europe, by stations WWV, WWVH and MSF. The tests made by station JJY on 2.5, 5 and 10 Mc/s show that the whole of Japan will receive a continuous service from this station when the forthcoming continuous transmission commences ; no doubt the service area will extend far beyond the borders of Japan. There will still remain however many large and populous areas of the world, such as South America, parts of Africa, parts of Asia and Australasia, where the service is no more than intermittent, and the same applies to some important shipping and air routes. This state of affairs can only be remedied by the provision

* This Report was adopted unanimously.

** Recommendation No. 18, Recommendation No. 70, Study Programme No. 25, Recommendation No. 122, Study Programme No. 68 (VII).

of additional transmissions from suitably located points. In this connexion it is pertinent that very useful results are being obtained with transmitter powers of the order of 1 kW (WWVH, MSF, IBF, JJY) ; it is clear that large and expensive transmitters are not necessary.

At many places where strong signals are received from one or more standard frequency stations the service is often rendered useless for long periods by interference from communication stations. Since the standard frequency and time service is intended to be of general benefit, administrations are urged to co-operate in clearing the standard frequency bands (Recommendation No. 122). As long as the existing interference continues the proposed simultaneous interruption of transmissions from all standard frequency stations, so that radio noise may be measured, would be of little value and for the time being it is not considered useful to include this question in Recommendation No. 122 and Study Programme No. 68 (VII).

Mutual interference between standard frequency transmissions has been regarded as a potential source of serious trouble from the inception of the work. The evidence available at present shows that such interference causes little trouble to the " ordinary " user of the service, who is interested in time or frequency calibrations of moderate accuracy, say 1 part in $10^6$ in terms of carrier frequency, or to rather better than 1 second in terms of time. Specialist users interested in precise frequency comparisons or time determinations, are however often seriously inconvenienced ; highly accurate frequency comparisons are practically impossible when two signals of comparable strength are present. Highly accurate frequency calibrations are being made to an increasing extent in terms of time signals, which are less disturbed by mutual interference and which are less subject to Doppler errors. In the case of time signal transmissions mutual interference gives rise to the difficulty of identifying the signals that originate independently at the different stations and the proposals, made at earlier meetings, for the use of different sub-carrier frequencies and for time-sharing are continued in Recommendation No. 122 and Study Programme No. 68 (VII). Experience has shown that highly accurate time signal measurements can be made, despite the presence of more than one signal, by the use of a suitable cathode ray oscilloscope display.

The main criticisms of the time signals have been in terms of *(a)* inadequate power, *(b)* poor identification of the minutes, and *(c)* interference from additional audio frequency modulation. The second and third of these have given rise to definite recommendations for positive minute identification by lengthening the first impulse of each minute and for the inclusion in the programme cycle of a transmission of a reasonably long period of time impulses unaccompanied by any other modulation (Recommendation No. 122). Several proposals have been made for increasing the energy content of the time impulses and these are incorporated in Study Programme No. 68 (VII). If the energy content of the time impulses can be greatly increased, for example by the use of high-peak-power pulse transmitters, the reception of a distant transmission in the presence of a local one, as is required in several important scientific uses, for example propagation-time determination, will be greatly facilitated.

It is hoped that the preparation and distribution of reports on the deviations and adjustments of standard frequency transmissions (Recommendation No. 122) will be expedited in the future. Reports relating to stations JJY and IBF will be available in the near future. Since the reports relating to one station are of particular interest to those concerned with the operation of another, it is proposed that the reports could usefully be interchanged directly between the stations, as well as through C.C.I.R. channels, to reduce delay. The Forms B, C and D called for in Study Programme No. 25 have been little used. It is considered that their value does not merit the considerable labour involved in their regular preparation and distribution. It has been decided to discontinue their distribution and to rely on the normal conference documents submitted by administrations to the C.C.I.R. for information on service and interference areas. It is thought that direct action by an administration operating a standard frequency station that suffers interference from a communication service is more likely to produce rapid and effective results than the passing of reports through C.C.I.R. channels.

Reference to propagation disturbance warnings, which was included in the recommendations of earlier meetings, has been omitted from Recommendation No. 122 because of the difficulties that would arise if several different standard frequency stations all broadcast propagation information, which would in general differ from station to station, for it would refer to different radio paths. Also it is feared that if the amount of such information included in standard frequency transmissions were to increase greatly, the usefulness of the transmissions for their primary purpose would be decreased. The U.S.A. and Japan, however, declared their intention of continuing their broadcasts of ionospheric information in their standard frequency transmissions.

On the other hand Study Group VI have proposed (Study Programme No. 62 (VI)) a technique to facilitate the use of standard frequency transmissions for field strength measurements in propagation studies. The study of this problem has been included in Study Programme No. 68 (VII).

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## REPORT No. 30 *

## THE USE OF RADIO CIRCUITS IN ASSOCIATION WITH 5-UNIT START-STOP TELEGRAPH APPARATUS

(Question No. 19 — Study Programme No. 27)
(Study Group No. IX)

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

CONSIDERING :

*(a)* That Art. 34, § 3 of the Telegraph Regulations (Paris Revision, 1949) recommends the use on international telegraph circuits, subject to certain reservations, of 5-unit apparatus employing the International Telegraph alphabet No. 2 ;

*(b)* That it is desirable to provide simple means of interconnecting wire and radio circuits ;

*(c)* That considerable use is being made of synchronous and start-stop telegraph systems on international radio circuits ;

*(d)* That the use of the 5-unit code, particularly in start-stop systems, is liable to errors not immediately detectable ;

*(e)* That the use of special codes on the radio circuit permits a reduction in the number of errors ;

UNANIMOUSLY REPORTS AS FOLLOWS :

In considering whether or not to adopt synchronous or start-stop systems using 5-unit code on radio circuits, administrations recognize that :

**1.** Synchronous systems generally give rise to fewer errors than do start-stop systems operating at the same or somewhat lower baud speeds, and that the poorer performance of the latter is partly due to the transient loss of synchronism that may follow the mutilation of a start or a stop signal ;

**2.** Another factor handicapping the start-stop system is its inherently smaller tolerance to distortion ;

**3.** Notwithstanding factors 1. and 2. above, the quality of the radio transmission and certain operational factors, including the minimum accuracy necessary for the type of traffic being handled and the volume of such traffic, will largely determine whether synchronous or start-stop systems are preferable in any particular case.

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* This Report was adopted unanimously.

# REPORT No. 31 *

## WIDE-BAND RADIO SYSTEMS OPERATING IN THE VHF (METRIC), UHF (DECIMETRIC) AND SHF (CENTIMETRIC) BANDS

(Study Programm No. 28 (IX))
(Study Group No. IX)

(London, 1953)

After considering the various documents submitted by administrations in connection with Study Programme No. 28 (IX) the VIIth Plenary Assembly of the C.C.I.R. finds that it is clear that this work is of a very long term nature. Indeed it is for consideration whether or not it is practicable at the present stage of development of the types of system being considered to be specific about many of the subjects mentioned in the Study Programme. The process of engineering evolution does not appear to have gone far enough for judgments to be made which may not be shown to be wrong at a later stage of development. The C.C.I.R. has therefore decided to retain the Study Programme.

Nevertheless, at this stage, it has been found desirable to formulate a number of questions in an endeavour to make the future work of the C.C.I.R. in this matter more definite.

The discussions which have taken place during the VIIth Plenary Assembly have enabled the views of various administrations on certain aspects of Study Programme No. 28 (IX) to be assessed and compared. These opinions are summarized below (the paragraph numbering corresponds to that used in formulating Study Programme No. 28 (IX).

1. *Questions for study by the C.C.I.F.*

Information is awaited from the C.C.I.F.

2. *Questions for study by the C.C.I.R.*

2.1 *Transmission characteristics of radio systems.*

The general principle laid down in Recommendation No. 40 that for radio telephone systems operating at frequencies above 30 Mc/s, the objective should be to attain the transmission performance recommended by the C.C.I.F., is reaffirmed. It is noted that whilst the transmission characteristics of frequency-division multiplex radio systems may be readily related to the relevant C.C.I.F. standards, it is too early yet to formulate transmission characteristics for time division multiplex systems, and that these, in most cases, cannot be directly related in detail to existing C.C.I.F. standards.

However, it is noted that there is an increasing number of types of wide-band radio systems in use, and it appears that there are advantages to be gained by standardising as many relevant characteristics as possible. Three new questions (Questions Nos. 92 (IX), 93 (IX) and 97 (IX)) are therefore submitted in an endeavour to make the study more specific.

2.2 *Radio propagation, fading, diversity reception, noise and interference.*

The large number of factors that have to be taken into account in any propagation study are emphasised and reference is made to papers by Bullington ** in which simplified data are summarized in nomogram form. The need is stressed for different approaches to system surveys in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands and also for use of the highest suitable operating frequency.

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* This Report was adopted unanimously.

** " Radio Propagation at Frequencies above 30 Mc s ", K. BULLINGTON, *Proc. I.R.E.*, October 1947, 35.

A question (Question No. 85 (V)) is proposed because existing propagation questions were framed to provide answers which are not directly usable by point-to-point system designers, and since the overall signal-to-noise ratio performance of radio systems is directly dependent upon propagation characteristics.

2.3 *Considerations involved in choice of sites for radio stations.*

The large amount of preliminary work that is necessary before laying out a radio system ; the need for accurate topographical maps (or failing that the need for aerial survey), and the need for propagation tests in order to confirm the proposed choice of station locations and antenna heights are emphasised *. Such tests are regarded as essential at present, but it should be a longer-term aim of the radio engineer to determine the correlation between radio-propagation characteristics and geographical and climatic conditions in order that future planning may become less dependent on the results of local propagation tests. It is particularly important to pay careful attention to length of link-section, antenna-height etc., on any section of a UHF (decimetric) or SHF (centimetric) system that traverses terrain where weather conditions are known to be very stable, or on the other hand where substantial ground reflections are to be expected. Examples of such terrain are over-water paths, extensive salt flats or other overland paths where the intervening ground is relatively flat and unbroken.

2.4 *Modulation processes and methods of multiplexing.*

For long distance broad band systems there are operational and technical advantages in using frequency division multiplex, in order that blocks of channels in such systems may be connected directly to similar blocks in line transmission systems, and that advantage may be taken of the peak-load-sharing features inherent in such systems. However, while it is considered undesirable to make specific recommendations at this stage for systems of modulation, multiplexing or interconnection at radio frequencies, two new questions (Questions Nos. 92 (IX) and 93 (IX)) are proposed in an attempt to guide future studies in the hope that it may be possible to avoid further divergence of practice in cases where standardisation of certain overall system parameters seems desirable.

2.5 *Radio equipment (Transmitters, receivers, relay stations, aerials, and transmission lines)*

A study of systems in current use has revealed a considerable variety of types of equipment, and that there are differences even between systems of similar performance operating at similar frequencies. Equipment will, in general, be engineered by the manufacturers or users to be suitable for each particular case. Therefore, the attention of the C.C.I.R. should be confined to the overall results obtained.

2.6 *Methods of measurement on a radio system.*

When a radio system is connected to landlines its overall performance can be measured between the landline terminal points as though it were part of that system. The methods to be used for measuring performance of radio systems will generally be specified by the manufacturer or engineer designing the system.

Nevertheless it is desirable to coordinate system measurement and maintenance procedures in the case of integrated line and radio networks and to make future studies more specific a question (Question No. 96 (IX)) has been formulated.

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* " A technique for 4000 Mc/s propagation testing for radio-relay systems ", W.J. Bray & R.L. Corke, *Journal I.E.E.*, Part. III.a, No. 18, 1952 p. 281 and seq.

" Path testing for a radio route ", R.D. Campbell, *Electrical Engineering*, **72**, No. 7, July 1953.

Since, however, the portion of a radio system whose performance is least predictable is the transmission path it may be desirable to measure separately those parameters which affect transmission over the radio path.

3. *Question for study by the C.C.I.F. with C.C.I.R. representatives.*

Information is awaited from the C.C.I.F.

4. *Question for study by the C.C.I.R. with C.C.I.F. representatives.*

4.1 *Supervisory and monitoring facilities on radio systems.*

It may be necessary to adopt different procedures on radio systems, the terminal stations of which contain channel modulating and translating equipment, and on radio systems which are closely integrated with cable systems, for example, radio systems in which the final audio or carrier line terminal equipment is distant from the radio-terminal station.

In certain circumstances the performance of radio systems might be degraded by a requirement for supervisory or pilot signals of an associated cable system to be transmitted over the radio system and vice versa. Similarly, additional requirements may be imposed upon a cable system if it is required to transmit, in addition, supervisory signals from the radio system. Thus there may be advantages in separating the two supervisory systems in such cases.

The supervisory and monitoring facilities on radio-relay systems will, in many cases, be specified by the manufacturer or engineer designing the system.

4.2 *The percentage of time during which the required transmission characteristics can be expected to be met for telephone, broadcast programme, television and telegraph signals.*

This portion of the Study Programme is a long term study, and answers can be derived only from long experience. It is essential that as much information as possible on the overall performance of multi-link broad band radio relay systems be compiled. It would be very desirable if the C.C.I.F. would provide information to the C.C.I.R. on the percentage of time during which specified transmission characteristics, in particular noise-level or signal-to-noise ratios, are achieved in practice on existing cable systems for various types of signal. To this end two questions have been formulated for submission to the C.C.I.F. (Questions Nos. 111 and 112).

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## REPORT No. 32 *

## HIGH FREQUENCY BROADCASTING : DIRECTIONAL ANTENNA SYSTEMS

(Question No. 23 (X))
(Study Group No. X)

(London, 1953)

Question No. 23 (X) is concerned with the reduction of subsidiary lobes in high frequency broadcasting directional antenna systems for the purpose of avoiding interference in frequency sharing. This interference is generally caused by the radiation pattern of the transmitting antenna having subsidiary lobes in unwanted directions, or by scatter of the energy of the main lobe, due to propagation anomalies. Reduction in intensity of the subsidiary lobes is possible by correct

* This Report was adopted unanimously.

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 ; utilising 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 beam width of 27°. It should be noted that Christiansen (5) attains results from a four-unit array of rhombics which are equivalent to large arrays of tuned elements. He confirmed this on radiotelegraph circuits over a period of some years.

Reduction of subsidiary lobes when the main beam is slewed is a difficult problem as the angle of slew, type of antenna, and distortion of its radiation pattern must be considered. This makes it more difficult to give general rules for subsidiary lobe reduction.

A type of array commonly used (8) consists of four rows of radiating elements, each containing four elements with the lowest row one wavelength above ground. The array is normally provided with a reflector, and the feeder arrangements usually allow for reversing or slewing. The slewing in azimuth of the direction of maximum radiation of this type of array is achieved by the adjustment of the relative phase of the current distribution between the left and right halves of the array. The limit of effective slewing by this means can be taken as 17° on either side of the normal direction, but the amount of slew commonly used does not as a rule exceed 15°.

While this method of slewing does not appreciably affect the horizontal width of the main lobe of radiation, it does increase its asymmetry and at the same time produces a principal subsidiary lobe of considerable intensity. The ratio of the field strength of the main lobe in a slewed array compared with that in the unslewed condition has been determined theoretically ; for the type of aerial under discussion the ratios for 0°, 5°, 10° and 15° of slew would be 1.0, .98, .94 and .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 .18, .27, .45 and .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 :

*(a)* 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 aerial ;

*(b)* 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 aerial ;

*(c)* by limiting radiation in all directions other than those comprised in the main lobe to a certain proportion of that given by an omnidirectional aerial.

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3. CHRISTIANSEN, W.N. " Directional Patterns for Rhombic Antennae ", *A.W.A. Tech. Rev.*, **7**, p. 33, September 1946.
4. CHRISTIANSEN, W.N., JENVEY, W.W., CARMEN, R.D., " Radio-Frequency Measurements on Rhombic Antennae ", *A.W.A. Tech. Rev.*, **7**, p. 131, Dec. 1946.
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6. See e.g. : KRAUS, J.D., *Antennas*, First Ed., p. 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. I.R.E.*, **24**, p. 335, June 1946.
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9. PAGE, H., " The Measured Performance of Horizontal Dipole Transmitting Arrays ", *Journal I.E.E.*, **92**, No. 18, June 1945.


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## REPORT No. 33 *

# QUESTIONS Nos. 14 AND 15 OF THE C.C.I.F.

## (Study Group No. X)

(London, 1953)

*Question No. 14.*

Many administrations consider that the most significant parameter to monitor at the input of a radio telephone circuit during transmission is the peak value of the programme voltage. Since distortions of very short duration may generally be tolerated, however, a peak meter with an integration time of up to about 30 milliseconds is commonly used.

Other administrations consider that several parameters ought to be monitored at the input, amongst others the peak value, the mean value and the minimum value, and that the VU type of meter with an integration time of about 300 milliseconds gives an indication that bears a relationship to these values and has been found satisfactory in practice.

The level indicated by a VU type of meter will generally differ from that indicated by a " peak " type of meter by an amount that varies according to the type of programme and which may be 10 db or more.

*Question No. 15.*

Although there is evidence to show that the present provisional psophometer curve is not entirely satisfactory, it is considered untimely to change it until more comprehensive data are available.

When such data are available it is desirable that a new weighting curve should be formulated, extending to the higher and lower frequencies and if possible in a form that could be obtained by reasonably simple electrical networks.

It is also considered desirable to establish a method of measuring disturbances, the energies of which are concentrated at discrete frequencies.

*Note.* — This report is to be transmitted to the C.C.I.F.

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* This Report was adopted unanimously.

# REPORT No. 34

## RATIO OF THE WANTED TO THE UNWANTED SIGNAL IN TELEVISION

(Question No. 67 (XI))
(Study Group No. XI)

(London, 1953)

This report has been prepared using the available results of subjective tests on the tolerable ratios " wanted signal/unwanted signal " in television.

The protection ratios given in this report are considered acceptable for a short percentage of the time, not precisely defined, but assumed to be between 1% and 10%.

The protection ratios refer to a viewing distance of four times the picture height.

The protection ratios refer to the limit of just tolerable interference : protection ratios for just perceptible interference would be 6 to 10 db higher.

When utilizing the protection ratios, suitable allowance will have to be made for fading by adding to these ratios the root sum square of the fading of the wanted and unwanted signals. Alternatively, the allowance for fading can be determined using the curves of field strengths exceeded for 1% or 10% of the time when fading of the wanted signal is small compared to the fading of the unwanted signal.

No account has been taken of the possible effect of using directional receiving antennae or of the advantage which might be gained by using different polarisations for transmission of the wanted and unwanted signals. The protection ratios quoted refer in all cases to the signals at the input of the receiver.

The values to be considered are respectively the RMS value of the carrier at the peak of the modulation envelope for the television signal and the RMS values of the unmodulated carrier for amplitude modulated and frequency modulated sound transmissions.

1. *Interference within the same channel — Protection ratio for the picture signal when the wanted and unwanted signals have the same line frequency.*

   (a) *Carriers separated less than 100 c/s but not synchronized.*
   Just tolerable interference : 45 db.

   (b) *Carriers separated by 2/3 of the line frequency.*
   Just tolerable interference : 30 db.

   (c) *Carriers separated by 1/2 of the line frequency.*
   Just tolerable interference : 27 db.

2. *Interference within the same channel — Protection ratio for the picture signal when the wanted and unwanted signals have different line frequencies.*

   (a) *Carriers separated less than 100 c/s but not synchronized.*
   Just tolerable interference : 45 db.

   (b) *Carriers separated by 1/2 or 2/3 of the line frequency of the wanted signal.*
   As in case 1 (b) and 1 (c) the offset brings an improvement in the protection of the picture signal. This improvement, however, is reduced, since the line frequency of the

unwanted signal is different from the line frequency of the wanted signal ; the amount of the reduction depends on the relation between the line frequencies. More tests are needed before figures can be given for the protection ratios in this case.

3. *Adjacent channel interference.*

The worst interference on the picture signal results from the sound transmission in the adjacent channel. The figures given below relate to the case when the separation between the vision carrier and the adjacent channel sound carrier is 1.5 Mc/s.

(a) *Frequency modulated sound carrier.*

Just tolerable interference : −6 db.

(b) *Amplitude modulated sound carrier.*

Just tolerable interference : 0 db.

Fairly conservative values have been chosen, to take account of the divergence in performance between different types of television receivers. However, future developments in receiver design will probably enable somewhat higher interfering signals to be tolerated in all cases.

4. *Overlapping channel interference.*

In the attached figure, curves are given for the protection ratio required when a television signal, using 819, 625, 525 or 405 lines suffers interference from a vision signal of any of the systems or by a frequency modulated sound signal. The curves cover the case when the carrier of the interfering signal lies within the vision channel of the wanted transmission.

If the interfering signal is an amplitude modulated sound signal, 5 db should be added to the protection ratios shown by the curves. These curves are tentative and may require modification in the light of further experience.

It is theoretically possible to gain a further advantage by the use of offset methods using a frequency separation between the carriers equal to an odd multiple of half the line frequency. Further tests are needed before it can be said what precise advantage could be derived. Variation of line frequency would render difficult the offsetting at high multiples of half the line frequency.

In the particular case of overlapping sidebands known as the " tête-bêche " arrangement, the protection ratio can be roughly estimated from the curves in the attached figure and from the rejection afforded to the unwanted carrier. More tests are needed before further guidance can be given for the protection ratios required for specific cases.

5. *Protection ratio for the sound signal* (for just tolerable interference).

(a) *Wanted and unwanted frequency modulated signals:* 20 db.

(b) *Wanted and unwanted amplitude modulated signals:*

For a frequency difference below the audio frequency range : 30 db.
For a frequency difference within the audio frequency range : 40 db.
For a frequency difference above the audio frequency range : 15 db.

(c) *Wanted amplitude modulated signal, unwanted frequency modulated signal:*

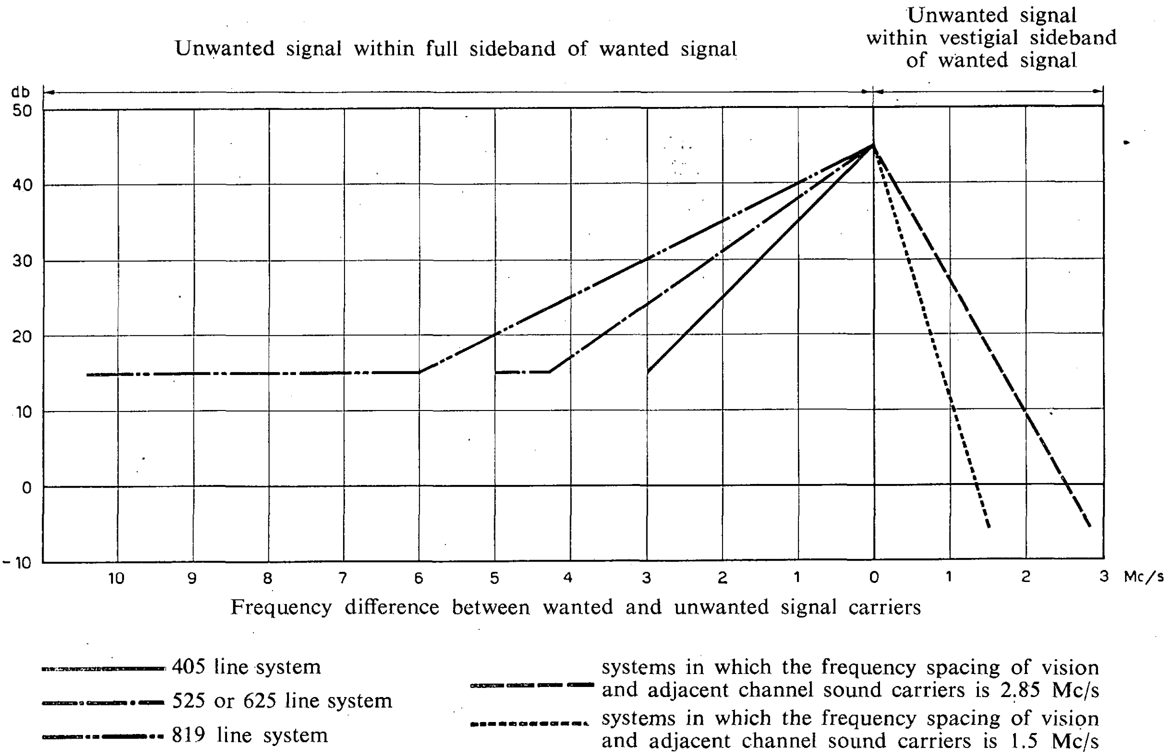
No frequency difference : 40 db.
25 kc/s frequency difference : 30 db.
50 kc/s frequency difference : 12 db.

(d) *Wanted frequency modulated signal, unwanted amplitude modulated signal:* 20 db.

The above quoted figures, while giving the protection ratios required, will in practice be used to determine the frequency separation which may be needed between the sound carriers.

The C.C.I.R. is of the opinion that Question No. 67 (XI) should remain on the agenda and that further theoretical and experimental work should continue on this question.

PROTECTION RATIOS REQUIRED BY VISION SIGNAL AGAINST UNWANTED VISION OR FREQUENCY MODULATED SOUND SIGNAL




*Note.* — For an amplitude modulated sound signal the protection ratios required are about 5 db higher.

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## REPORT No. 35 *

## TELEVISION SYSTEMS

(Recommendation No. 29) **
(Study Group No. XI)

It has not been possible to arrive at unanimous agreement on certain television standards. An extensive study has been made of four systems of black-and-white television, identified by the number of lines per picture as the 405-line system, the 525-line system, the 625-line system, and the 819-line system.

As a result of this study, the attached table has been prepared for the information of those administrations which may wish to establish one of these systems.

The possibility has been discussed of achieving unification of the television systems by the adoption of a channel width of 8.4 Mv/s. No specific proposals for the number of lines, and other transmission standards, have been discussed in connection with this bandwidth.

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* This Report was adopted unanimously. It replaces Repoit No. 15.
** This Recommendation has become Question No. 64 (XI).

| Item | Description of Item | Systems 405 | 525 | 625 | 819 | Belgian 625 | Belgian 819 |
|---|---|---|---|---|---|---|---|
| 1 | Number of lines per picture | 405 | 525 | 625 | 819 | 625 | 819 |
| 2 | Video bandwidth . . . Mc/s | 3 | 4 | 5 | 10.4 | 5 | 5 |
| 3 | Channel width . . . Mc/s | 5 | 6 | 7 | 14 | 7 | 7 |
| 4 | Sound carrier relative to vision carrier . . Mc/s | −3.5 | +4.5 | +5.5 | −11.15 [2]) | +5.5 | +5.5 |
| 5 | Sound carrier relative to edge of channel . Mc/s | +0.25 | −0.25 | −0.25 | +0.10 [2]) | −0.25 | −0.25 |
| 6 | Ideal vision transmitter characteristic | (See Fig. 1) | (See Fig. 4) | (See Fig. 7) | (See Fig. 10) | (See Fig. 13) | (See Fig. 13) |
| 7 | Interlace [1]) | 2/1 | 2/1 | 2/1 | 2/1 | 2/1 | 2/1 |
| 8 | System capable of operating independently of power supply frequency [1]) | Yes | Yes | Yes | Yes | Yes | Yes |
| 9 | Line frequency . . . c/s | 10 125 | 15 750 | 15 625±0.1 % | 20 475 | 15 625±0.1 % | 20 475±0.1 % |
| 10 | Field frequency . . . c/s | 50 | 60 | 50 | 50 | 50 | 50 |
| 11 | Picture frequency . . . c/s | 25 | 30 | 25 | 25 | 25 | 25 |
| 12 | Aspect ratio [1]) | 4/3 | 4/3 | 4/3 | 4/3 | 4/3 | 4/3 |
| 13 | Scanning during active periods [1]) | L. to R. & Top to B. | L. to R. & Top to B. | L. to R. & Top to B. | L. to R. & Top to B. | L. to R. & Top to B. | L. to R. & Top to B. |
| 14 | Type of vision modulation [1]) | Amplitude | Amplitude | Amplitude | Amplitude | Amplitude | Amplitude |
| 15 | Vision emission characteristics [1]) | Asymmetric | Asymmetric | Asymmetric | Asymmetric | Asymmetric | Asymmetric |
| 16 | Sense of vision modulation | Positive | Negative | Negative | Positive | Positive | Positive |
| 17 | Black level independent of picture content [1]) | Yes | Yes | Yes | Yes | Yes | Yes |
| 18 | Level of black as % of peak carrier | 30 | 75 | 75 | 25 | 25 | 25 |
| 19 | Minimum level of carrier as % of peak carrier | 0 | ⩽ 15 [3]) | 10 | ⩽ 3 | 0 to 3 | 0 to 3 |
| 20 | Synchronizing waveform | (See Figs. 2 & 3) | (See Figs. 5 & 6) | (See Figs. 8 & 9) | (See Figs. 11 & 12) | (See Figs. 14 & 16) | (See Figs. 15 & 16) |
| 21 | Sound modulation | A3 | F3 ±25 kc/s 75 micro-seconds pre-emphasis | F3 ±50 kc/s 50 micro-seconds pre-emphasis | A3 | A3 50 micro-seconds pre-emphasis | A3 50 micro-seconds pre-emphasis |
| 22 | Ratio of vision to sound effective radiated power | 4/1 | from 2/1 to 2/3 | 5/1 | 4/1 | — | — |

1) Items 7, 8, 12, 13, 14, 15 and 17 are in accordance with Recommendation No. 82. See Recommendation No. 82 for further details.

2) The administrations which desire to adopt this system should conform to the provisions of Recommendation No. 82.

3) At maximum luminance.

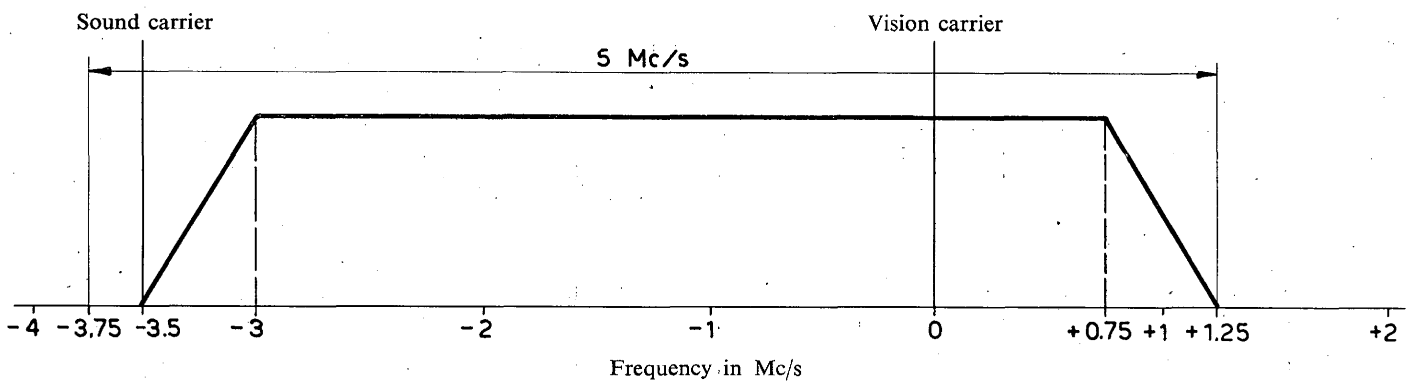



FIGURE 1

*Ideal characteristic for vision transmitter, 405-line system*

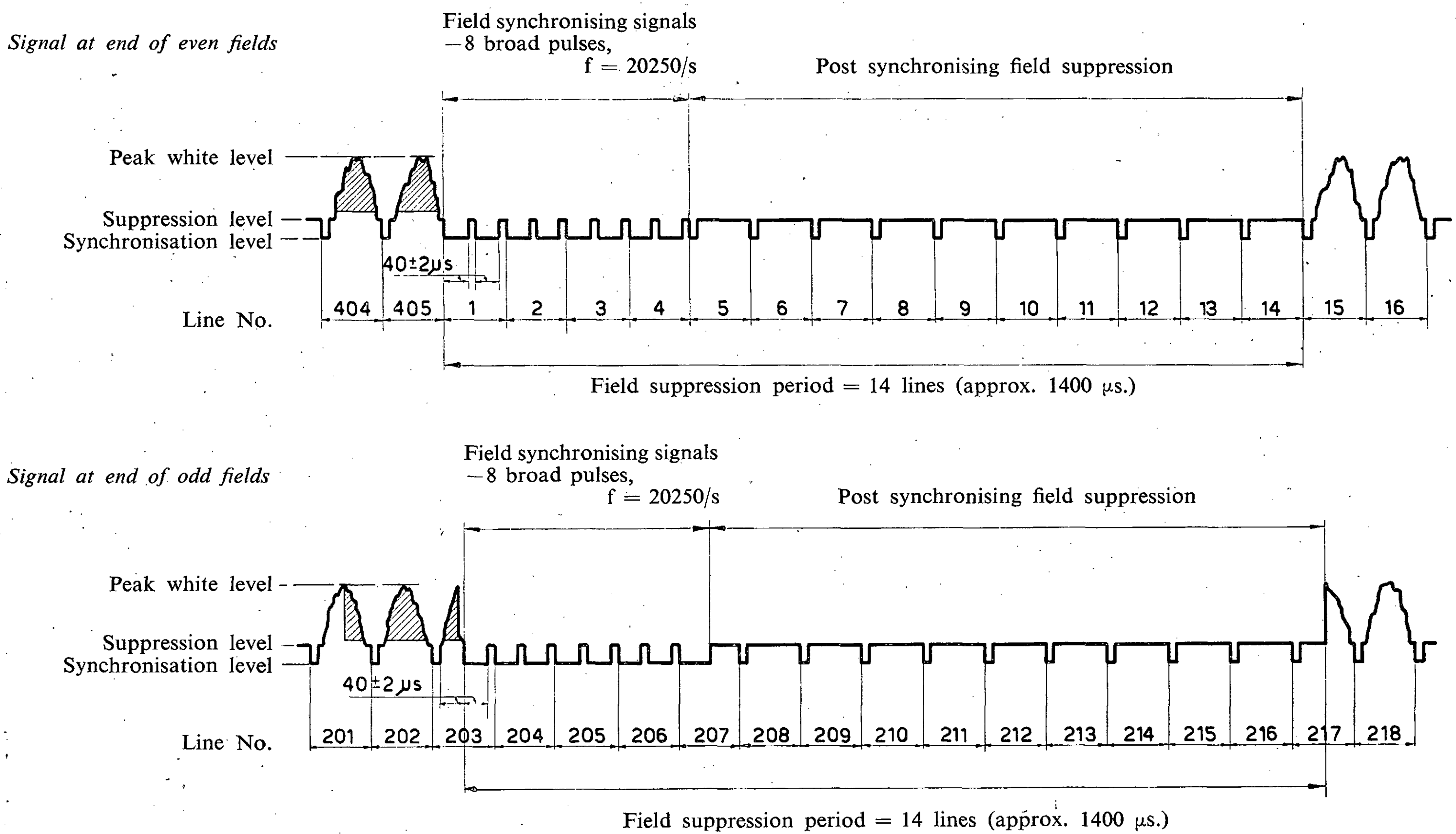



FIGURE 2

*Synchronising waveform, 405-line system*

The hatched part of the signal shown can either be occupied by a suppression pulse up to 2 lines in length or by picture signal as shown.
A small pre-synchronising suppression pulse is shown at the opening of the frame suppression. This may be between 0 and 10 μs in length.

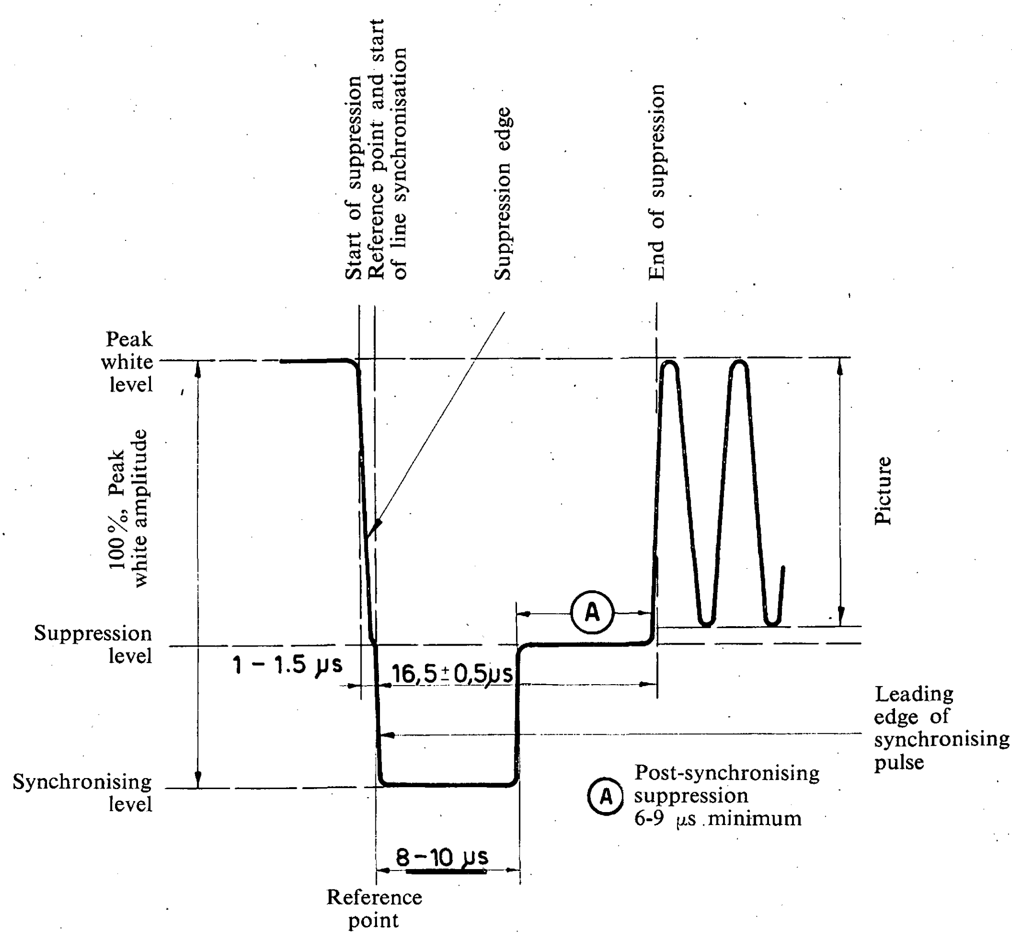



FIGURE 3

*Details of synchronising signal, 405-line system*

The signal is shown in its video form, but synchronising level corresponds to 0-3%.
Suppression level 30%±3%, and peak white 100% of carrier amplitude.
Time of rise of synchronising pulse (10% to 90%) 0.25 μs.
Time of rise of suppression edge (10% to 90%) should not exceed 1 μs.
Minimum post-synchronising suppression period 6 μs.
Field suppression period 14 lines and variation must be such as not to cause visible jitter on picture
Field frequency is tied to frequency of mains.

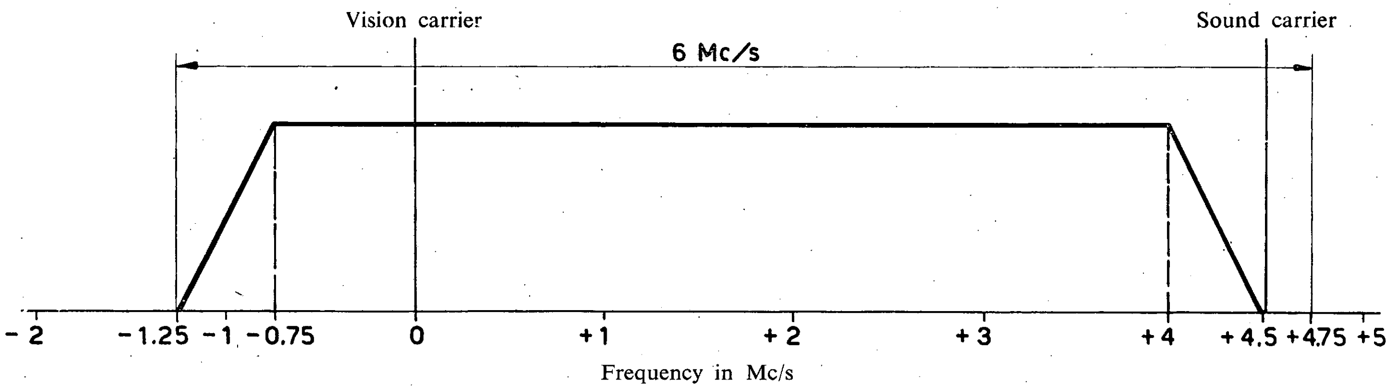
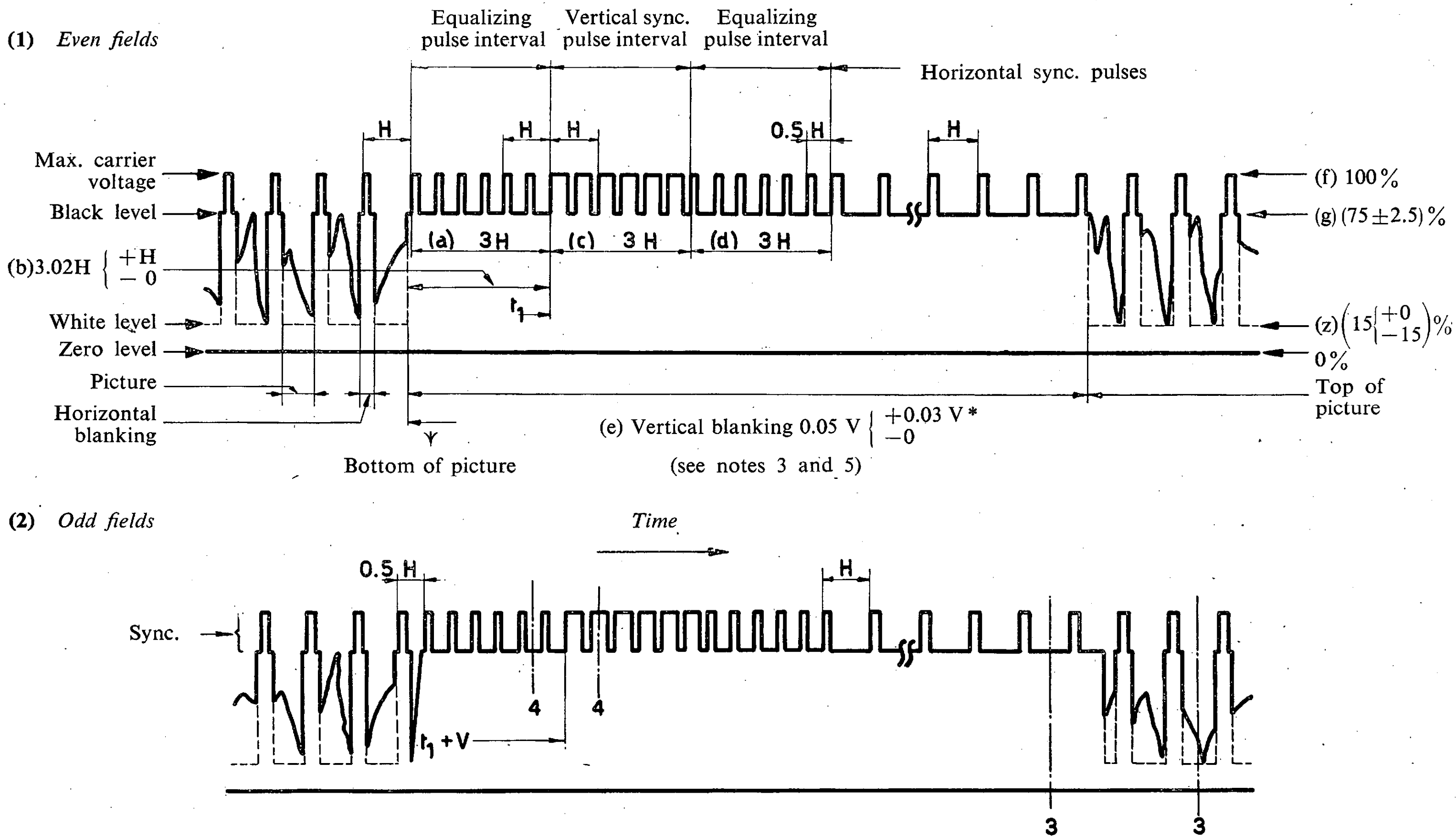



FIGURE 4

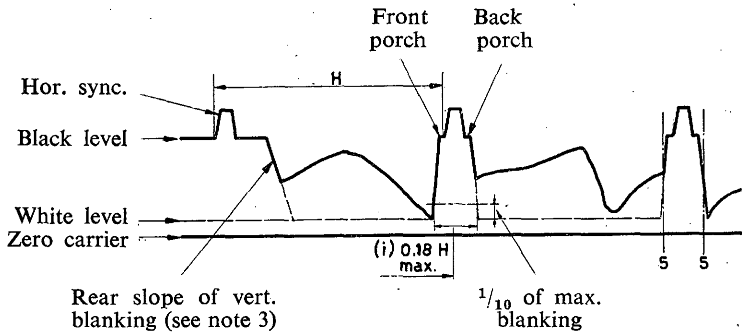
*Ideal characteristic for vision transmitter, 525-line system*



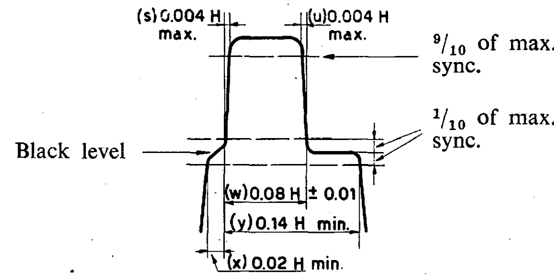

Horizontal dimensions not to scale

FIGURE 5

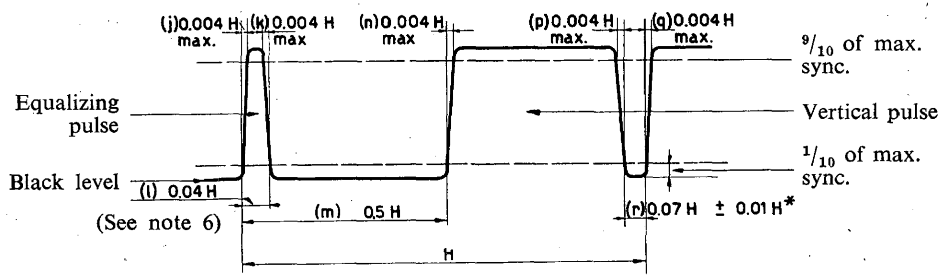
*Synchronising waveform, 525-line system*




**(3)** Details between 3-3 in **(2)** of fig. 5




**(5)** Details between 5-5 in **(3)**




**(4)** Details between 4-4 of fig. 5

Horizontal dimensions not to scale

FIGURE 6

*Details of synchronising waveform, 525-line system*

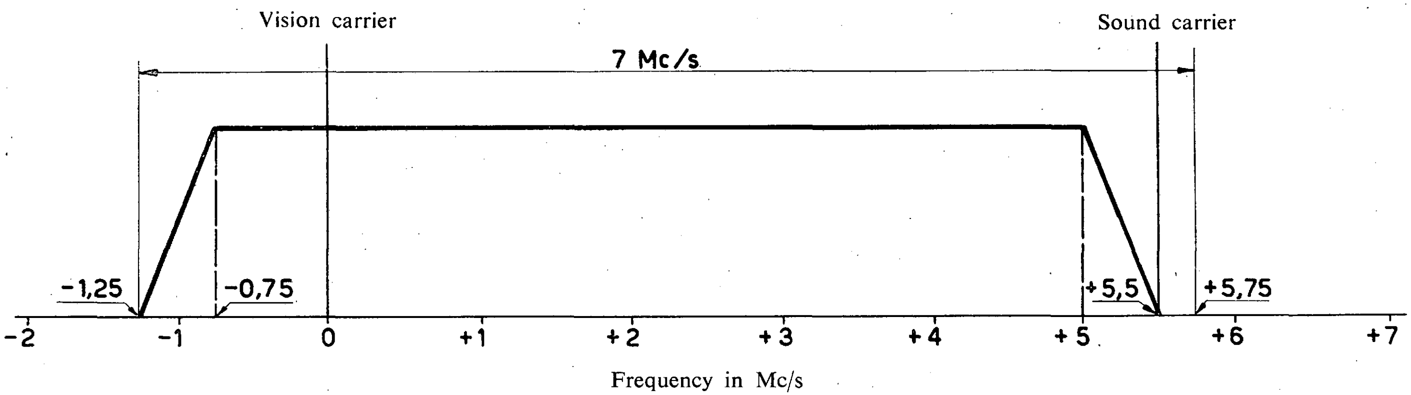
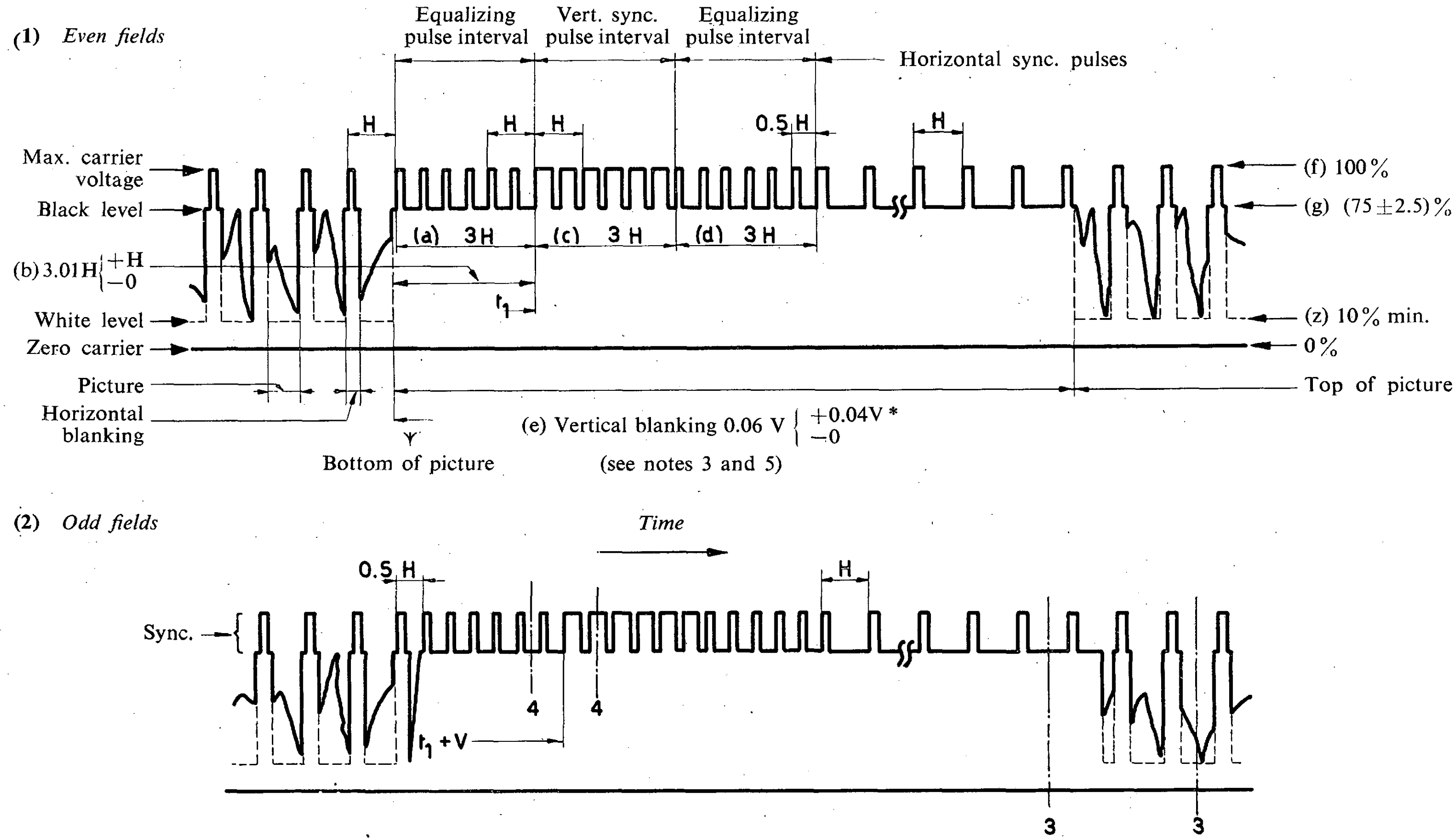



FIGURE 7

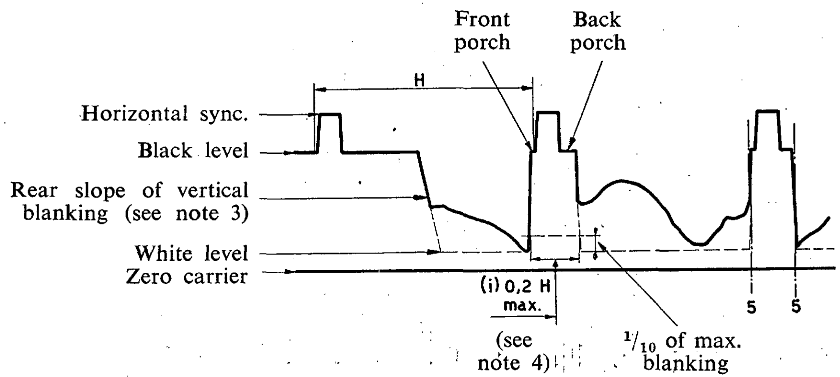
*Ideal characteristic for vision transmitter, 625-line system*



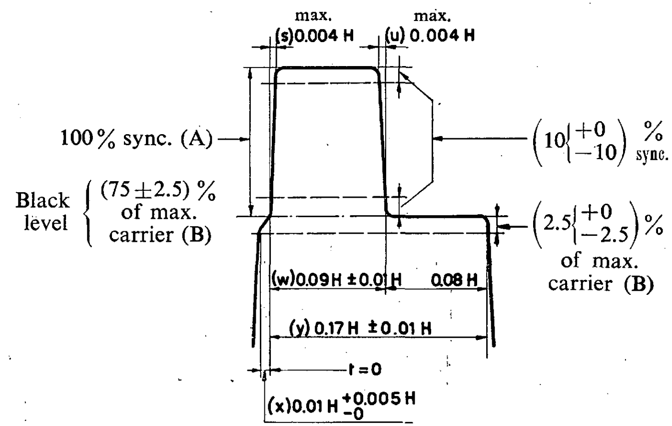

Horizontal dimensions not to scale

FIGURE 8

*Synchronising waveform, 625-line system*



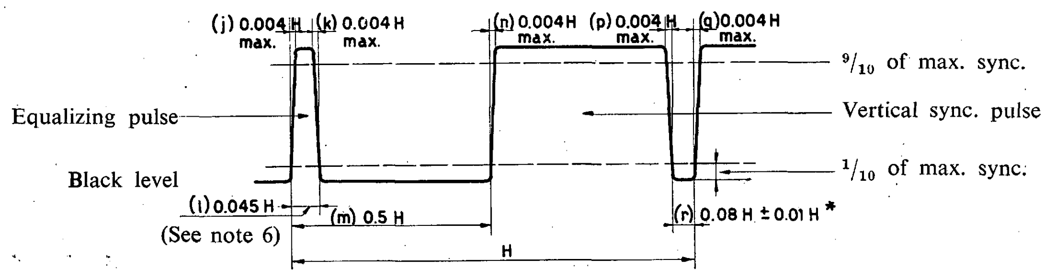

**(3)** Details of 3-3 in **(2)** of fig. 8




(A) Measured before modulation.

(B) Measured after ideal detection.

**(5)** Details between 5-5 of **(3)**.




**(4)** Details of 4-4 in **(2)** of fig. 8

Horizontal dimensions not to scale

FIGURE 9

*Details of synchronising waveform, 625-line system*

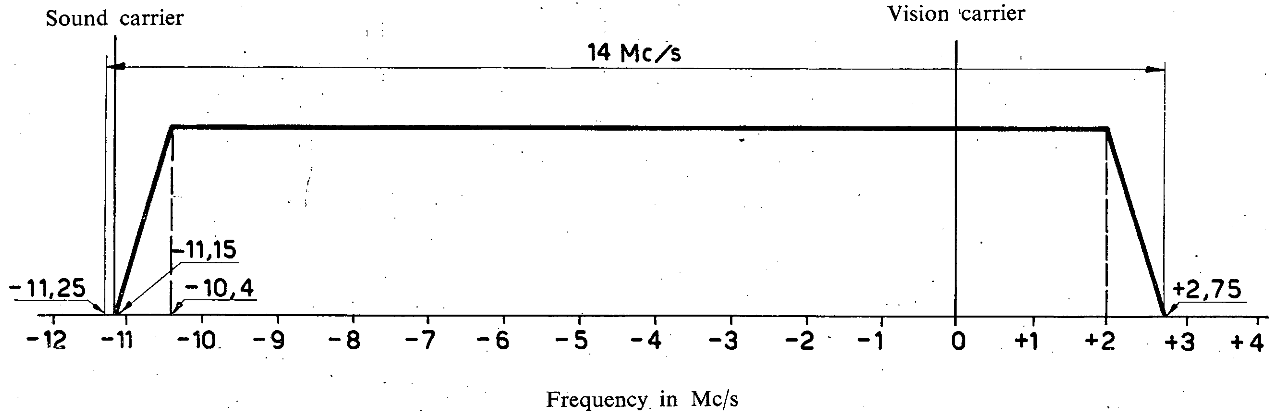



FIGURE 10

*Ideal characteristic for vision transmitter, 819-line system*

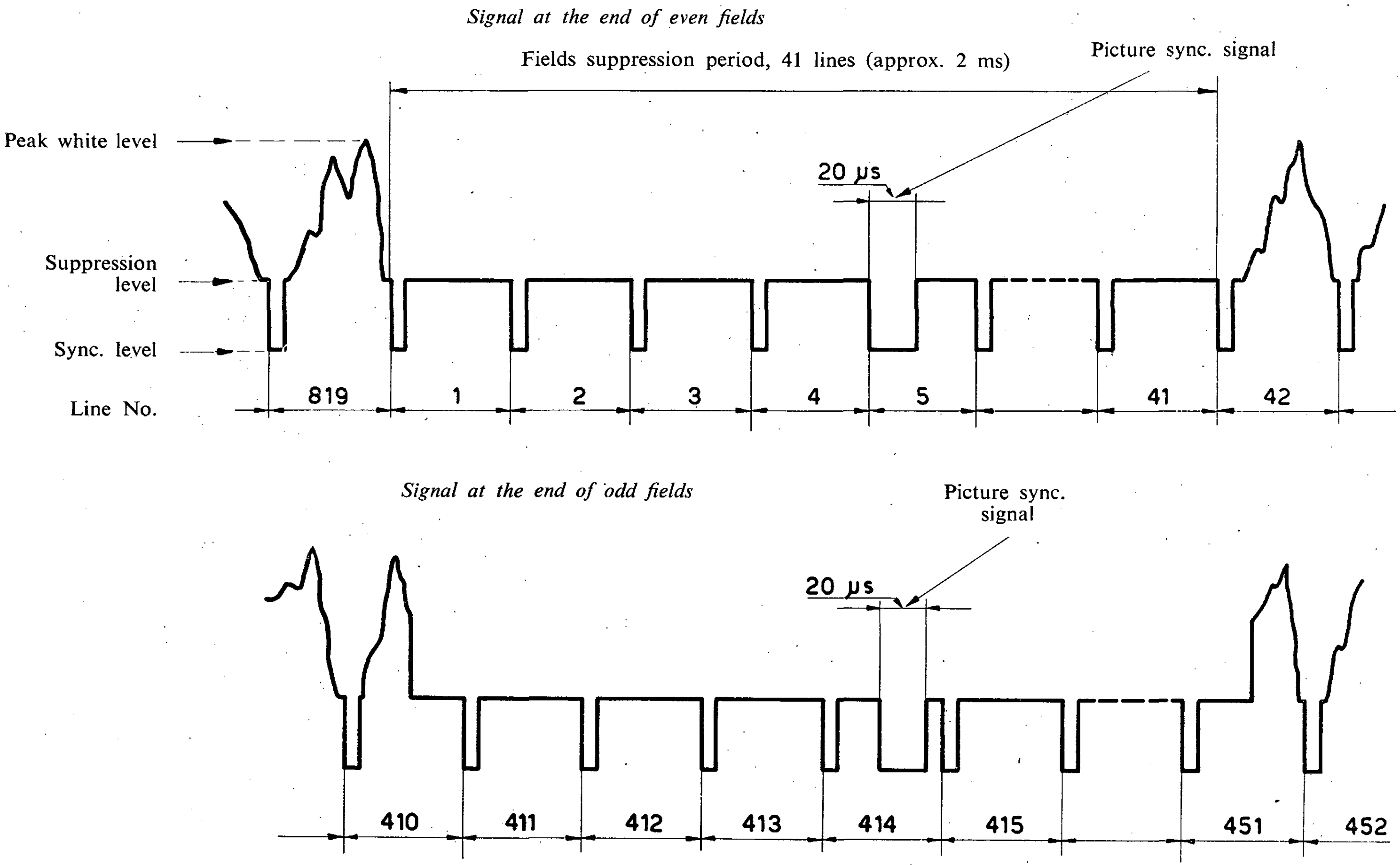
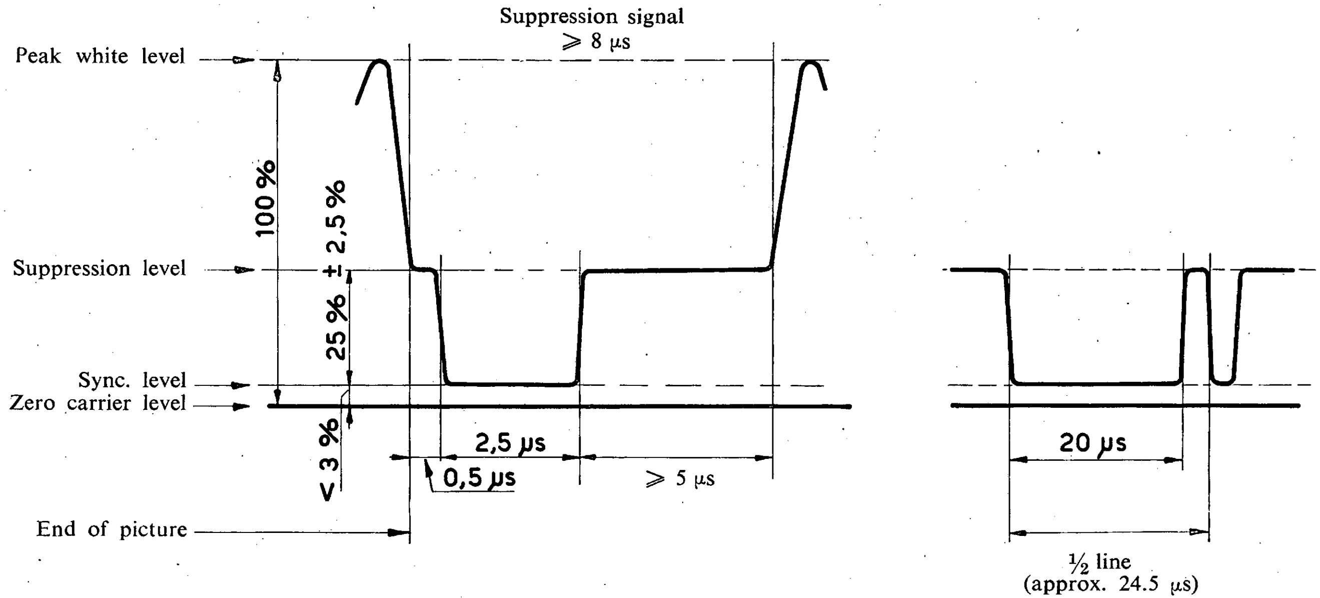



FIGURE 11

*Synchronising waveform, 819-line system*




Details of *line* sync. waveform
(High frequency signal)

Details of *picture* sync. signal
(Odd field)

FIGURE 12

*Details and duration of synchronising waveform, 819-line system*

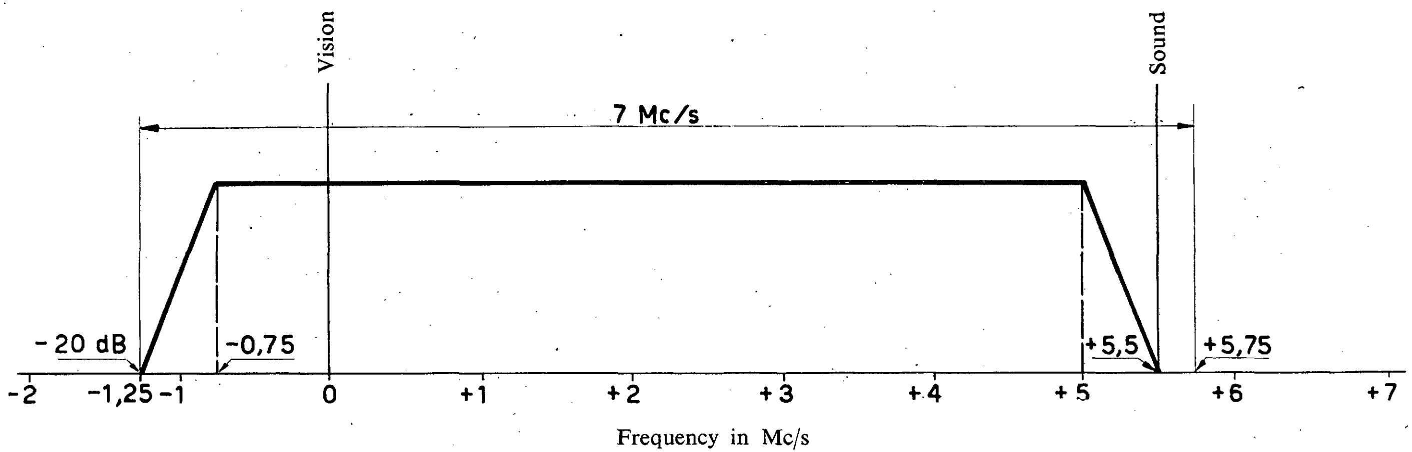
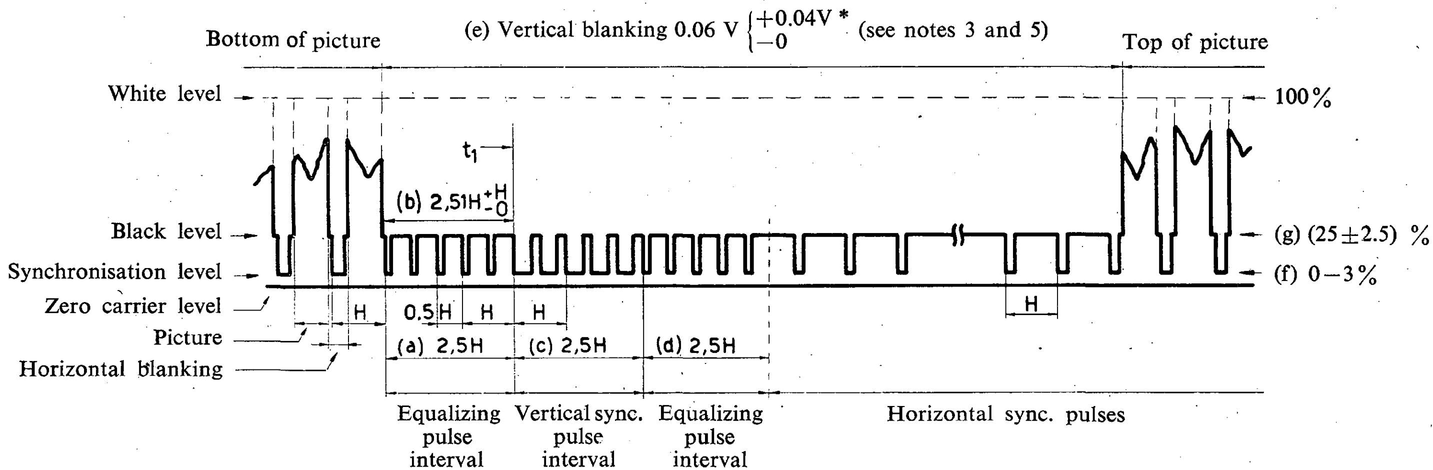



FIGURE 13

*Ideal characteristic for a vision transmitter, Belgian system*

*Note:* For a modulation frequency of 1.25 Mc/s or above, the attenuation of the voltage of the lower side-band is at least 20 db with reference to a modulation frequency of 200 kc/s.
The terms and values shown conform with Doc. RMA : TR 104-A (Oct. 1949).

(1) *Signal at the end of even fields*




(2) *Signal at the end of odd fields*

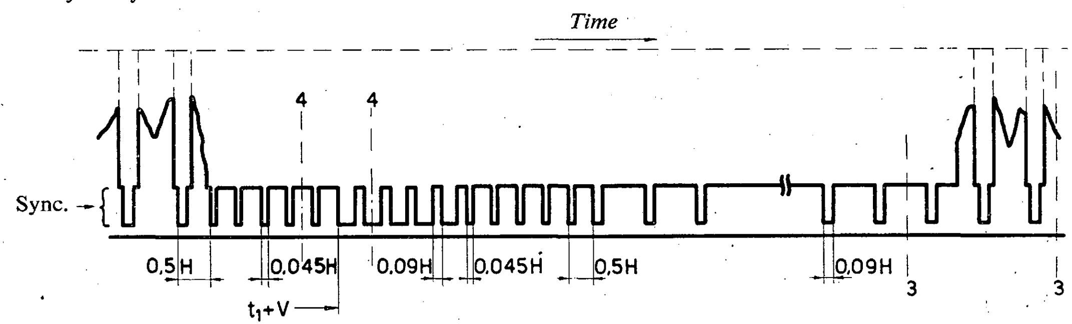
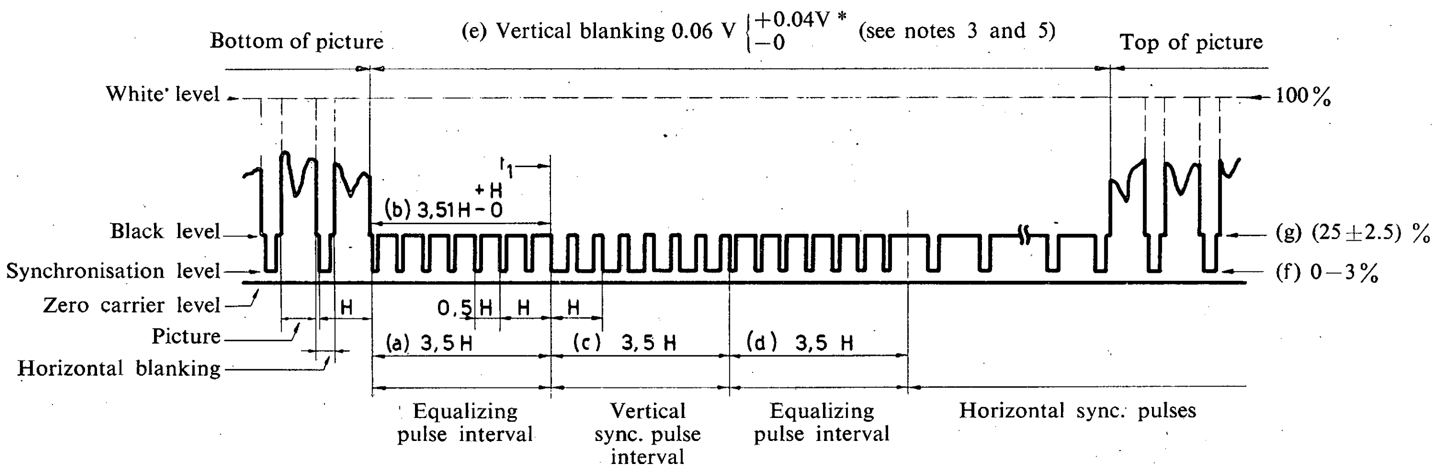



FIGURE 14

*Synchronising waveform, Belgian 625-line system*

(1) *Signal at the end of even fields*




(2) *Signal at the end of odd fields*

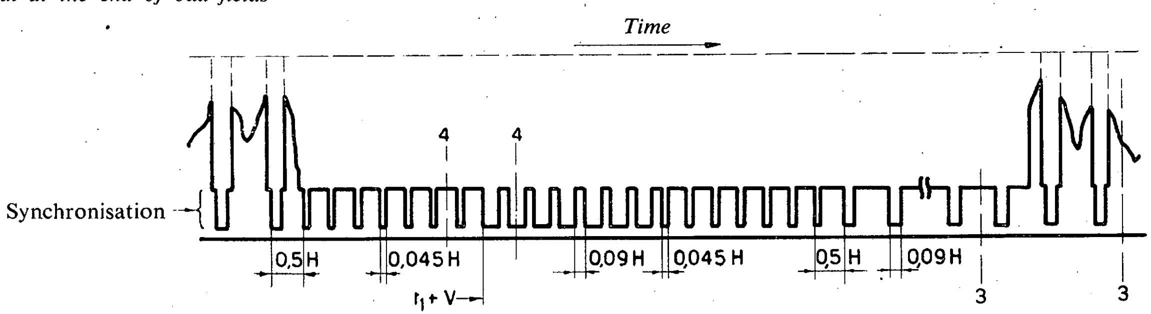
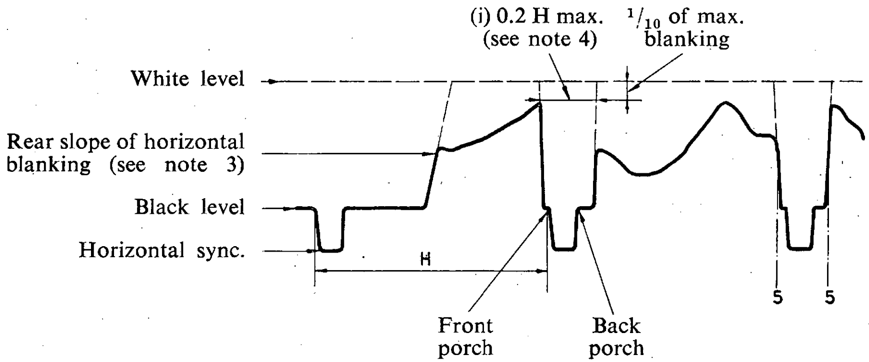
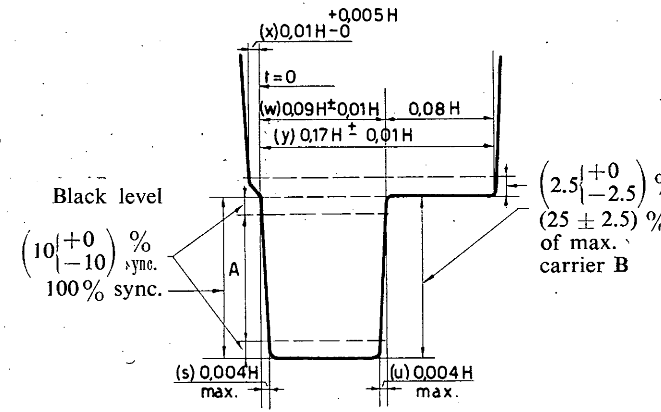



FIGURE 15

*Synchronising waveform, Belgian 819-line system*

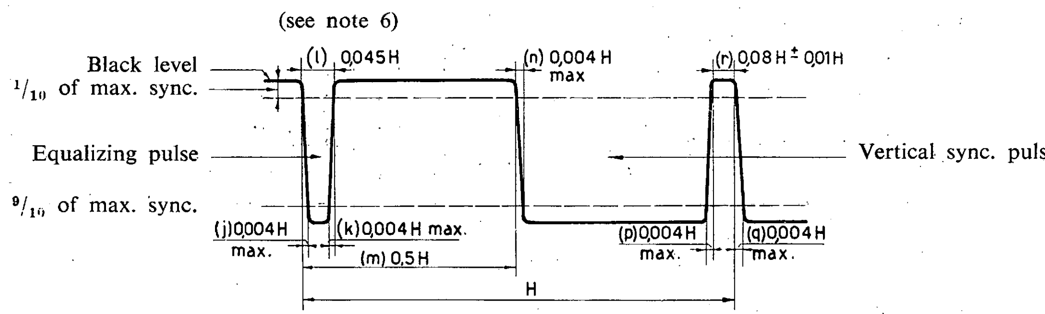



**(3)** Details between 3-3 in **(2)** of fig. 14




A. Measured before modulation
B. Measured after ideal detection

**(5)** Details between 5-5 of **(3)**




**(4)** Details between 4-4 in **(2)** of fig. 14

FIGURE 16

*Details of synchronising waveform, Belgian system*

# INFORMATION

## CONCERNING FIGURES 14, 15 AND 16

*Belgian 625-line system*

| Notation | Approximate duration | |
|---|---|---|
| H | | 64 µs |
| V | 312.5 H | 20 000 µs |
| a | 2.5 H | 160 µs |
| b | 2.51 to 3.51 H | 161 to 225 µs |
| c | 2.5 H | 160 µs |
| d | 2.5 H | 160 µs |
| e | 19 to 31 H | 1200 to 2000 µs (see notes 3 & 5) |
| i | <0.2 H | <12.8 µs (s. note 4) |
| j | <0.004 H | <0.25 µs |
| k | <0.004 H | <0.25 µs |
| l | 0.045 H | 2.9 µs (see note 6) |
| m | 0.5 H | 32 µs |
| n | <0.004 H | <0.25 µs |
| p | <0.004 H | <0.25 µs |
| q | <0.004 H | <0.25 µs |
| r | 0.07 H to 0.09 H | 4.5 to 5.8 µs |
| s | <0.004 H | <0.25 µs |
| u | <0.004 H | <0.25 µs |
| w | 0.08 H to 0.1 H | 5.1 to 6.4 µs |
| x | 0.001 H to 0.0015 H | 0.64 to 0.96 µs |
| y | 0.16 H to 0.18 H | 10.2 to 11.5 µs |

*Belgian 819-line system*

| Notation | Approximate duration | |
|---|---|---|
| H | | 49 µs |
| V | 409.5 H | 20 000 µs |
| a | 3.5 H | 171 µs |
| b | 3.51 to 4.51 H | 172 to 221 µs |
| c | 3.5 H | 171 µs |
| d | 3.5 H | 171 µs |
| e | 24.5 to 41 H | 1200 to 2000 µs (see notes 3 & 5) |
| i | <0.2 H | <9.8 µs (see note 4) |
| j | <0.004 H | <0.19 µs |
| k | <0.004 H | <0.19 µs |
| l | 0.045 H | 2.2 µs (see note 6) |
| m | 0.5 H | 24.5 µs |
| n | <0.004 H | <0.19 µs |
| p | <0.004 H | <0.19 µs |
| q | <0.004 H | <0.19 µs |
| r | 0.07 H to 0.09 H | 3.6 to 4.4 µs |
| s | <0.004 H | <0.19 µs |
| u | <0.004 H | <0.19 µs |
| w | 0.08 H to 0.1 H | 3.9 to 4.9 µs |
| x | 0.001 H to 0.0015 H | 0.49 to 0.74 µs |
| y | 0.16 H to 0.18 H | 7.8 to 8.8 µs |

## NOTES

*concerning Figures 5, 6, 8, 9, 14, 15 and 16*

1. H = Time from start of one line to start of next line.
2. V = Time from start of one field to start of next field.
3. Leading and trailing edges of vertical blanking should be complete in less than 0.1 H.
4. Leading and trailing slopes of horizontal blanking must be steep enough to preserve min. and max. values of (x + y) and (i) under all conditions of picture content.
5. Dimensions marked with an asterisk indicate that tolerances given are permitted only for long time variations, and not for successive cycles.
6. Equalizing pulse area shall be between 0.45 and 0.5 of the area of a horizontal sync. pulse.

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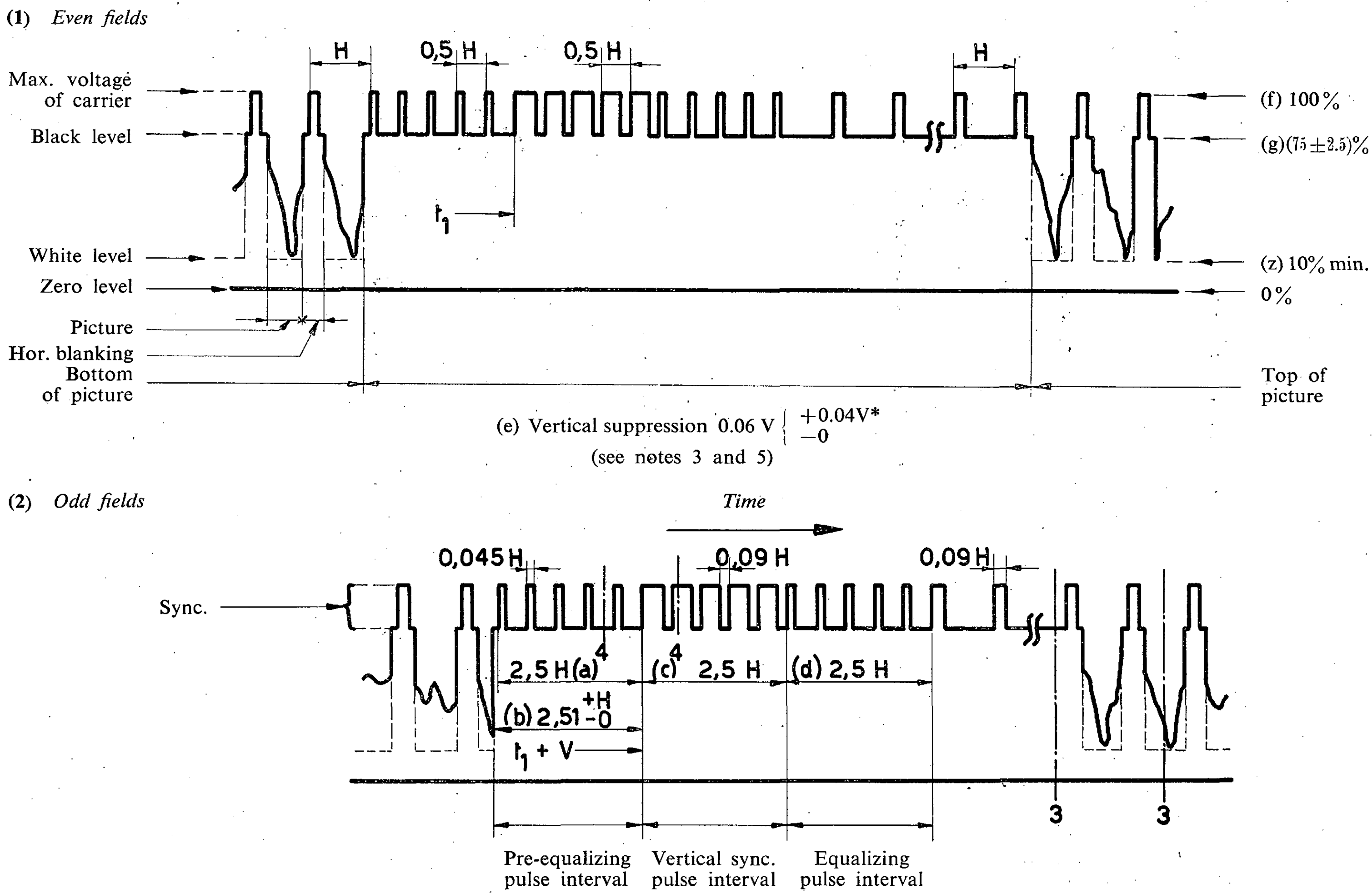
## NOTE BY DIRECTOR C.C.I.R.

*Variation to Figure 8 of Report No. 35*

At the 6th meeting of Study Group No. XI during the VIth Plenary Assembly it was agreed (See Doc. No. 490 of Geneva) that the Swiss delegate should initiate a discussion by correspondence amongst those concerned, on a modification of the vertical synchronisation signal to be used with the 625-line system. Doc. No. 360 of Geneva gives details and the new form proposed is reproduced in Fig. 8 *bis*.

The Swiss Administration now informs us (Oct. 17th, 1951) that following upon this consultation by correspondence no objection has been received to the adoption of this modified form.




Horizontal dimensions not to scale

FIGURE 8 *bis*

*Synchronising waveform, 625-line system*

(Variation of fig. 8)

# REPORT No. 36

## DESIGN OF AERIALS FOR TROPICAL BROADCASTING

(Question No. 70)
(Study Group No. XII)

(London, 1953)

This Report summarizes the information submitted to the C.C.I.R. in answer to the three questions to be studied under § 1, 2 and 3, of Geneva Question No. 70.

1. The transmitting aerial should be situated as near to the centre of the reception area as possible.

   For aerials relying on ground reflection for their vertical directivity the site should be chosen where the soil is of good conductivity, though, in cases 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 aerial array.

   Where it is not possible to site the aerial at the centre of the reception area, it is possible, with multi-element transmitting aerials, to slew the beam away from the vertical in the direction of the main reception area (see Annex). Angles of slew greater than about 15 degrees 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, central siting is less important.

2. The transmitting aerial 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 aerial should be economical in design and simple in operation.

   The aerial 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 aerial consisting of a simple dipole between a quarter and a half wavelength above earth but, for smaller areas, more directive multi-element aerials would be desirable in order to reduce the low-angle radiation * (see Annex).

   It is considered desirable that the C.C.I.R. should include the curves shown in the Appendix, or similar ones, in its antenna charts.

   It is possible that the siting of the transmitting aerial 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 in answer to Question No. 69 (XII) dealing with propagation in the tropical zone, reference should be made to this point.

3. For the great majority of domestic tropical broadcast listeners only simple aerials are possible and the directivity of such aerials cannot be relied upon to improve the signal-to-noise ratio.

   The aerial 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

* " High frequency broadcast transmission with vertical radiation ", P. Adorian and A.H. Dickensen, *Journal of the British Institute of Radio Engineers.* February 1952.

to assume that the average listener's aerial cannot be better than that given in the report of the Geneva Planning Committee ; this consists of an L type aerial with horizontal and vertical limbs 16 feet in length (4.80 metres).

## ANNEX

### 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 $\frac{\lambda}{2}$ dipoles end to end, the rows being $\frac{\lambda}{2}$ 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.*

Figures 1, 2 and 3, show the polar diagrams in the two vertical planes for three types of array :

Figure 1 — A single dipole.
Figure 2 — Two rows, each of two dipoles.
Figure 3 — Four rows, each of four dipoles.

The polar diagram in the vertical plane parallel to the dipoles depends solely on the number of dipoles in a row. The polar 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 polar diagrams shown in figures 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 polar diagram in the plane containing the dipoles would be that of curve *(a)* Fig. 3, and the polar diagram in the plane at right-angles to the dipoles would be that of curve *(b)* Fig. 2.

3. *Height of array above ground.*

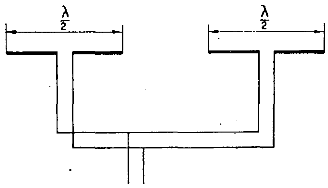
For the vertical radiated field to be a maximum, the optimum height of the dipoles above ground is $\frac{\lambda}{4}$ but the height is not critical. Fig. 1, 2 and 3 correspond to a height of 0.2 $\lambda$ above ground, but each of the curves shown may be converted to apply to any height of h wavelengths above ground, by multiplying by :

$$\frac{\sin\ (2\ \pi h \cos\theta)}{\sin\ (0.4\ \pi \cos\theta)}$$

4. *Slewing.*

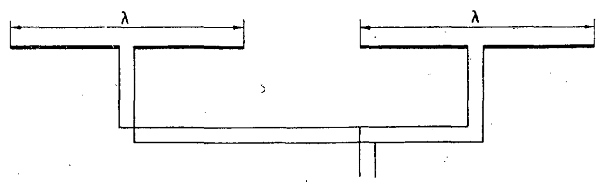
Polar diagrams shown in Fig. 1, 2 and 3 assume equal co-phasal currents in all the half-wave dipoles, and as may be seen, this results in a polar diagram suitable for a station situated in the centre of the service area. If it is desired to site a station away from that area, the direction of the vertical 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. In the case of an array with two dipoles in each row the polar diagram will be modified by multiplying by :

$$\frac{\cos\left(\frac{\pi}{2}\sin\theta + \frac{\varphi}{2}\right)}{\cos\left(\frac{\pi}{2}\sin\theta\right)}$$

In the case of an array with four dipoles in each row, the polar diagram will be modified by multiplying by :

$$\frac{\cos\left(\pi\sin\theta + \frac{\varphi}{2}\right)}{\cos\left(\pi\sin\theta\right)}$$

where $\varphi$ is the phase difference between the currents in the two halves of the array. The approximate angle of slew, in terms of the phase difference between the two halves of the array is :

$$\sin^{-1}\frac{\varphi}{\pi} \quad \text{for the array two dipoles wide}$$

$$\sin^{-1}\frac{\varphi}{2\pi} \quad \text{for the array four dipoles wide}$$

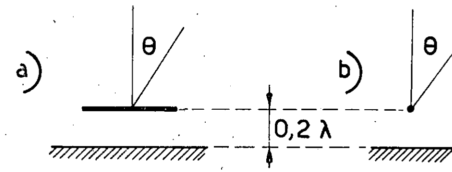
It is inadvisable to slew the main lobe more than approximately 15°, as large side lobes will otherwise form which may cause interference outside the service area.

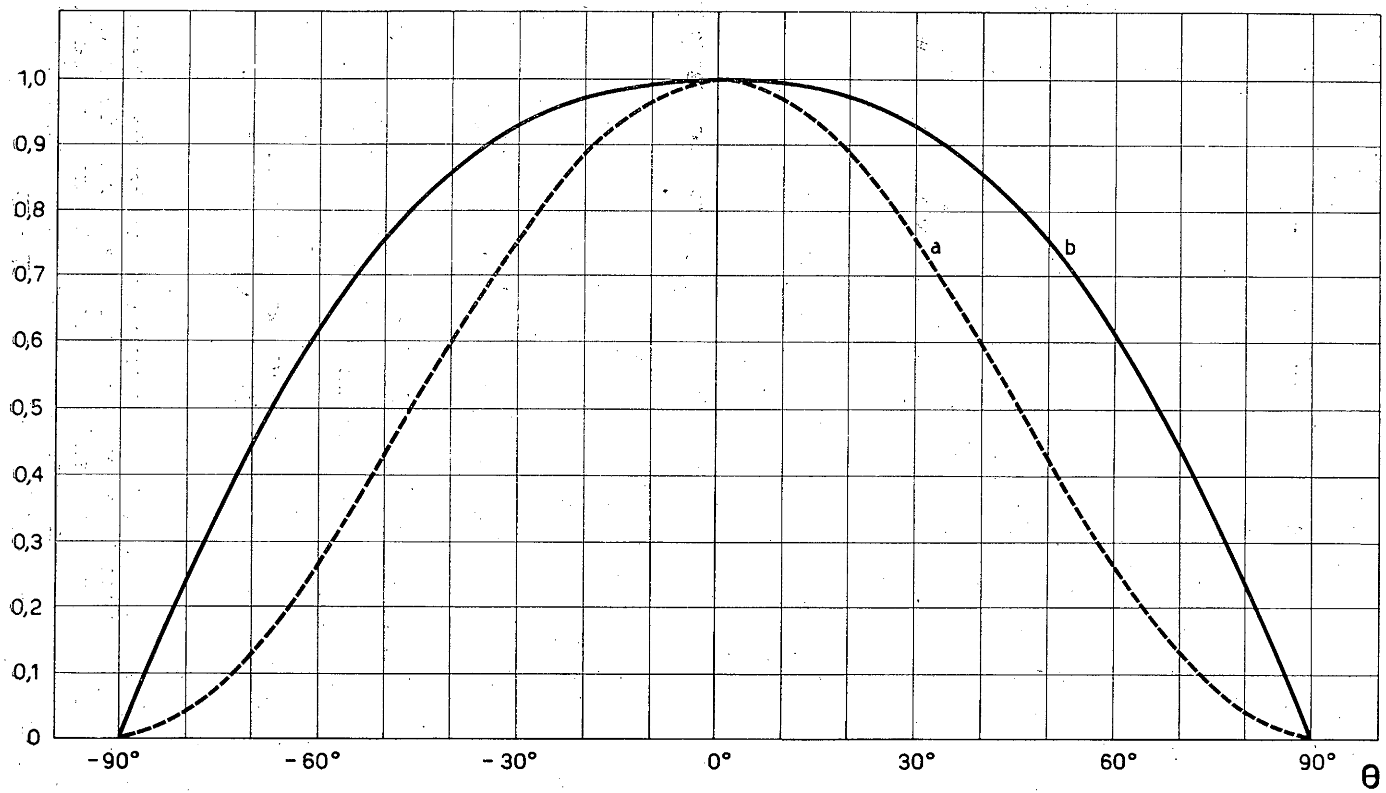
5. *Ground conductivity.*

In many cases, the conductivity of the ground is such that the efficiency and the polar 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 0.1 $\lambda$ 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 $\frac{\lambda}{2}$ beyond the extremities of the array when viewed in plan.

(*a*) Polar diagram in the vertical plane parallel to the dipole

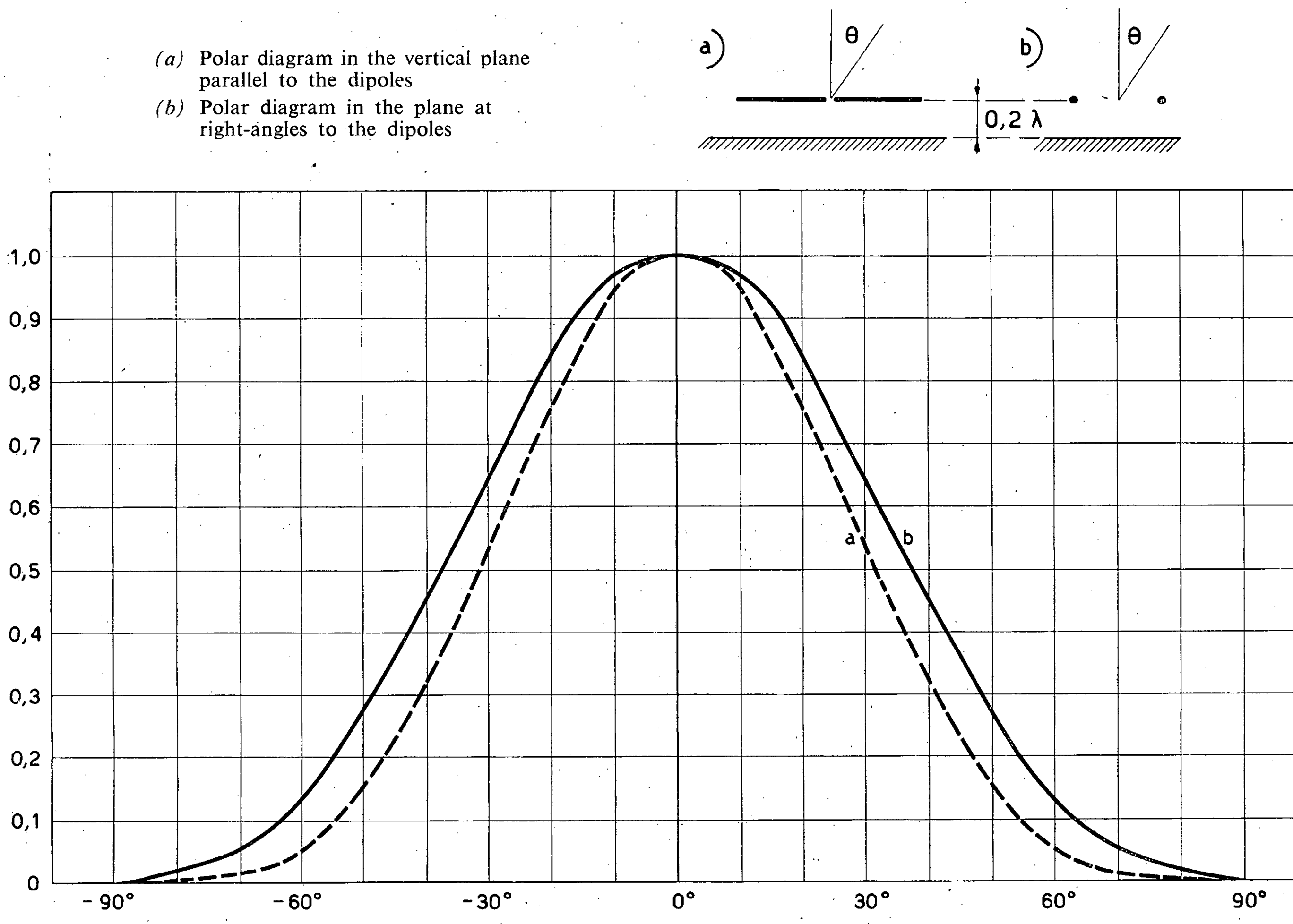
(*b*) Polar diagram in the plane at right-angles to the dipole




*Polar diagram of single* $\frac{\lambda}{2}$ *horizontal dipole*

FIGURE 1

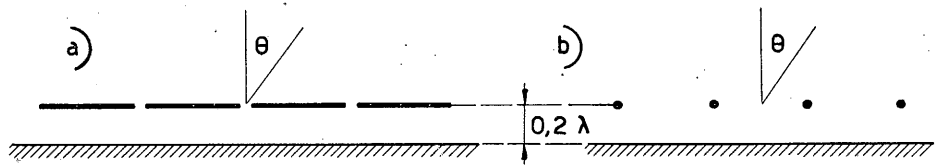


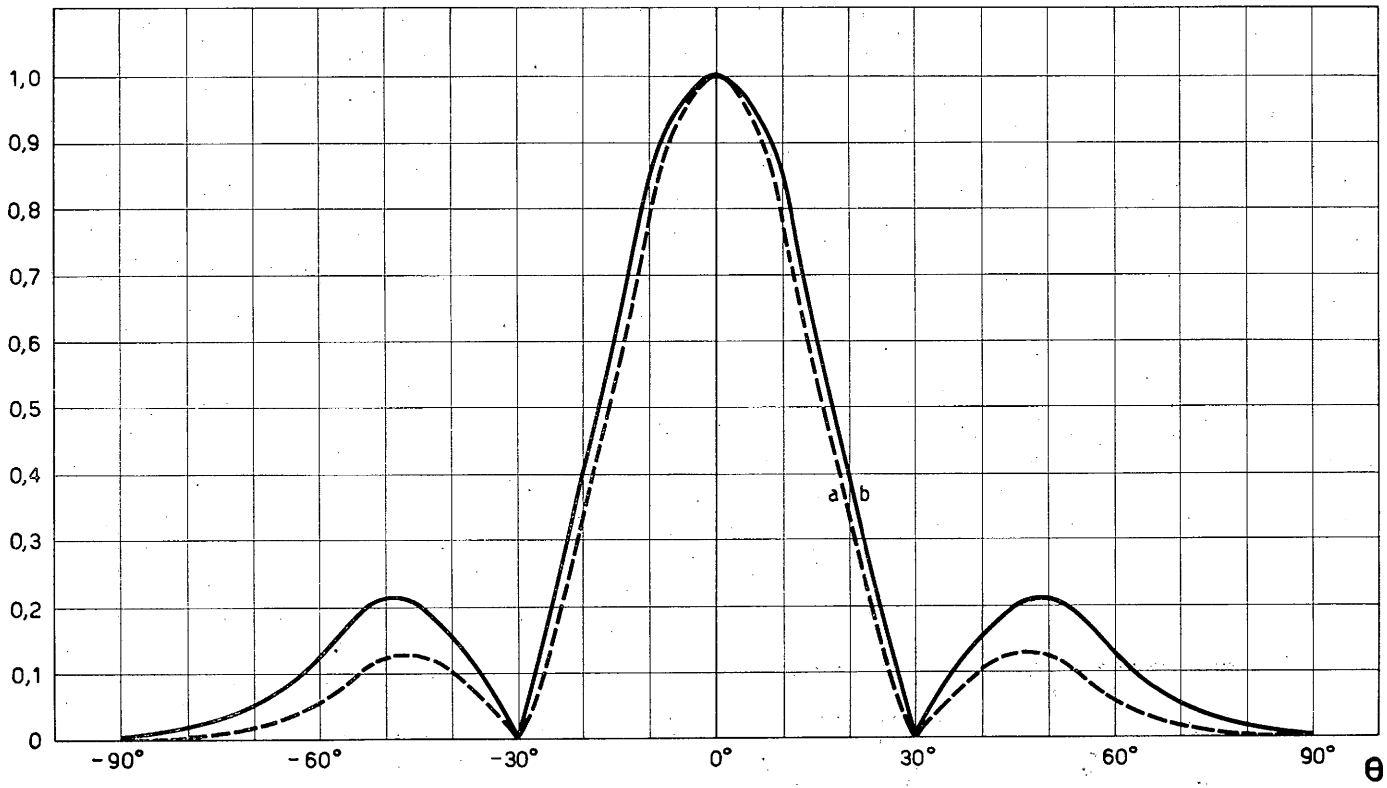

*Polar diagram of H2/2 array on its back*

FIGURE 2

*(a)* Polar diagram in the vertical plane parallel to the dipoles

*(a)* Polar diagram in the plane at right-angles to the dipoles




*Polar diagram of H4/4 array on its back*

FIGURE 3

# REPORT No. 37 *

## DECIMAL CLASSIFICATION

(Question No. 72 (XIV))
(Study Group No. XIV)

(London, 1953)

1. *Present state of the question as from the initial conditions.*

1.1 It is the function of the International Federation for Documentation (F.I.D.) to ensure, when necessary, the revision of questions out of date or no longer adequate in respect of the Universal Decimal Classification (U.D.C.).

1.2 With respect to the whole range of electrical technology the F.I.D. has entrusted this task to a committee consisting of specialists in this field, the International Committee for the Application of Decimal Classification in the field of Electrical Technology (C.I.C.E.).

1.3 With respect to the subdivisions appropriate to telecommunication, the C.C.I.E. has set up a further group of specialists, the International Sub-Committee for the Classification of Telecommunications (S.C.I.C.T.), composed of telecommunication documentalists and technicians.

1.4 The F.I.D. has secured the following aid from the Specialised Secretariat of the C.C.I.R in respect of the task allotted to the S.C.I.C.T. : jointly with the Directors of the C.C.I.T. and the C.C.I.F., and with the concurrence of the International Chairman of Study Group XIV, the Director of the C.C.I.R. has helped the F.I.D. to obtain from several administrations, members of the I.T.U., the nomination of competent personalities for this task ; the three Directors of the C.C.I.'s have jointly requested the F.I.D. to seek a united plan of classification within the entire field of telecommunications. They abstained from entering into any commitments vis-a-vis the F.I.D. in respect of the method of possible utilisation of the U.D.C. for the needs of the C.C.I.'s.

1.5 Duly noting this reservation, this initiative on the part of the Director of the C.C.I.R. has launched the study of Question No. 72, due account being taken of its complexity and of the consequent desirability of avoiding undue haste ; it has provided the most suitable means for drawing from the U.D.C. the maximum help to be expected from this system.

2. *New conditions relating to the question.*

2.1 The C.C.I.T. has recently informed the C.C.I.R. (Doc. No. 406) of the stand taken on this subject by the last plenary session (Arnhem, June 1953, Recommendation I.5 modifying Recommendation No. 241). Due consideration having been given to the importance of the problem of classification and the fact that the solution adopted by the U.D.C. has been put into practice, the text adopted, nevertheless, reopens the question of the very principle of this solution, pointing out that : the resources which can be expected from it seem to be more suitable to the needs of librarians and to the classification of general works, and that they are much less suitable for the needs of technicians ; they become less useful as the subjects concerned become more precise and more detailed, noting also that the desired classification is not only to avoid unfortunate juxtapositions, but more especially to provide a maximum of facilities and usefulness when searching for documents with one or several given aspects.

The Recommendation which follows it expresses the view that the three C.C.I.s should take a common stand in respect of this question and declare their intention of following the work of the S.C.I.C.T. as observers and without commitments.

* This Report was adopted unanimously.

2.2 The French Administration has put forward (Doc. No. 354 of London) a proposition inspired with the same considerations as those set forth in the preceding paragraph. It draws attention to the fact that the problem of classification allows of approaches towards other solutions than those which, as in the case of the U.D.C. and almost all systems so far proposed, recognise no other principle than that of a hierarchy of ramifications which distort the reality of the matter instead of being in keeping with it. It points out that some of the documentalists of the French Union of Documentary Organisations tend to move away from the U.D.C. in seeking a solution to the problem starting from a fundamentally different conception, and that an attempt at classification with a combinatory structure is under study at the (French) National Scientific Research Centre. It suggests to the C.C.I.R. that it might give its attention to these new approaches.

3. *Conclusions:*

The VIIth Plenary Assembly of the C.C.I.R. considers that the line of action to be followed until the next Plenary Assembly should be as follows :

3.1 In its relations with the F.I.D. or its specialised groups, the C.C.I.R. should avoid any official participation in the work of the S.C.I.C.T.

3.2 The Director of the C.C.I.R. should keep itself informed of the progress of this work, and submit the results to Study Group No. XIV so that the latter may consider the possibility of applying it to the needs of the C.C.I.R., using in this study any comparable material which may be available to it.

3.3 A future Plenary Assembly will have to decide on its possible use by the C.C.I.R.

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

*The draft Report, of which the text is given below, was drawn up by Working Group XI.D and approved by Study Group No. XI at their 5th Plenary meeting (Doc. No. 728, London). It was not submitted to the Drafting Committee nor to the Plenary Assembly, and therefore cannot be considered as a Report of the C.C.I.R.*

*Nevertheless, since it contains information which, although provisional, might be of use to the C.C.I.F., the Director of the C.C.I.R. has, in agreement with the Chairman of Study Group No. XI, thought it useful to include this draft Report in Vol. I.*

## Draft report of Sub-Group XI-D *

*Circuit characteristics for the transmission of television signals over long distances*

This report should not be regarded as an answer—even a provisional answer—to the set of questions posed by the C.C.I.F. and listed in Study Programme No. 32, since the information at present available is limited and much work remains to be done on the nominal value of the desired characteristics and on the tolerances that can be accepted. At the present stage of progress, therefore, it seems premature to contemplate international standardization.

However, it was felt to be worth while, in order to give as much help as possible to the C.C.I.F. experts in their own work, to show them what trends emerged from comparison of the desiderata of various countries as revealed in their written contributions or by word of mouth in the Sub-Group meetings.

* The U.S.S.R. delegation have made reservation on the subject of this draft Report.

Whenever it was considered possible, attempts have been made to unify these desiderata to some extent. On points giving rise to serious divergences of opinion—especially when caused by intrinsic differences in the systems used, such as those described in C.C.I.R. Report No. 35, the characteristics desired by the various countries have been recorded side by side.

The Sub-Group was-unanimous in emphasising the desirability and even the necessity of a joint meeting with C.C.I.F. Study Group No. 3 for an exchange of views between users and designers.

After these preliminary considerations, the following tendencies were expressed on the points contained in Study Programme No. 32 :

A. *Input and output impedances.*

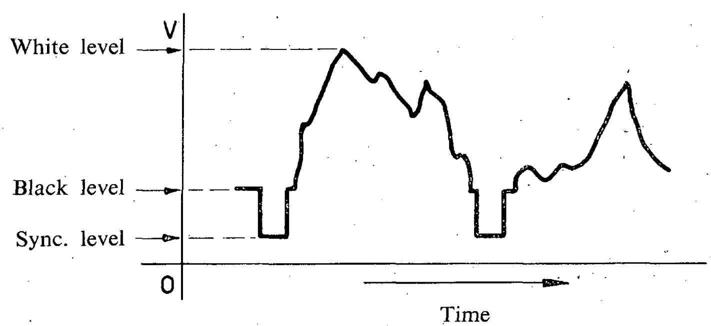
By input impedance of the circuit is meant the load impedance constituted by the circuit for the video source. By output impedance is meant the impedance at the terminals of which the video signals are restored to the user.

The nominal value of the input and output impedances is 75 ohms, not symmetrical in relation to earth.

The tolerances applicable to this nominal value cannot be clearly defined for the time being and further study will be required.

B. *Polarity and D.C. component.*

The *polarity* of the signals will be positive, i.e. such that the passage from black to white produces an increase, in the algebraical sense of the word, of the potential at the input or output impedance terminal which is not connected to earth (see Fig. 1).




V = potential difference between earth and the input or output impedance terminal not connected to earth (P.D. positive in an upward direction).

FIGURE 1

The *useful D.C. component* (i.e. the component which defines the average overall illumination of the picture) need not be transmitted. When it is provided by the video source feeding the transmission circuit or by the circuit itself at its output, it should fulfil the conditions defined below for the unwanted D.C. component.

The *unwanted D.C. component* (e.g. the component produced by D.C. tube supplies) will be such as not to dissipate more than 0.5 watts in the input or output impedance. Should this impedance be absent, the voltage should not exceed 60 volts.

C. *Amplitude of signal.*

The following table shows the values adopted in the different television systems in use for the nominal amplitude of the signal from peak white to the edge of the synchronizing signals :

| | |
|---|---|
| 405 lines | 1 Volt |
| 525 lines | 1.4 Volts ±25 %<br>and occasionally 2 Volts ±25 % |
| 625 lines | 1 Volt<br>1.5 Volts |
| 819 lines | 1 Volt |

It is suggested that in case of difficulty at the point of junction between the transmission circuits of two countries using different nominal signal amplitudes a four-terminal attenuator or 3 db amplifier could be inserted.

D. *Picture signal to synchronising signal ratio.*

The nominal values of the picture signal to synchronizing signal ratio will in principle be those indicated in C.C.I.R. Report No. 35 ; however, for ease of operation with the different systems, broadcasting organizations and transmission organizations may arrange among themselves to adopt a different ratio.

E. *Non-linearity.*

*(a)* For the complete amplitude range occupied by the vision signal, the slope of the amplitude/amplitude curve will not differ by more than ±10% from its average value. This condition applies to the complete studio-transmitter transmission circuit even if the television signal passes in transit through the installations of a broadcasting organization.

*(b)* The amplitude of the synchronizing signal at the output will not differ from that of the same signal at the input by more than ±3% of the overall peak-to-peak amplitude, the transmission circuit being adjusted in such a way that the overall peak-to-peak amplitudes at the input and at the output are equal.

F. *Gain stability.*

*(a)* Short-period variations (e.g., 1 second) :

± 0.3 db

*(b)* Medium-period variations (e.g., 1 hour) :

± 1 db

*(c)* Long-period variations (e.g., 1 month) :

If the circuit is unattended, i.e. is not adjusted before each transmission period, the gain should not depart from its nominal value by more than ±2 db.

If the circuit is permanently attended, the tolerances in *(b)* above will be applicable, i.e., the gain will have to be re-adjusted whenever it departs from its nominal value by more than ±1 db.

G. *Signal to noise ratio.*

The values given above must be observed for a percentage of time considerably higher than 99% ; moreover, no allowance has been made for a fading safety margin.

These values are a translation into decibels of the ratio

$$\frac{\text{peak-to-peak amplitude of picture signal}}{\text{quasi-peak-to-peak amplitude of noise}}$$

The quasi-peak-to-peak amplitude of the noise does not differ from its peak-to-peak amplitude when the noise is made up of periodic or impulsive disturbances. When the noise consists of continuous random disturbances, the quasi-peak-to-peak amplitude is defined as being equal to 8 times (18 db) the r.m.s. amplitude of the noise *.

* If the instantaneous amplitudes of the noise are normally distributed, the quasi-peak-to-peak amplitude is twice the instantaneous amplitude of the noise exceeded for about $5 \times 10^{-5}$ of the time.

*(a)* Random continuous noise with uniform distribution : 30 to 35 db according to system ;

*(a')* Random continuous noise with spectrum energy increasing with frequency : 25 to 30 db according to system ;

*(b)* Periodic noise : 55 db as regards the lower frequencies.

For high frequencies, some reduction of the figure given above can be allowed, but it is not yet possible to state exactly how much.

*Note.* — If the telephone administration uses for its adjustments the transmission of a low frequency near an uneven multiple of half the line frequency, the signal/noise ratio relating to the disturbance caused by this frequency on the pictures transmitted will be determined by arrangements between the administrations and organizations concerned.

*(c)* Discontinuous random noise : ratio of about 25 db for very short impulsive noise with low repetition rate.

For long impulsive noise and for high repetition rates it is not yet possible to define the required signal/noise ratio.

H. *Phase and amplitude response.*

*Characteristics proposed by the United Kingdom* (Doc. No. 39, de Stockholm).

*(a)* Amplitude/frequency characteristic :

| kc/s | up to 500 | 500-1000 | 1000-2800 |
|---|---|---|---|
| db | ±1 | ±1.5 | ±2.5 |

*(b)* Phase/frequency characteristic :

| kc/s | 200-2000 | 2000-2500 | 2500-2800 |
|---|---|---|---|
| μs | ±0.15 | ±0.25 | ±0.5 |

*(c)* The rise-time from 10% to 90% of the overall amplitude should not exceed 0.16 microseconds when the test is made with a pulse whose rise-time does not exceed 0.05 microseconds.

*Characteristics proposed by France* (Doc. No. 435).

*(a)* High frequencies :

The output signal characteristics corresponding to a unit signal, deemed ideal, applied between the input terminals :

— rise-time between amplitudes corresponding to 10% and 90% of the amplitude in the steady state ⩽65 mμs,
— overshoot ⩽10%,
— ratio of the amplitude of one transient oscillation to that of the following ⩾2.

*(b)* Low frequencies :

A standard signal of nominal amplitude, comprising a 50 c/s square signal superimposed on the normal synchronizing and suppression signals, is applied at the circuit input : on the resulting signal at the circuit output terminals, the potential difference between the corresponding extremities of the leading edges of two consecutive square signals should not exceed 3% of the peak-to-peak amplitude of the complete signal.

*Characteristics proposed by the Federal German Republic* (Doc. No. 334 and Ann. 1).

Transient response of a television transmission circuit to a test square signal repeated with a variable frequency.

1. Rise-time from 0.1 to 0.9 times the steady state amplitude . . . . . $\leqslant$ 0.1 µs
2. Just perceptible variations of the steady state amplitude :

   *(a)* for duration from 0.1 to 1 µs . . . . . . . . . . . . . . . . see Fig. 2
   (frequency of test square signal : approx. 0.2 to 0.5 Mc/s)

Rise time $\leqslant$ 0.1 µs

| ± t µs | + % | — % |
|---|---|---|
| 0.1 | 11.5 | 6.0 |
| 0.2 | 7.0 | 4.5 |
| 0.3 | 5.0 | 3.0 |
| 0.4 | 4.0 | 2.5 |
| 0.5 | 3.0 | 2.2 |
| 0.7 | 2.5 | 1.5 |
| 1.0 | 1.5 | 1.5 |

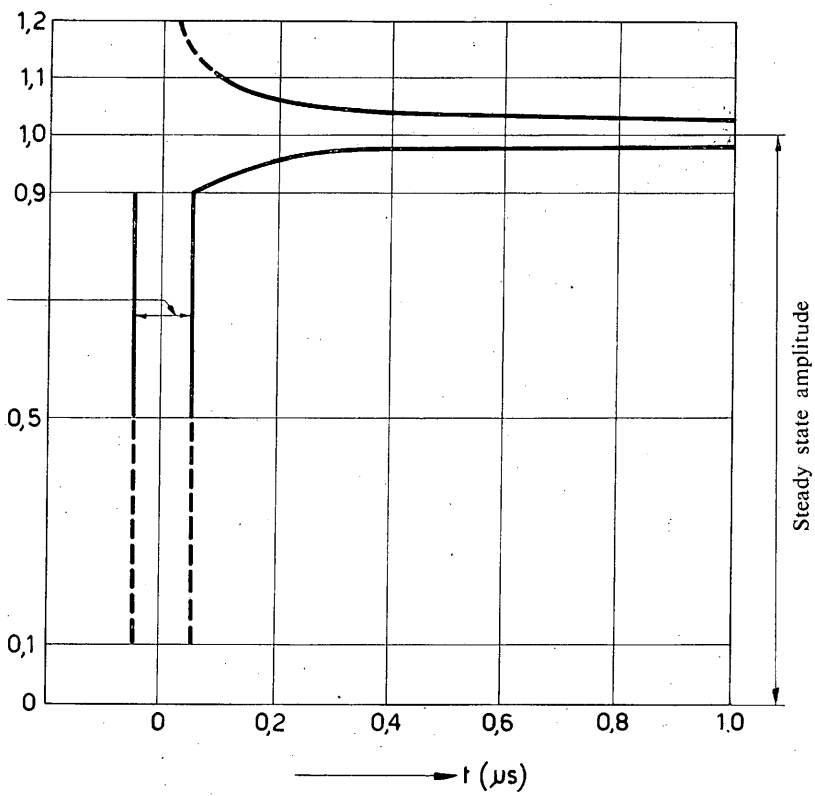



FIGURE 2

*(b)* for duration from 1 to 50 µs (roughly the line length)
(frequency of test square signal : approx. 10 kc/s to 100 kc/s)
— in case of slow transient variations ($\Delta t > 1$ µs) . . . . . . . ± 1.5 %
— in case of rapid transient variations ($\Delta t < 1$ µs) . . . . . . . ± 1.0 %
(e.g. long-delay echoes)

*(c)* for duration from 50 µs to 10 ms . . . . . . . . . . . . . . . ± 5.0 %
(frequency of test square signal 50 c/s to 1000 c/s)

The above values are only provisional, since the shape of the test signal has not yet been definitely established. Two shapes of test signal ean be considered :

1. A square signal with transition in the form of $\sin^2$ ;
2. A square signal with transition in the form of an integral sine ;
   (Rise-time : 0.1 to 0.9 ; 0.05 to 0.1 µs).

# DRAFT REPORT

## FREQUENCY STABILISATION OF TRANSMITTERS

**1. Introduction**

*(a)* In certain frequency bands a large number of transmitters at present in use are more stable than is required by the Radio Regulations (Atlantic City, 1947—App. 3) ;

*(b)* It seems possible and desirable that new transmitters for these frequency bands should comply with more stringent tolerances;

*(c)* The additional cost involved in ensuring that these new transmitters comply with the new tolerances is negligible in comparison with the prime cost and operating expenses of the equipment.

**2. Conclusion**

On the basis of the documents available at Brussels (March-April; 1955) it seems practicable to keep the frequency of new transmitters within the following limits :

2.1 In Band B of App. 3 of the Radio Regulations (535 kc/s — 1605 kc/s), $\pm 10$ c/s.

2.2 In Band D of App. 3 of the Radio Regulations (4,000 kc/s — 30,000 kc/s) for Fixed Stations with a power of more than 500 watts, $\pm 0.0015\%$.

2.3 In Band D of App. 3 of the Radio Regulations for Fixed Stations with a power of 500 watts or less, $\pm 0.005\%$.

2.4 In Band D of App. 3 of the Radio Regulations for Coastal and Aeronautical Stations with a power of more than 500 watts, $\pm 0.0015\%$.

2.5 In Band D of App. 3 of the Radio Regulations for Broadcasting Stations, $\pm 0.0015\%$.

2.6 In Band E of App. 3 of the Radio Regulations (30 Mc/s — 100 Mc/s) for Land Stations, $\pm 0.0075\%$.

2.7 In Band E of App. 3 of the Radio Regulations for Mobile Stations, $\pm 0.0075\%$.

2.8 In the event of the above standards of performance being adopted by an Administrative Radio Conference as revised tolerances for App. 3 of the Radio Regulations, three years might be necessary to enable all organizations to achieve these standards.

2.9 Existing transmitters should be improved to meet these standards of performance as soon as possible and the date by which all existing transmitters can be made to meet the new standards should be studied in the near future.

**3.** The study is not complete and it is noted that closer limits might be adopted in some of the frequency bands. Administrations are requested to submit further contributions to this study for consideration at the Plenary Assembly at Warsaw.

# DRAFT REPORT ON THE REQUIREMENTS FOR THE TRANSMISSION OF TELEVISION OVER LONG DISTANCES

(Study Programme No. 32 (XI))

*revision of Draft Report of Sub-Group XI-D (see p.268 of this volume)*

## I. General

1. *Long distance and junction lines.*

The C.C.I.F. has established the following definition for a television circuit AD for international television transmission by line :

*(a)* The junction line AB, linking the studio or switching centre, situated at point A, to the input B of the long distance line ;

*(b)* Long distance line BC ;

*(c)* Junction line CD connecting the output end C of the long distance line to a studio, switching centre or radio transmitter, situated at point D.

C.C.I.R. Study Group No. XI agrees to the adoption of this definition for radio relay links or mixed cable and radio systems. The Study Group considers that the requirements given in Section II below can be regarded as applicable to the long distance line BC, provided the junction lines AB and CD are not long enough to cause appreciable distortion.

2. *Hypothetical reference circuit for TV transmission over radio links.*

C.C.I.R. Study Group No. XI recommends for a radio relay link system a hypothetical reference circuit 2500 km long, with two intermediate video connection points.

3. *Video connection points.*

At each video connection point, the output terminals of one set of equipment are connected to the input terminals of the next set of equipment by a length of cable, equalized if necessary.

(a) *At the input to a long distance line*

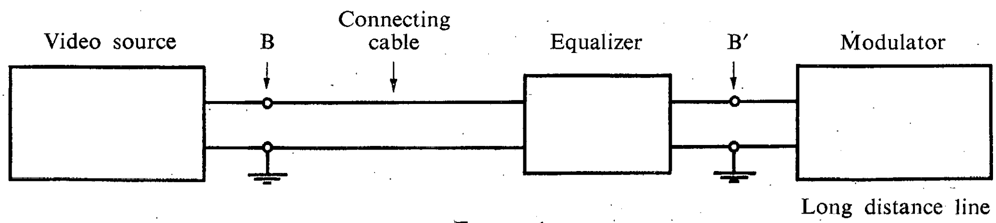



FIGURE 1

The terminals at B are considered to be the input terminals of the long distance line. The connection BB′ is a permanent link forming part of the long distance line.

(b) *At the output of a long distance line*

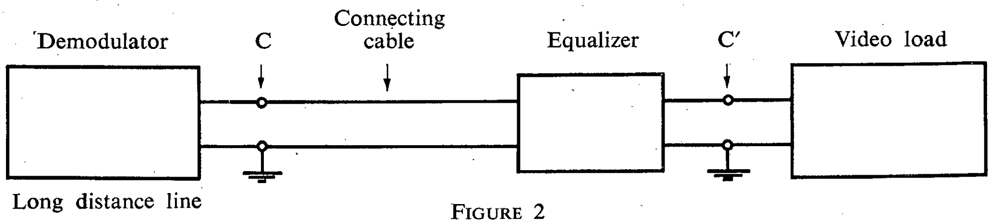



FIGURE 2

The terminals at C are considered to be the output terminals of the long distance line. The connection CC′ does not form part of the long distance line.

## II. Requirements for the transmission of black and white television signals

A. *Impedance.*

The impedances looking into the video input/output terminals of the equipments terminating a long distance link shall have a nominal value of 75 ohms with one terminal connected to earth, and a return loss * of not less than 24 db relative to 75 ohms.

In fixing this tolerance it is assumed that :

*(a)* the impedances looking into the terminals of the source and the load connected to the long distance link will also have a return loss of not less than 24 db relative to 75 ohms ** ;

*(b)* The cable used to make these connections will have, at the higher video frequencies, a characteristic impedance with a return loss of not less than 30 db relative to 75 ohms.

B. *Polarity and DC component.*

The polarity of the signals at any video connection point shall be positive, i.e., such that passage from black to white produces an increase, in the algebraical sense of the word, of the potential at the terminal which is not connected to earth (see diagram below).

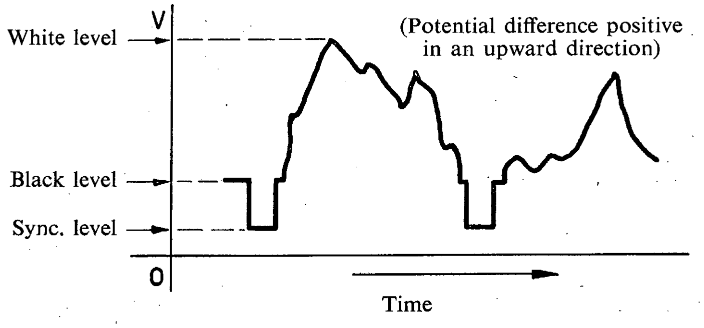



FIGURE 3

* The return loss of an impedance Z relative to 75 ohms is :

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

** The French Administration reserves the right to adopt different values for the return loss provided that the quality of transmission is maintained.

The Administration of the Federal German Republic reserves the right to express its final opinion concerning the return loss values. This will be done as soon as possible.

The useful DC component (i.e. the component which is related to the average overall illumination of the picture) may or may not be present in the signal from the video source and need not be transmitted over a link or delivered at the output terminals.

Any unwanted DC component accompanying the signal and quite unrelated to it (e.g. the component due to DC valve supplies) shall not cause more than 0.5 watt to be dissipated in the impedance (nominally 75 ohms) to which it is connected. Should this load impedance be disconnected, the voltage of the unwanted component shall not exceed 60 volts.

C. *Peak-to-peak amplitude of overall signal* *.

At the terminals B (Fig. 1) and C (Fig. 2) the nominal amplitude of the signal, from peak white to the tip of the synchronizing signal shall be :

1 volt for all the European television systems described in C.C.I.R. Report No. 35 (London, 1953). On initial adjustment for setting up a long distance circuit, the peak-to-peak amplitude of the signal shall be adjusted to within ±5% of this value of 1 volt at the terminals B and C.

For the 525 line system used in the USA, the nominal value adopted, corresponding to that of 1 V defined above, is, as a general rule, 1.4 V with a tolerance of ±25% and sometimes 2 V ±25%.

D. *Peak-to-peak amplitude of synchronising signal.*

During the initial setting up period the peak-to-peak amplitude of the synchronising signal transmitted by itself shall be 0.3 V ±0.02 V at all the video connection points where the nominal peak-to-peak amplitude of the overall signal is 1 V.

E. *Non-linearity distortion.*

(a) *For the picture signal*

The annexes to the present report give the admissible tolerances and the measurement methods proposed by the Administrations of the following countries : France, Federal German Republic, United Kingdom and Switzerland.

(b) *For the synchronising signal*

The tolerances for the peak-to-peak amplitude of the synchronising signal at the output of a long distance circuit are : + 10% to — 30% of the nominal value provided that any variation is slow. For rapid variations, particularly if associated with the picture content, more stringent tolerances will be required, but these cannot at present be specified. The annex submitted by the Swiss Administration contains an example of these tolerances and describes the methods of measurement used.

F. *Gain stability.*

Until a better method of measuring the gain stability of a television transmission circuit has been determined, the following method and tolerances are recommended. The tolerances are intended to include any variations due to propagation effects.

The peak-to-peak amplitude of the signal at the input to the circuit is set up to a value within the range 1 volt ± 5% and is then maintained constant. The variation of the peak-to-peak amplitude of the signal at the output of the circuit shall not exceed the following values for :

---

* Theoretically the amplitude should be measured with the useful DC component of the signal restored, but in practice this is not necessary. This remark applies equally to § D.

*(a)* Short-period variations (e.g. 1 second) : ±0.3 db * ;

*(b)* Medium-period variations (e.g. 1 hour) : ±1 db ;

*(c)* Long-period variations (e.g. 1 month) :

— if the circuit is unattended, i.e. not adjusted before each transmission period, the gain should not depart from its nominal value by more than ±2 db,

— if the circuit is permanently attended, the tolerances in *(b)* above will be applicable, i.e., the gain will have to be readjusted whenever it departs from its nominal value by more than ±1 db.

G. *Signal-to-noise ratio.*

The values given below should be achieved for not less than 99% of the time **.

The values quoted are a translation into decibels of the ratio :

$$\frac{\text{peak-to-peak amplitude of picture signal (excluding synchronising pulses)}}{\text{RMS *** amplitude of noise in the bandwidth 0 to } f_c}$$

in the case of random noise, $f_c$ being the upper limit of the frequency band for the system considered

and of the ratio :

$$\frac{\text{peak-to-peak amplitude of picture signal (excluding synchronising pulses)}}{\text{peak-to-peak amplitude of noise}}$$

in the case of periodic noise or discontinuous random noise.

The tables below give, for the different systems, the figures for :

*(a)* random continuous noise with a uniform energy versus frequency spectrum ;

*(a')* random continuous noise with the spectrum energy rising with frequency at a rate of 6 db per octave ;

*(b)* periodic noise.

*405 line system*

*(a)* 50 db
*(a')* 42 db } $f_c = 3$ Mc/s

*(b)* 30 db at 50 c/s
45 db at 100 c/s
55 db between 1 kc/s and 1 Mc/s
55 db decreasing linearly to 25 db between 1 and 3 Mc/s.

* The French Administration considers that it will be difficult to satisfy the condition *(a)* in all cases, and especially with radio relay links when tropospheric propagation effects give rise to deep fading with rapid variations.

** The precise meaning intended by "99% of the time" requires further study in collaboration with Study Group No. IX.

*** The RMS value for random continuous noise is recommended rather than the quasi peak-to-peak value specified in the draft report of Sub-Group XI-D (London, 1953, Vol. I, p. 270) because there is some difficulty in fixing the ratio of the quasi peak-to-peak to RMS values.

*625 line systems and Belgian 819 line system*

*(a)* 48 db } $f_c$ = 5 Mc/s when the RF channel is 7 Mc/s
*(a')* 41 db } and 6 Mc/s when the RF channel is 8 Mc/s.
*(b)* 30 db at 50 c/s
45 db at 100 c/s
50 db from 1 kc/s to 1 Mc/s
50 db decreasing linearly to 30 db between 1 and $f_c$ Mc/s.

*819 line system*

*(a)* * } $f_c$ = 10 Mc/s
*(a')* 37 db }
*(b)* 45 db from 50 c/s to 1 Mc/s
45 db decreasing linearly to 20 db at 6 Mc/s
20 db from 6 to 10 Mc/s.

*For all systems*

Discontinuous random noise :
25 db for very short impulsive noise with a low repetition rate.
For long impulsive noise and for high repetition rates it is not yet possible to define the required signal-to-noise ratio.

H. *Amplitude and phase response.*

*405 line system*

*(a)* Amplitude/frequency characteristics :

| kc/s | up to 500 | 1000 | 2800 |
|---|---|---|---|
| db | ±1 | ±1.5 | ±2.5 |

The tolerances are relative to the amplitude measured at 100 kc/s and increase linearly between the frequencies specified.

*(b)* Group delay frequency characteristics :

| kc/s | 200-2000 | 2000-2500 | 2500-2800 |
|---|---|---|---|
| μs | ±0.15 | ±0.25 | ±0.5 |

Group delay is measured with a 100 kc/s modulation on the test frequency and the tolerances are relative to the delay at 200 kc/s.

* Noise of type *(a)* only arises in transmission by coaxial cable and no value is given as this type of transmission is not at present used for the 819 line system.

*625 line systems and Belgian 819 line system*

1. *For channel width 7 Mc/s.*

Attenuation (db)

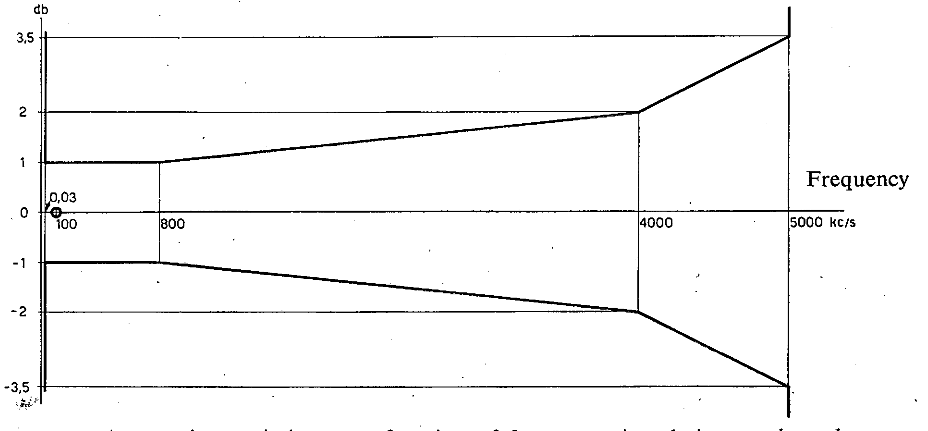



*Figure 4.* — Attenuation variation as a function of frequency, in relation to the value for 100 kc/s

Group delay (microseconds)

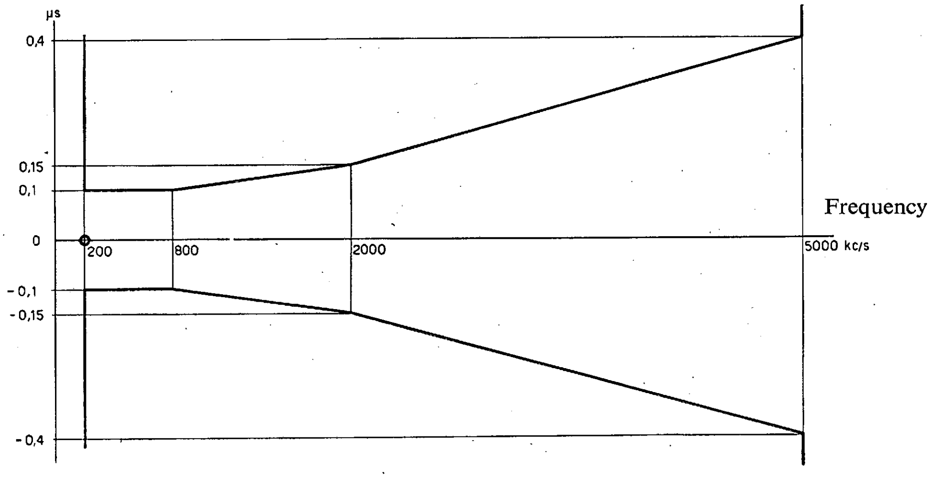



*Figure 5.* — Variation in group delay as a function of frequency, in relation to the value for 200 kc/s

FIGURES 4 AND 5. — *Amplitude and phase characteristics provisionally proposed for television transmission circuits (625 line system)*

*Notes.* — 1. Moreover, in an interval of 100 kc/s, the variation should not exceed 0.1 microsecond. The limits for envelope delay may appear somewhat wide ; no closer limits can be fixed at present.

2. On the other hand, the " phase change-frequency " characteristic for 30 c/s to 200 kc/s should not deviate by more than $\pm 6^{\circ}$ from a straight line with an ordinate origin equal to 0 or to a whole multiple of $360^{\circ}$.

2. *For channel width 8 Mc/s* (as for 1), except that the frequency 5000 kc/s should be changed to 6000 kc/s.

*819 line system.*

Attenuation (db)

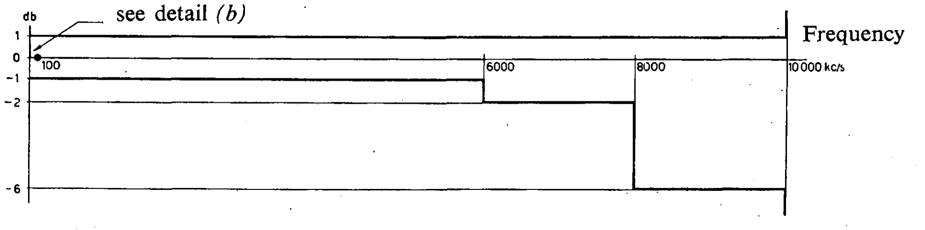
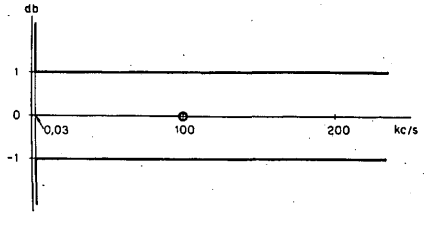



*Figure 6.* — *(a)* Attenuation variation as a function of frequency, in relation to the value for 100 kc/s




*(b)* Detail of diagram *(a)*, 30 c/s to 200 kc/s

Group delay time (microseconds)

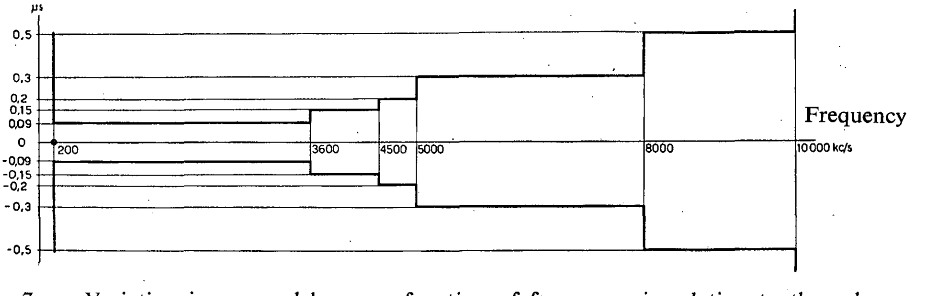



*Figure 7.* — Variation in group delay as a function of frequency, in relation to the value for 200 kc/s

FIGURES 6 AND 7. — *Amplitude and phase characteristics provisionally proposed for television transmission circuits (819 line system)*

*Notes :*

1. Certain of the characteristics given in this paragraph were intended to apply only to a circuit 1000 km long without intermediate video connection points.

   The C.C.I.R. asks the C.C.I.F. whether all the characteristics could be accepted for a hypothetical reference circuit of 2500 km with two intermediate video connection points.

2. The C.C.I.R. directs the attention of the C.C.I.F. to the fact that the amplitude and phase characteristics specified do not ensure, *ipso facto*, that the very low frequency response of the circuit will be satisfactory. To check that the very low frequency response is satisfactory, it is advisable to use a special test waveform of nominal amplitude comprising a 50 c/s square wave superimposed on normal synchronising and suppression signals. When this signal is applied to the input of a circuit, the corresponding signal at the output shall be such that the change of potential over half a period along the top or bottom of the 50 c/s square wave does not exceed a few per cent of the overall peak-to-peak amplitude.

3. The above specifications for the steady state values, although useful, if not indeed indispensable in the calculation of circuit elements for picture transmission, do not, however, give the full assurance of a satisfactory transmission of transients which are of first importance in television. The C.C.I.F. had also made proposals concerning the form of test signals for transients.

   The C.C.I.R. is not yet in a position to give its opinion on these proposals and on tolerable distortions in the shape of the signals at the output of the circuit. But is wishes to underline its great interest in carrying out this study and to emphasize the urgency of concluding it.

## III. Requirements for the transmission of colour television signals

In the absence of theoretical and/or experimental data on the colour systems that may be brought into use, at least in Europe, it is impossible at present to indicate, even approximately, the corresponding requirements. It is reasonable to expect, however, that the requirements given in Section II for the transmission of black and white signals might have to be modified to some extent.

## ANNEX I

FRANCE

### Specifications for non-linearity distortion

Two separate specifications are proposed for the definition of signal distortion due to non-linearity.

The first specification is for the " vision " portion of the signal and concerns the *slope* variation of the output/input amplitude characteristic.

The second is for the " synchronisation " portion of the signal and concerns the amplitude of the outgoing synchronising signal.

In practice the measurements are made simultaneously :

The two test signals represented by the following figure, are fed successively to the circuit input :

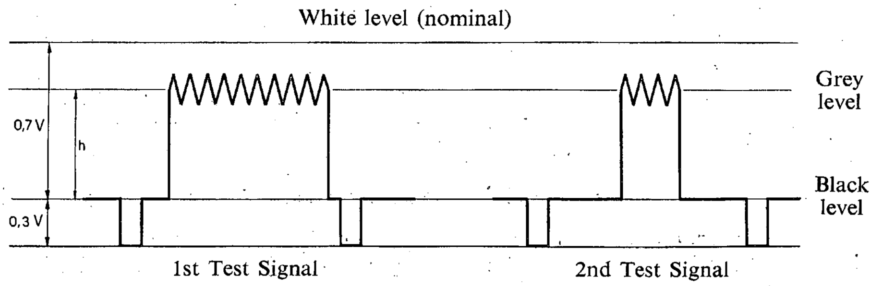



FIGURE 8

Both signals consist of :

— a grey level h adjustable between 0.1 V and 0.8 V ;

— a sinusoïdal or square modulation, superimposed on the grey level, with a peak-to-peak amplitude equal to 0.2 V and a frequency of the order of 500 kc/s ;

— a synchronising signal with an amplitude of 0.3 V.

The grey level duration of the first test signal is equal to the non-blanking duration of the line while that of the second is approximately $^1/_8$ of that duration.

With the transmission equivalent so adjusted that the nominal voltage at the output corresponds to that at the input, h is made to vary and measurement is taken of the peak-to-peak output amplitude of the modulation superimposed on the grey level, as well as of the peak-to-peak output amplitude of the synchronising signal.

These measurements should satisfy the following conditions :

*(a)* With h varying from 0.1 V to 0.6 V, the modulation amplitude should not be lower than 0.75 times its maximum value.

*(b)* With h varying from 0.1 V to 0.8 V, the tolerance should be reduced to 0.6 times (circuit slightly overloaded).

*(c)* With h varying from 0.1 V to 0.8 V, the amplitude of the synchronising signal should remain equal to + 0.03 V or — 0.09 V.

*Note:* Owing to lack of practical experience with a circuit 2500 km long, the above values are tentative.

## ANNEX II

### FEDERAL GERMAN REPUBLIC

**Method for measurement of non-linear distortion**

1. A test signal is fed to the video input of the television circuit (see Fig. 9). The signal consists of line synchronising pulses and a sawtooth voltage with a duration equal to that of ¼ line, followed by a continuous white level, lasting till the end of the line. A 4 Mc/s sine frequency, for instance, with a peak-to-peak amplitude equal to 10% of the total voltage is superimposed on the sawtooth voltage. (The exact sawtooth voltage values are given in the figure ; these are selected in such a way as to ensure that the modulated sawtooth peak elongations reach the white and the black levels simultaneously).

A passband filter for 4 Mc/s is inserted at the circuit output. Finally, the slope of the amplitude/amplitude curve is measured by means of an oscilloscope (see Fig. 11).

To ascertain whether the slope thus measured is sufficiently independent of the continuous component value, the test signal is modified as shown in Fig. 10, i.e., the sawtooth is shifted from one end of the line to the other.

For the tolerance, a value of $\pm 10\%$ the mean value is accepted. This method has been found to provide measurements with an accuracy of $\pm 3\%$, which is considered acceptable.

2. The following method is proposed for the measurement of synchronising pulse distortion :

With test signals, corresponding either to Fig. 9 or Fig. 10, the synchronising pulse voltages should not show variations of more than $+10\%$ or $-30\%$ of the measured value, when the synchronising pulses are transmitted alone.

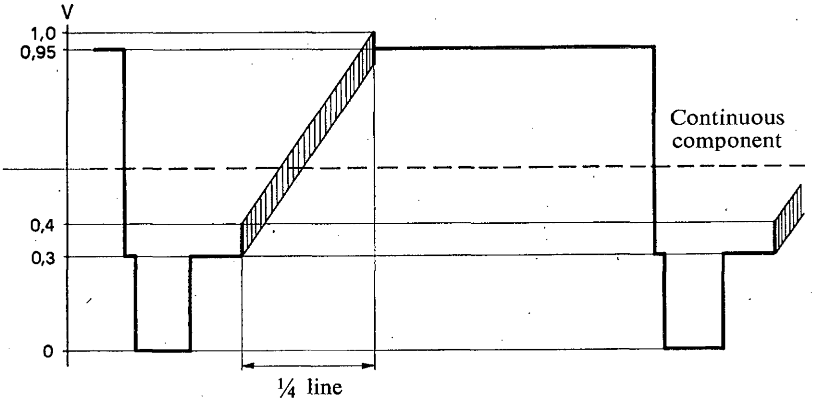



FIGURE 9

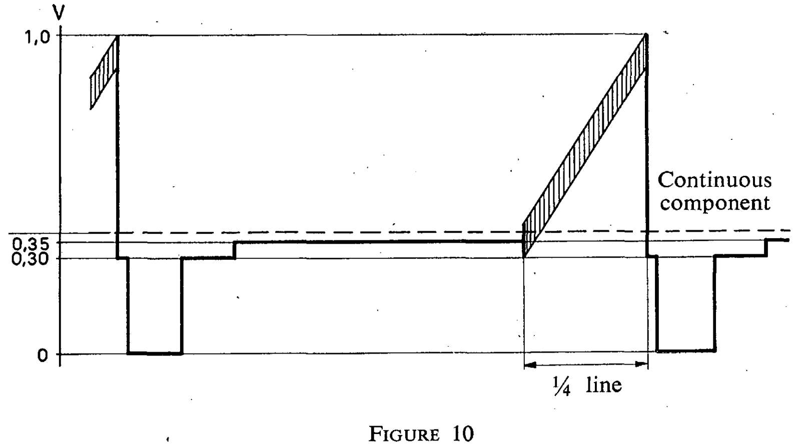



FIGURE 10

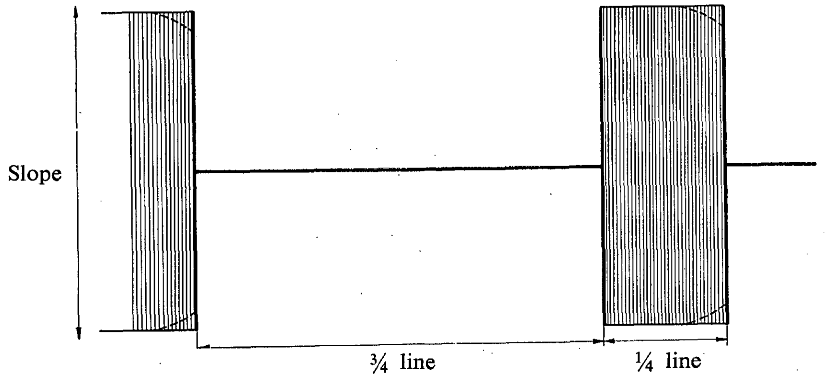



FIGURE 11

## ANNEX III

### UNITED KINGDOM

### Non-linearity

For the measurement of non-linearity, the following procedure may be adopted :

(i) The gain of the circuit is determined and set within the permitted tolerance while transmitting synchronising signals only ;

(ii) A narrow white bar (10% line period) is then added to the synchronising pulses and increased in amplitude in steps of 20% from 0 to 100% of the total picture amplitude at the input. The corresponding bar amplitudes are measured at the output ;

(iii) The same procedure is then carried out with a bar occupying the full available line width, the amplitudes of the bar and the synchronising signal being measured at the output for each input level setting.

Then for all amplitudes of the narrow and wide bar the ratio amplitude of bar at output : amplitude of bar at input, shall lie between the limits 0.9 and 1.1 times the gain of the circuit (the gain being nominally one), and the amplitude of the synchronising signal at the output shall not vary by more than + 10 % to — 30 % of its amplitude measured with synchronising pulses only present.

Other methods of measurement utilizing more complicated test signals may be employed if desired for rapid measurements so long as the range of voltage excursions explored is substantially the same as that covered by the two simple waveforms detailed above.

# ANNEX IV

## SWITZERLAND

### Measurements and tolerances of the non-linear distortions of a TV circuit

To assess the amount of non-linear distortion present in a TV transmission system, the following measurements are carried out and the results obtained are required to line within the tolerances indicated.

*Test Signal I*

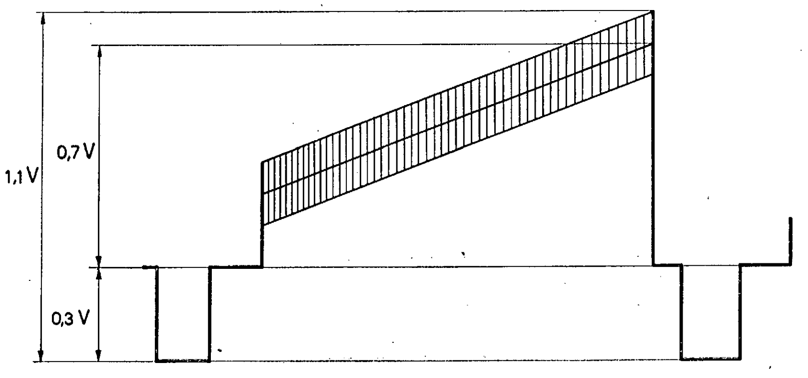



FIGURE 12

*Definition.*

CW signal of variable frequency (2 .... 5.5 Mc/s) and constant amplitude (100 mV peak-to-peak) superimposed on standard line sawtooth.

*Measurement.*

The CW part of the signal is removed at the output of the circuit by means of a high-pass filter ($f_{-1}$ = 1.8 Mc/s) envelope-detected and applied to an oscilloscope.

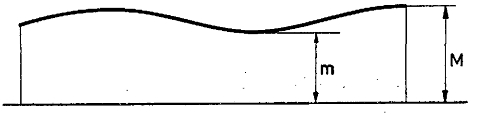



FIGURE 13

*Tolerance*

$m \geqslant \frac{8}{10}$ M for any one given frequency in the specified range.

### Test Signal II

*Definition.*

CW signal of variable frequency (2... 5.5 Mc/s) and constant amplitude (100 mV peak-to-peak) superimposed on variable grey line signal.

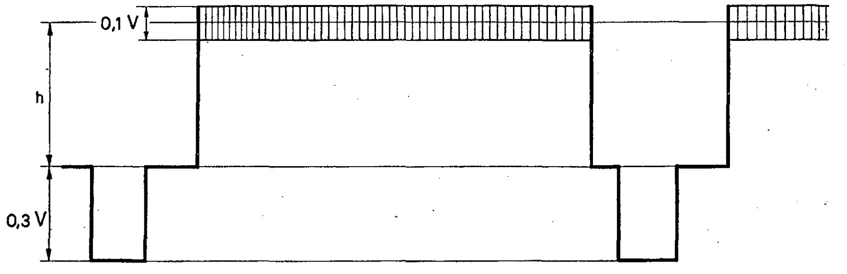



FIGURE 14

*Measurements.*

*(a)* The output signal is directly connected to an oscilloscope. The circuit is assumed to have been set up (e.g. peak white signal at the input at standard level to produce 1.0 V peak-to-peak, at the output). Then the ratio of h at the input to h at the output with or without the CW signal shall, for values of h between 0.1 and 0.7 V, always lie within the range 0.9 to 1.1.

*(b)* The output signal is fed through the high-pass filter as under I and may or may not be envelope-detected. Then for any value of h between 0.1 and 0.7 V the peak amplitude of the CW signal (or its envelope) shall not vary by more than $\pm 10\%$.

### Test Signal III

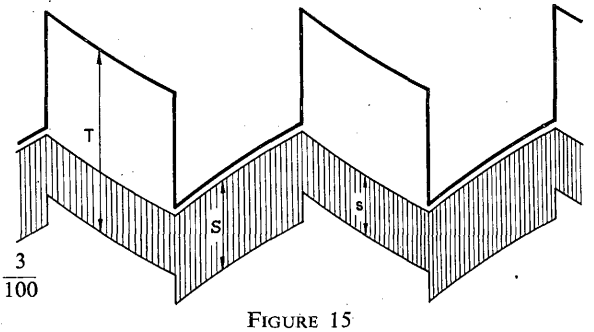
*Definition.*

50 c/s square-wave properly suppressed and superimposed on line synchronising signal.

*Measurement.*

Directly with oscilloscope, before black level clamping (if any).

*Tolerance.*




$$\frac{S-s}{T} \leqslant \frac{3}{100}$$

FIGURE 15

*Note:* All signals are used also for measuring other circuit characteristics.

# RESOLUTIONS

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## RESOLUTION No. 5

## MEANS OF EXPRESSION

### Definitions, Vocabulary, Graphical and Letter Symbols

(Recommendations Nos. 26 and 34 of the C.C.I.R. and Resolutions Nos. 66, 67 and 175 of the Administrative Council of the I.T.U.)
(Study Group No. XIV)

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

CONSIDERING :

*(a)* That it is of the first importance to standardize the means of expression (terms, symbols, measurement units) with a view to better and more rapid understanding among the participants in the work of the C.C.I. s ;

*(b)* That such standardization is far from being accomplished ;

UNANIMOUSLY RESOLVES :

1. That each study group of the C.C.I.R. should establish a list of definitions of the principal terms and symbols used in the branch of radiocommunication with which it is concerned ;

2. That the Director of the C.C.I.R., as his other duties permit, shall collect available information concerning the standardization of means of expression (terms with their definitions, graphical and letter symbols) ;

3. That administrations should collaborate to their utmost in the preparation of a list of radio communication terms, by forwarding to the Director of the C.C.I.R. the glossary of technical terms and documents of national standards, if any, together with any other documents that may be of value in compiling a first draft list of terms and symbols ;

4. That the Director of the C.C.I.R. should examine all the documentation he is thus able to collect and reach agreement with the chairman of the Study Group on Vocabulary as to subsequent work, with a view to examination by the VIIth Plenary Assembly of the C.C.I.R. ;

5. That care should be taken not to duplicate work already carried out by national or other international organizations.

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## RESOLUTION No. 10

## EXTENSION OF THE C.C.I.R. PROPAGATION CURVES BELOW 300 kc/s

(Study Group No. IV)

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

CONSIDERING :

*(a)* That the I.F.R.B. in Doc. No. 346, Question *(d)*, has requested that propagation curves given in Recommendation No. 52 be extended to distances above 2000 km for frequencies between 10 kc/s and 300 kc/s ;

*(b)* That this extension could be limited to distances corresponding to field strengths of not less than 0.1 $\mu V/m$ ;

*(c)* That for the construction of these curves only the first term of the residues series has to be used ;

*(d)* That at very little cost, the extension of the curves could therefore be made by the Secretariat of the C.C.I.R. ;

*(e)* That, however, ionospheric reflections on the frequencies under consideration, may, even in day-time, become of major importance ;

RESOLVES :

**1.** That the attention of the I.F.R.B. be drawn to :

1.1 Paragraph *(d)* above ;

1.2 The fact that the sky-wave on frequencies below 300 kc/s and for distances larger than 2000 km may be predominant, bearing in mind the limitations mentioned in Recommendation No. 52 (§ (i) of Annex) ;

**2.** That information be sought from Study Group No. VI concerning the expected values of the field strength of the sky-wave on these frequencies and distances.

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## RESOLUTION No. 11

## PUBLICATION OF GROUND-WAVE PROPAGATION CURVES BETWEEN 30 AND 300 Mc/s

(Question No. 6 (IV) — Study Programme No. 16)
(Study Group No. IV)

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

CONSIDERING :

*(a)* That the idealized theoretical curves of this nature would be useful in connection with the planning and operation of telecommunication services ;

*(b)* That the extension of these curves to frequencies of the order of 300 Mc/s is justified. At the higher frequencies and large distances ground irregularities and tropospheric influences cause departures from the theoretically assumed conditions, nevertheless theoretical curves remain of considerable value for reference purposes and to indicate the effects of these factors ;

*(c)* That in view of the increasing influence of the troposphere and terrain at still higher frequencies it is for the present considered that the extension of the curves beyond 300 Mc/s is not justified ;

*(d)* That refraction in the troposphere does affect the received field strength, and that the value of effective earth radius which on average conforms most nearly to measured data above 10 Mc/s, at least for temperate climates, is 4/3 of the actual radius ;

RESOLVES THAT :

**1.** Such curves should be prepared to meet the following conditions :

1.1 The calculations shall be made for frequencies of 30, 60, 100, 150, 200 and 300 Mc/s ;

1.2 The maximum distance to be covered will be 200 km, and the curves shall be carried in towards the transmitter to the vicinity of the first maximum of field strength ;

1.3 The elevation of the transmitting antenna above the ground for which the curves shall be constructed are 10, 20, 50, 100, 200, 500 and 1000 metres ;

1.4 The elevation of the receiving antenna above the ground for which the curves shall be constructed are 0, 2, 5, 10, 20, 50, 100, 200, 500 and 1000 metres ;

1.5 Both horizontal and vertical polarisations shall be considered ;

1.6 The curves shall be constructed for sea and land paths. For sea-water a relative dielectric constant of 80 and a conductivity of $4 \times 10^{-11}$ e.m.u. shall be assumed. For land the values shall be 10 and $10^{-13}$ respectively ;

1.7 Standard refraction shall be allowed for by employing an effective earth radius equal to 4/3 of the actual earth radius ;

1.8 The curves shall be presented in the following way :

- — the abscissa shall represent the distance linearly in kilometres. The ordinate will indicate the field strength in decibels relative to 1 microvolt/metre between the limits 0 and + 100 db. One centimetre shall correspond to 10 decibels ;
- — the curves shall refer to a half-wave transmitting dipole, the moment of which corresponds in free space to a field in the equatorial plane of

$$\frac{2.22 \times 10^5}{D_{km}} \; \mu V/m \qquad \text{(See Annex)}$$

- — each individual diagram will contain curves for all receiving heights and for a single combination of the stated values of transmitting heights, frequency, polarisation and ground constants ;
- — a separate curve should be drawn (dotted) indicating the free space values of field strength ;
- — if possible, more than one diagram shall be printed on a single sheet of the book of curves, to facilitate cross-reference. As an example, the opened book might show 2 curves on the left hand page and 2 curves on the right hand page, the conditions for all four diagrams being identical except for a progressive change of transmitter height. Thus, 4 curves would be shown together for transmitter heights 10, 20, 50 and 100 metres, and four curves would be shown together for transmitter heights 100, 200, 500 and 1000 metres.

1.9 The basis for the calculations shall be the rigorous mathematical treatment developed from the Hankel functions where the residues series has to be used. At the same time, lengthy calculations which lead to an accuracy which is not significant under the conditions of use should be avoided. Without some preliminary work it is not possible to specify the approximation which might be used ;

**2.** That the Director of the C.C.I.R., (this being the most appropriate organisation), should be asked to undertake this work ;

**3.** In organising the work the attention of the Director of the C.C.I.R. is drawn to the publications named in U.K. Doc. No. 154 (4.3.2) and the Italian Docs. Nos. 260 and 287.

*Note.* — Careful consideration of the number of points for which calculations would be required suggests that the total effort would represent very approximately 1000 man hours. This estimate assumes that the work would be carried out by a University graduate or person of equivalent standard.

## ANNEX

In order to give the curves a precise significance, it has been resolved above that they be calculated accurately for the ideal type of transmitting antenna to which the rigid mathematical analysis applies, namely a very short antenna or dipole of known moment. It is therefore desirable to use the same value of the dipole moment for all heights of this antenna. The power radiated by it will then vary with its height, but it would not be feasible to label each curve with the corresponding radiated power, as the problem of determining the radiation resistance of an antenna above an imperfectly conducting spherical earth is extremely complex and has not been solved to an accuracy comparable to that to which the curves will be drawn. For the same reason it would not be practicable to adjust the curves to correspond to a constant radiated power from the ideal antenna.

Instead of specifying the dipole moment, it is more practicable to state the field which the dipole would produce in its equatorial plane at a sufficiently great distance in free space. If this is expressed as $\frac{k \times 10^5}{D}$ $\mu$V/m where k is proportional to the dipole moment and D is the distance in km, such a dipole would produce a cymomotive force of 100k volts in its equatorial plane in free space, or a e.m.f. of 200k volts at the surface of a perfectly conducting plane earth if it is placed in a vertical position at any height above it, small compared with the distance D.

The field at the distances for which the curves are to be drawn, i.e. beyond the last maximum going from the transmitter and into the diffraction region, will be derived mainly from the energy leaving the transmitter at low angles of elevation and very little from the energy leaving at high angles. If, therefore, two different antennae producing the same field in the equatorial plane in free space have polar diagrams that only differ significantly at high angles of elevation, they will produce substantially the same field under the conditions specified for the curves when one is substituted for the other.

An aerial of great practical interest to the engineer for use in the proposed frequency range is the half-wave dipole and its polar diagram in free space for a given field in the equatorial plane is close to that of the very short antenna except at high angles of elevation. Such a half-wave dipole in free space will set up a field of $\frac{2.22}{D}$ $10^5$ $\mu$V/m, corresponding to a c.m.f. of 222 Volts in its equatorial plane when it radiates 1 kW.

Thus, as the value chosen for k is 2.22, the curves that it is proposed to construct for the short antenna will correspond for all practical purposes to chose for a half-wave dipole that would radiate 1 kW in free space, provided that the transmitter height associated with the curves is interpreted as the height of the mid-point of the half-wave dipole. This is a device that is widely used by engineers, and as for most of the conditions to which the curves apply the transmitter will be several wave-lengths above the ground, the actual radiated power will be effectively 1 kW in most cases.

It must be remembered, however, that for the lowest frequency of 30 Mc/s and the lowest height of 10 metres when the propagation is for vertical polarisation over sea, the radiated power may be significantly different from 1 kW, e.g. by as much as 3 decibels. It is nevertheless considered desirable to define the dipole moment in the proposed manner as for the general conditions to which the curves apply, since it meets the requirements of the engineer who is familiar with the idea of radiated power.

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## RESOLUTION No. 12

## USAGE AND MEANING OF MUF

(Recommendation No. 57, § 1)
(Study Group No. VI)

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

CONSIDERING :

*(a)* That responsibility for standards, symbols and conventions in connection with the production and reduction of ionospheric data has now been assigned to and accepted by U.R.S.I. ;

*(b)* That, nevertheless, confusion is known to have arisen in the minds of operating personnel as a result of the two distinct usages now prevalent for the term MUF :

— the observed or calculated value at a particular instant of maximum usable frequency corresponding to specific conditions in a specific portion of the ever changing ionosphere ;
— the median observed or predicted value of the above quantity at a particular time of day determined, for example, for a period of one calendar month ;

*(c)* That the definition of MUF as simply " maximum usable frequency " according to Ann. I of Geneva Recommendation No. 57 is not sufficiently explicit to prevent or resolve the above confusion ;

*(d)* That a large volume of technical and scientific literature recognizes MUF as having a meaning corresponding to the first usage referred to in *(b)* above ;

UNANIMOUSLY RESOLVES :

1. That the attention of U.R.S.I. be drawn to the need for clarification of the definition of MUF, so as to ensure that it shall be understood to describe an instantaneous condition of a particular region of the variable ionosphere ;

2. That the single word " MUF " extensively used by prediction agencies on basic prediction charts and specific circuit predictions derived therefrom should be replaced by the two words " median MUF " whenever, in fact, the median value of MUF is meant ;

3. That the attention of U.R.S.I. be also drawn to the need for corresponding clarification in the definition of d-MUF.

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## RESOLUTION No. 13

## PREPARATION OF SHORT-TERM FORECASTS OF IONOSPHERIC DISTURBANCES

(Study Group No. VI)

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

CONSIDERING :

*(a)* The growing importance of short-term forecasts of ionospheric disturbances in facilitating modifications to normal operating arrangements ;

*(b)* The progress made in the study of the correlation between ionospheric and magnetic disturbances ;

*(c)* The desirability of expediting, as much as possible, the preparation and dissemination of these forecasts ;

*(d)* Point 2 of Recommendation No. 59, which advocates that the information required for the preparation of short-term forecasts of ionospheric disturbances should be centralised by the appropriate official agencies, as far as possible by the most direct electrical means of communication between these agencies and the various scientific institutes concerned ;

RESOLVES :

That administrations be encouraged to take the necessary steps to establish direct communication between their official agencies responsible for the preparation of short-term forecasts of ionospheric disturbances, and the scientific organisations which provide the required magnetic, solar, and other information.

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## RESOLUTION No. 14

### INVESTIGATION OF CIRCULARLY POLARIZED EMITTED WAVES PROPAGATED VIA THE IONOSPHERE

(Study Group No. VI)

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

CONSIDERING :

*(a)* That experiments with circularly polarized emitted waves, in the HF band, both at vertical incidence in the ionosphere and at oblique incidence, may yield important results for radiocommunication regarding the study of magneto-ionic effects ;

*(b)* That for long-distance transmission, a considerable part of the fading-phenomena is due to the interference of left-handed and right-handed circularly polarized waves ;

UNANIMOUSLY RESOLVES :

That U.R.S.I. be invited to start investigation of the ionospheric propagation of waves emitted with circular or elliptical polarization and inform the C.C.I.R. of the results.

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## RESOLUTION No. 15 *

### STANDARDIZATION OF FACSIMILE APPARATUS FOR USE ON COMBINED RADIO AND METALLIC CIRCUITS

(Study Group No. IX)

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

CONSIDERING :

*(a)* That a Joint Study Group of the C.C.I.T. and C.C.I.R., under the direction of the C.C.I.T. has already been formed for the study of certain aspects of " Transmission of half-tone pictures over combined radio and metallic circuits " ;

*(b)* That this Joint Study Group has not yet completed its work ;

*(c)* That the C.C.I.R. takes considerable interest in C.C.I.T. Question No. 46 - Arnhem (i.e. Question No. VI.8 (amended) of the Geneva Revision) concerning the characteristics of apparatus for the transmission by facsimile of :

— telegrams in the public telegraph service ;
— business documents ;
— documents of large size such as, for example, meteorological charts ;

*(d)* That other questions concerning facsimile telegraphy which are of joint interest to the C.C.I.T. and C.C.I.R. will probably arise ;

UNANIMOUSLY RESOLVES :

That the Joint Study Group of the C.C.I.T. and C.C.I.R. should remain in being to study these matters.

* The present Recommendation in conjunction with Recommendation No. 127 and Question No. 95 (IX) completes the study of Question No. 58.

## RESOLUTION No. 16

## STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

### Cine type spools

(Study Group No. X)

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

CONSIDERING :

*(a)* That, although various standards for magnetic tape recording at a speed of $7\frac{1}{2}$ in/s (19.05 cm/s) have been agreed, the cine type of spool normally used at this speed has not been standardized for broadcasting, but continues to appear in an increasing number of varieties in various countries ;

*(b)* That the rapidly increasing use of cine type spools makes it likely that if their standardization is delayed until the next Plenary Assembly of the C.C.I.R., it will be too late to be effective ;

RESOLVES :

**1.** That the members of C.C.I.R. Study Group No. X who are most urgently concerned with this problem should, as soon as possible, exchange information concerning the dimensions of the various cine type spools in use in their own countries ;

**2.** If standardization cannot be agreed by correspondence, these members should meet in the early part of 1954 to see if a provisional international agreement can be reached at least on the most important spool dimensions.

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## RESOLUTION No. 17

## THE USE OF THE 26 Mc/s BROADCASTING BAND

(Study Group No. X)

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

CONSIDERING :

*(a)* That it is important that long-distance broadcasting should use all channels available to it ;

*(b)* That, when the smoothed relative sunspot number reaches 70, long-distance broadcast transmissions can be carried out efficiently during daylight hours, over many routes, on frequencies within the 26 Mc/s broadcasting band ;

*(c)* That hitherto these frequencies have been very little used ;

*(d)* That such transmissions on these frequencies, whenever they are possible, are particularly advantageous because of the very low atmospheric noise intensity, and the low absorption ;

*(e)* That this band will not be fully used until receivers covering it are available ;

UNANIMOUSLY RESOLVES :

1. That administrations should bring to the notice of broadcasting organizations the advantages of the 26 Mc/s band for long-distance broadcasting when ionospheric conditions are favourable ;

2. That, when broadcasting organizations have decided that they will make use of the 26 Mc/s band, they should make their intention known well in advance, in order to expedite the availability of suitable receivers.

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## RESOLUTION No. 18

### PUBLICATION OF SERVICE CODES IN USE IN THE INTERNATIONAL TELEGRAPH SERVICE

(Study Group No. XIII)

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

CONSIDERING :

*(a)* That the C.C.I.T. during its VIIth Plenary Assembly adopted the following question :

" The study, in collaboration with the C.C.I.R., of the possibility of assembling in a separate volume, to be published by the General Secretariat of the Union, the various codes regarded as useful in the International Telegraph Service (line and radio) for universal use by that service " ;

*(b)* That the C.C.I.T. has requested the C.C.I.R. to collaborate in the study of that question ;

*(c)* That it is of importance to assemble all service codes useful in the telegraph service (such as those contained in App. I of the International Telegraph Regulations, Q-code, etc.) ;

UNANIMOUSLY RESOLVES :

1. That the C.C.I.R. should co-operate with the C.C.I.T. in assembling the volume mentioned under *(a)* above, on the understanding that C.C.I.T. assume the supervision and responsibility for this work ;

2. That the assembling in one volume of the various codes at present in use will be a first step towards a more unified system of service codes ;

3. That the administrations should study the possibility of eventual unification of these codes.

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## RESOLUTION No. 19

### IDENTIFICATION OF RADIO STATIONS

(Study Group No. XIII)

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

CONSIDERING :

*(a)* That the need for solution of the problems raised in Question No. 104 (XIII) and Study Programme No. 78 (XIII) is rapidly becoming more acute, more widespread and increasing use is being made of the radio spectrum, as well as greater use of multi-channel and high speed F1 systems, thus resulting in increased congestion in the radio frequency spectrum, particularly below 27 500 kc/s ;

(*b*) That only slight progress has been made in the study of Question No. 17 and Study Programme No. 26 ;

(*c*) That representations have been made by the I.F.R.B. to the C.C.I.R. to expedite satisfactory solutions of the problem posed in C.C.I.R. Question No. 17 and Study Programme No. 26 to facilitate the work of monitoring stations and to further the program adopted by the E.A.R.C., Geneva, 1951 ;

(*d*) That increased emphasis is desirable in finding prompt and satisfactory solutions to the question of " Identification of Radio Stations ", and particularly that means should be found to superimpose, or otherwise transmit the call sign, preceded, when appropriate, by a special signal * on radio transmissions employing multi-channel and high speed F1 systems ;

RESOLVES :

That, in the meantime, and as a matter of urgency, administrations should take such measures as will ensure transmission of the call sign preceded when appropriate by a special signal *, in a manner readily receivable and understandable by monitoring stations, as frequently as practicable, having regard to the present urgent need to facilitate international monitoring and more particularly to the furtherance of present efforts by administrations, assisted by the I.F.R.B., to carry out the decisions of the E.A.R.C., in Geneva, 1951.

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* See Recommendation No. 132.

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# QUESTIONS
# AND
# STUDY PROGRAMMES

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# Questions and Study Programmes assigned to Study Group No. I

## QUESTION No. 1 (I) *

## REVISION OF ATLANTIC CITY RECOMMENDATION No. 4

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

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

UNANIMOUSLY RESOLVES :

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

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

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

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

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

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

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

AND UNANIMOUSLY DECIDES :

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

* Study Programmes Nos. 2 (I), 3 (I), 39 (I) and 40 (I) arise from this Question.
** Concern Questions No. 1 (I), No. 2 (which no longer remains for study) and No. 3 (III).

## STUDY PROGRAMME No. 2 (I) *

# HARMONICS AND PARASITIC EMISSIONS

(Question No. 1.b (I))

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

CONSIDERING :

*(a)* That in the case of wave propagation at frequencies where ionospheric reflection plays an important part, the harmonics may propagate differently from the fundamental in different directions due to the wide difference in frequencies ; this effect is in addition to that caused by the antenna directivity not being the same for the fundamental and harmonic frequencies ;

*(b)* That the harmonics of a transmitter provided for one class of service may interfere with other classes of service in other parts of the spectrum ;

*(c)* That the relationships between fundamental and harmonic field intensities and between radiated harmonic power and harmonic field intensity measured at a distance from the transmitter differ markedly in the cases :

— where both the fundamental emission and the harmonic involve ionospheric propagation,
— where only the harmonic involves ionospheric propagation,
— where only the fundamental emission involves ionospheric propagation,
— where neither the fundamental emission nor the harmonic involves ionospheric propagation ;

*(d)* That a more definite evaluation of the effects of the limiting values specified in App. 4 of the Radio Regulations, 1947, should be determined ;

*(e)* That, in order to achieve or maintain a good standard of practice for transmitters with respect to the suppression of harmonics, it is essential to have readily applicable methods of specifying and testing equipments ;

*(f)* That, since many existing high power transmitters have a fundamental to harmonic power ratio of 70 db or greater, it is desirable to consider further :

— the need for revised limits for harmonic power output for such cases,
— reduction of harmonic radiation from conductors with non-linear characteristics located within the high intensity fundamental field of the transmitter which might act as subsidiary generators ;

*(g)* That different relationships exist between the signal-to-noise ratios appropriate for the several services in the various frequency bands and interferences caused by harmonic radiations. For example, in view of the susceptibility of television to interference, the particular harmonics falling within television channels ** which are in use in the vicinity of the interfering station are of paramount importance. The attenuation of these particular harmonics may in some cases need to be substantially greater than limits which may be applicable for some other services. Other services may also have special requirements peculiar to their own needs ;

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* This Study Programme arises from Question No. 1 (I).

** Television channels may be set up in certain cases in the following broadcasting bands : (Band I, 41 to 68 Mc/s ; II, 87.5 to 100 Mc/s ; III, 174 to 216 Mc/s ; and IV, 470 to 960 Mc/s).
For additional details see the Atlantic City Frequency Allocation Table, Chap. 3, Art. 5 of the Radio Regulations.

DECIDES that the following studies shall be carried out :

1. App. 4 of the Radio Regulations, 1947, should be re-evaluated, for which purpose the various administrations should submit data on harmonic power and field intensity measurements to enable a more definite evaluation to be made of the relationships between them. Such evaluation should take into account the signal-to-noise ratio aspects as related to the different services with regard to the harmonic interference problem.

2. To secure further data on methods of measurement of harmonic power by the substitution method and on the equipment to be used, particularly with regard to correctly connecting the auxiliary generator to the antenna feeder.

3. To secure further data on alternative methods of measuring harmonic power.

4. Study of the elements of antenna and antenna feeder design useful in reducing harmonic radiations.

5. Determination of the special conditions which may apply to certain high power transmitters (for example 100 kW or greater) which in many cases at present have a fundamental to harmonic power ratio of 70 db or greater. In this connection consideration should be given to radiation from conductors with non-linear characteristics which such transmitters may excite.

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## STUDY PROGRAMME No. 3 (I) *

## FREQUENCY STABILISATION OF TRANSMITTERS

(Question No. 1.c (I))

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

CONSIDERING :

*(a)* That Question No. 1.c of the C.C.I.R. refers to frequency stability, by which is meant constancy of frequency ;

*(b)* That improvement in the utilisation of the radio-frequency bands depends also on the accurate positioning of the mean frequency, that is, on the accuracy of the frequency determining elements as distinct from their stability ;

*(c)* That degrees of accuracy and stability far in excess of those required by the Radio Regulations of Atlantic City are available, but that such provision may, in certain cases, conflict with economic considerations and design considerations such as weight and volume;

*(d)* That advancements in technique are being made in obtaining high accuracy and stability, whilst still meeting economic and design requirements ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Study of improved methods of attaining high accuracy and stability of the frequency of radio emissions, consistent with economic and design requirements.

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* This Study Programme arises from Question No. 1 (I).

# STUDY PROGRAMME No. 39 (I) *

## BANDWIDTH OF EMISSIONS

(Question No. 1.a (I) — Recommendation No. 87)

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

CONSIDERING :

*(a)* Question No. 1.a (I) ;

*(b)* That Recommendation No. 87 which contains partial answers to Question No. 1.a was based on theoretical considerations as well as on results of measurements made under conditions which do not always represent those of actual traffic ;

*(c)* That it is therefore necessary to extend the theoretical and the experimental studies on the spectra appropriate to the various classes of emission ;

*(d)* That the definition of the bandwidth occupied in the Radio Regulations of Atlantic City is such that measurements of the bandwidth occupied are difficult even at a short distance from the transmitter ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

Continuation of the studies of bandwidths and spectra under actual traffic conditions in the different cases met with in practice and for all classes of emission in accordance with the following provisions :

**1.** The studies should be carried out simultaneously by theoretical and experimental methods and a detailed comparison should be made of the results obtained by both methods.

The experimental studies should make use of the methods of measurement set out in Recommendation No. 88 as well as methods of measurement in actual traffic, which might be developed along the lines of Study Programme No. 40 (I).

**2.** These studies should be conducted for the various classes of emissions as follows :

2.1 *Class A1, A2 and F1 emissions.*

A sufficiently large number of measurements of spectra and of signal shape should be carried out with different types of transmitters at present in use.

The appropriate means for limiting the spectra of these transmitters as well as of new transmitters to be constructed, should be studied, with the aim, on the one hand, of determining the requisite filters, and, on the other hand, of achieving a sufficient linearity of the amplifying stages or the frequency modulators.

The transmitters so improved should be put in service so that final conclusions on their behaviour may be established for various operating conditions.

2.2 *Class A3 emissions.*

Measurements of radiation outside the necessary band should be made with transmitters of different types using this class of emission, and particularly with independent sideband transmitters.

These measurements should be made with narrow bandwidth measuring apparatus such as is described in Recommendation No. 88 and the results should be compared with those obtained with wideband apparatus, as mentioned in Recommendation No. 87, § 2.4.

* This Study Programme replaces Study Programme No. 17 and arises from Question No. 1 (I).

It would be useful to obtain these measurements when the transmitter is modulated by an artificial voice or by white noise ; these two modulations approximately reproducing the two practical cases where the transmitter is used without a privacy equipment or with a band-splitting privacy device.

Methods for still further reducing out-of-band radiation should be investigated.

2.3 *Other classes of emission.*

Comparable studies should be undertaken for the other classes of emission used in international telecommunications, in particular for the classes of emission used in the HF (decametric) band such as :

— Multiplex emissions of various types ;
— Class A4 and F4 emissions.

These studies should then be extended to the classes of emission used in the VHF (metric) and UHF (decimetric) bands.

**3.** A new definition should be sought of occupied bandwidth, which will facilitate bandwidth measurements while still permitting their theoretical determination.

This new definition should not lead, for the classes of emission already studied, to results very different from those given by the definition contained in the Atlantic City Radio Regulations.

In this connection consideration should be given to suggestions that the out-of-band radiation might be defined :

— by a fixed maximum level for the corresponding components of the spectrum ;
— by a fixed maximum value for the corresponding radiation per unit of bandwidth.

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## STUDY PROGRAMME No. 40 (I) *

## METHODS OF MEASURING EMITTED SPECTRA IN ACTUAL TRAFFIC

(Question No. 1.a (I))

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

CONSIDERING :

*(a)* That it is of the highest importance to be able to determine with accuracy the bandwidth occupied and the spectrum of emissions in actual traffic ;

*(b)* That the documentary material at present available does not give a full idea of the value of the results obtained in actual traffic with the apparatus used for measuring the spectrum of a periodic signal ;

UNANIMOUSLY DECIDES that the following study should be carried out :

**1.** For a given type of measuring equipment, comparison of the results obtained on periodic signals and on actual traffic signals of comparable characteristics and of the same telegraph speed ;

**2.** Comparison of the results obtained with different methods such as those described in Recommendation No. 88 ;

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* This Study Programme arises from Question No. 1 (I).

3. Continuation of experimental and mathematical studies in an attempt to bring out the physical meaning of the results obtained in actual traffic, considering various forms of energy distribution within the spectrum, especially those resulting from the use of privacy systems ;

4. Examination of the results obtained when using the method 1.1 of Recommendation No. 88 in cases where the bandwidth of the filter is inadequate to provide sufficient discrimination against adjacent components ;

5. Determination of the degree of accuracy obtainable with different methods such as those described in Recommendation No. 88.

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## QUESTION No. 18 (I)

## TELEGRAPHIC DISTORTION

The C.C.I.R., (Stockholm, 1948 — Geneva, 1951)

UNANIMOUSLY DECIDES :

That it is advantageous that a joint study should be made by the C.C.I.T. and the C.C.I.R. of the following question :

Establishment of a general definition of telegraphic distortion, capable of being usefully applied to the case of radiotelegraphy.

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## QUESTION No. 20 (I) *

## FREQUENCY-SHIFT KEYING

The C.C.I.R., (Stockholm, 1948 — Geneva, 1951)

CONSIDERING :

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

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

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

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

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* Study Programme No. 41 (I) arises from this Question.

UNANIMOUSLY DECIDES that the following question be studied :

1. Fixation of one or more standard values of deviation for the fixed and mobile services in the various frequency bands, having regard to the various factors, in particular :
   (a) the frequency spectrum resulting from the keying operation,
   (b) the degree of frequency diversity desired,
   (c) economy of bandwidth,
   (d) instability of frequencies ;
2. Standardization of the relative position of the marking frequency and the spacing frequency (is it desirable to utilize the upper frequency for mark and the lower frequency for space or vice versa ?) ;
3. Compilation of a standard terminology regarding the characteristics of systems employing frequency-shift keying.

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## STUDY PROGRAMME No. 41 (I) *

## FREQUENCY-SHIFT KEYING

(Question No. 20 (I)

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

CONSIDERING :

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

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

UNANIMOUSLY DECIDES that the following study should be carried out :

1. The determination in each particular case of recommended values of frequency shift for emissions using frequencies between 2000 and 27 000 kc/s ;
2. The determination in each particular case of recommended values of frequency shift for emissions using frequencies below 2000 kc/s.

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## QUESTION No. 74 (I) **

## ARRANGEMENT OF CHANNELS IN MULTI-CHANNEL TELEGRAPH SYSTEMS FOR LONG-RANGE RADIO CIRCUITS OPERATING ON FREQUENCIES BELOW ABOUT 30 Mc/s

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

CONSIDERING :

(a) That lack of uniformity in the arrangement and designation of the channels in multi-channel telegraph systems for long-range radio circuits operating on frequencies below about 30 Mc/s may give rise to certain difficulties when one transmitting station has to work with more than one receiving station ;

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* This Study Programme replaces Study Programme No. 4 and arises from Question No. 20 (I).

** This Question replaces Question No. 46.

*(b)* That many such systems are in use besides the multi-channel voice-frequency telegraph systems referred to in Question No. 43 (III) ;

UNANIMOUSLY DECIDES that the following question should be studied :

What is the best way of arranging and designating the channels in multi-channel telegraph systems for long-range radio circuits operating on frequencies below about 30 Mc/s ?

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## QUESTION No. 75 (I) *

## LIMITATION OF UNWANTED RADIATION FROM INDUSTRIAL INSTALLATIONS

(Question No. 3 (III))

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

CONSIDERING :

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

*(b)* That the harmonious co-existence of radio services with industrial installations producing radio oscillations involves close collaboration between organizations representing the manufacturers and users of these installations on the one hand, and the radio services on the other, for which the existing collaboration between the C.C.I.R. and the Special International Committee on Radio Interference (C.I.S.P.R.) provides ;

*(c)* That the C.I.S.P.R. has already extensively studied and continues to study the permissible signal/interference ratios for sound and television broadcasting, but has not yet made equivalent studies for other radio services ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. Study of the most appropriate means of determining the level of intentional or parasitic oscillations produced by industrial, scientific or medical apparatus ;

2. Determination of the level to which it should be practicable to reduce such oscillations.

*Note.* — In this study the C.C.I.R. should keep itself informed on the results of the studies of the C.I.S.P.R. on the same subject, in order to avoid duplication of work.

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* See Question No. 84 (III).

# Questions and Study Programmes assigned to Study Group No. II

## QUESTION No. 76 (II) *

## SENSITIVITY AND NOISE FACTOR

(Stockholm, 1948 — Geneva, 1951 — London, 1953)

The C.C.I.R.,

CONSIDERING :

*(a)* That Recommendation No. 94 gives only limited data on receiver sensitivity and noise factor ;

*(b)* That receiver noise is of greater importance at higher frequencies than at lower frequencies ;

*(c)* That, in the case of radio telegraphy receivers :

— a non-linear relation, due, for example, to the use of a non-linear detector or discriminator, or a telegraph signal-shaping circuit, may exist between the depth of modulation of that signal and the output signal level ;

— such non-linearity changes the effect of noise from an amplitude variation into a variation of the duration of the telegraph signal elements at the output of the receiver ;

— the foregoing considerations may make it impracticable to measure sensitivity in terms of the input required to produce a specified signal/noise ratio at the receiver output in the conventional way ;

*(d)* That, in the case of television receivers (vision channel) :

— the sensitivity may be determined by either :

the electrical output vision signal level and signal/noise ratio, or the visual quality of the reproduced picture as determined by the contrast ratio, brightness level, linearity (gamma) and imperfection of synchronization ** ;

— in order to determine the reference sensitivity, it is desirable to adopt certain reference values for :

the electrical output vision signal level, signal/noise ratio and bandwidth,

or the corresponding visual parameters, noting however, that certain difficulties exist at present in the optical determination of signal/noise ratio in the reproduced picture ;

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* This Question replaces Question No. 47.

** Some information on the methods of test and the results of measurements are given in Ann. V to Recommendation No. 94.

— in order to estimate the maximum usable sensitivity reckoned from the reference sensitivity, a known, and preferably simple relation between the input signal level and the electrical or visual output of the receiver is desirable ;

— in some cases the maximum usable sensitivity may be limited by imperfect synchronization, and in such cases a simple relation between the input signal level and the effectiveness of synchronization may not exist ;

— different television systems exist in various countries ;

UNANIMOUSLY DECIDES that the following question should be studied :

**1.** What are the representative values for reference sensitivity and noise figure for the various types of apparatus used for the reception of different classes of emission in the different services ? (See Recommendation No. 94). (Figures should especially be obtained for frequencies greater than 30 Mc/s).

2. What are appropriate methods of defining the sensitivity of receivers, including the influence of receiver noise, for types of receivers which cannot be adequately defined by the methods given in Recommendation No. 94 (e.g. telegraphy, television or pulse-code modulation receivers) ? (Appropriate figures defining the sensitivity of such receivers and the corresponding measuring methods should be given).

3. Should the sensitivity of a telegraphy receiver be defined in terms of the input, modulated in a specified manner, such that the distortion of the telegraphy signals at the output of the receiver shall not exceed a given percentage with a specified probability of its occurrence ? *

**4.**1 Should the sensitivity of television receivers be defined and measured in terms of :

*(a)* the electrical output,

*(b)* the visual quality of the reproduced picture, i.e. by optical methods ;

*(c)* or a combination of *(a)* and *(b)* ?

4.2 What modulation of the test signal and what reference values for the output signal level, signal/noise ratio and bandwidth should be used in electrical measurements, in order to derive the reference sensitivity, and what are the corresponding parameters in the case of visual measurements ?

4.3 What methods can be used to determine the maximum usable sensitivity reckoned from the reference sensitivity, in the case of non-linear receivers, and those in which the sensitivity is limited by imperfect synchronization ?

4.4 To what extent is it desirable and practicable to unify the methods used for defining and measuring the sensitivity of vision receivers used in the various television systems ?

*Note.* — The study detailed in § 3 should be made in collaboration with the C.C.I.T. For the study detailed in § 4, the studies carried out in this field by the International Electrotechnical Commission should be taken into account.

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## QUESTION No. 77 (II)

## FREQUENCY STABILITY OF RECEIVERS

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

CONSIDERING :

*(a)* That, in accordance with Study Programme No. 5, information has been collected on the frequency stability of some receivers and the means to improve it, and that this information has been summarised in Recommendation No. 96 ;

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* See Report No. 1 and Question No. 18 (I).
Some information on a method of measurement and the results obtained in the case of a frequency-shift telegraph receiver is given in Doc. No. 119, London.

*(b)* That, nevertheless, the study of frequency stability should be continued, in order to collect more data on a greater number of receivers and on a greater number of types of receiver, including those not, or insufficiently, considered in Recommendation No. 96.

*(c)* That, in certain receivers, e.g., those in which the frequency-change oscillators are crystal controlled or which incorporate automatic frequency control, the stability of the filters may be a deciding factor in determining the overall stability ;

UNANIMOUSLY DECIDES that the following questions should be studied :

1. What is the extent of the improvement obtained with respect to the frequency stability of receivers, by the application of Recommendation No. 96 ?

2. Can the methods and results given in Recommendation No. 96 be extended to other classes of receivers, e.g., television, frequency-modulation, and if so, what are representative values for the frequency stability of these receivers ?

3. What methods are most effective in improving the frequency stability of the filters and what are representative values for the frequency stability achieved ?

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## QUESTION No. 78 (II)

## CHOICE OF INTERMEDIATE FREQUENCY AND PROTECTION AGAINST UNDESIRED RESPONSES OF SUPER-HETERODYNE RECEIVERS

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

CONSIDERING :

*(a)* That super-heterodyne receivers may respond to signals of frequency other than that to which the receiver is tuned ;

*(b)* That the frequencies of undesired responses may coincide with the frequencies of other services, generally operating in nearby localities, thus producing interference ;

*(c)* That super-heterodyne receivers may also have undesired responses due, for example, to harmonics of the signal to which the receiver is tuned and which are caused by non-linearity in the early stages of the receiver ;

*(d)* That the value chosen for the intermediate frequency influences both the frequencies and the amplitudes of the undesired responses ;

*(e)* That technical and economic reasons limit the radio-frequency selectivity and linearity that it is possible to provide in broadcast receivers for sound and television services, and that interference arising from these limitations is already appreciable * ;

*(f)* That other services, e.g. maritime mobile, may be subject to interference when operating in the vicinity of powerful transmitters ** ;

*(g)* That it may not be practicable, because of the need to use all available frequency allocations, to prevent interference due to undesired responses in receivers by the prohibition of transmissions on the intermediate or other frequencies ;

*(h)* That the susceptibility of receivers to undesired responses may need to be taken into account when preparing frequency assignment plans for the various services ;

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* The European Broadcasting Union has drawn attention to these problems ; see Doc. Nos. 323 and 324 (London).

** The Comité International Radio-Maritime has drawn attention to this problem, see Doc. No. 102, § 6 (London).

UNANIMOUSLY DECIDES that the following questions should be studied :

1. What are the factors that determine the frequencies and amplitudes of the undesired responses of receivers and what are typical values for receivers of the various classes, e.g. sound broadcasting, television, maritime mobile ?

2. What methods, not requiring an undue increase in cost, e.g. the choice of the intermediate frequency or other means, may be employed to achieve a useful improvement in the performance of receivers with regard to undesired responses, and what is the extent of this improvement ?

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## QUESTION No. 79 (II)

## THE RESPONSES OF RADIO RECEIVERS TO QUASI-IMPULSIVE INTERFERENCE

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

CONSIDERING :

*(a)* That many types of interference, e.g., from atmospheric phenomena, ignition systems, motors and other electrical equipment, cannot be considered either as random noise or simple isolated impulses, but may be regarded as " quasi-impulsive " ;

*(b)* That in many practical cases this form of interference sets a limit to the usable sensitivity of receivers ;

*(c)* That the response of receivers to quasi-impulsive interference is conditioned by the type of modulation, e.g., amplitude, frequency or pulse modulation, used for the transmission of the desired signal ;

*(d)* That the significance of the response of a receiver to such interference depends on the type of signal being transmitted (e.g., radiotelephony, radiotelegraphy, television) ;

*(e)* That the peak amplitude of the interference may greatly exceed the desired signal amplitude, thereby producing non-linear effects in receivers ;

*(f)* That adequate means for simulating quasi-impulsive interference are desirable in order that the response of receivers of the various classes to such interference may be measured and compared, particularly under the non-linear conditions noted above ;

*(g)* That means for expressing mathematically the essential characteristics of quasi-impulsive interference may be desirable, e.g., for facilitating theoretical as well as practical studies of the response of receivers to such interference ;

*(h)* That representative values for the response of receivers of the various classes to quasi-impulsive interference, including the effectiveness of any means for reducing such interference to a minimum (e.g., amplitude-limiters, balancing and differentiating techniques), are necessary for system-planning purposes ;

UNANIMOUSLY DECIDES that the following questions should be studied :

1. What parameters of quasi-impulsive interference are of the greatest importance in determining the response of receivers of the various types to such interference ?

2. What are the methods of measuring and the most useful definitions of the response of receivers of the various types to quasi-impulsive interference, taking into account any non-linear effects that may occur in practice ?

3. How best can the usable sensitivity of receivers be defined when the limiting factor is the response to quasi-impulsive interference ?

4. To what extent can quasi-impulsive interference be adequately simulated, e.g., by an impulse generator or by a recording and reproducing system, and what are the essential characteristics of such a generator ?

5. What are the representative values for the response of receivers of the various types to quasi-impulsive interference, including the effectiveness of the various means for reducing such interference to a minimum ?

*Note.* — This Question should be studied in close collaboration with C.I.S.P.R. * in order to avoid duplication of the work already being carried out by the C.I.S.P.R. on sound and television broadcast receivers. It should also take note of the studies being carried out by the U.R.S.I. in connection with atmospheric interferences.

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## QUESTION No. 80 (II)

## UNDESIRED EMISSIONS FROM RECEIVERS

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

CONSIDERING :

*(a)* That many receivers produce undesired emissions due, for example :
- to the stray fields of the frequency-changing oscillators and intermediate-frequency amplifiers,
- in the case of television receivers, to the line-scanning oscillators and radio-frequency oscillators sometimes used in receiver power supplies and for other purposes ;

*(b)* That such undesired emissions may occur over a wide range of frequencies and produce interference in many different services ;

*(c)* That cases of such interference are already numerous, e.g. :
- interference to aircraft and marine VHF (metric) communication services, caused by the frequency-change oscillators of television receivers ;
- interference to LF (kilometric) and MF (hectometric) sound broadcasting and communication services, caused by the harmonics of line-scanning oscillators of television receivers ;

*(d)* That undesired emissions may take place from not only the receiver itself, but also from the aerial or external conductors associated with the receiver ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What are the most suitable methods of measuring and expressing the amplitudes of undesired emissions from receivers ?

2. What are representative values for the amplitudes of undesired emissions from receivers of the various classes, and how do these amplitudes vary with distance ?

3. What methods, not requiring an undue increase in the cost of receivers, may be used to achieve a useful reduction in the amplitudes of undesired emissions and what is the extent of this improvement ?

*Note.* — This question should be studied in close collaboration with C.I.S.P.R. * in order to avoid duplication of the work already carried out by the C.I.S.P.R. on sound and television broadcasting receivers. It should also take note of the studies being carried out by the U.R.S.I. in connection with atmospheric interferences.

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* See Recommendation No. 131.

## STUDY PROGRAMME No. 42 (II) *

## SELECTIVITY OF RECEIVERS

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

CONSIDERING :

*(a)* That selectivity measurements so far produced have been limited primarily to receivers suitable for A1, A2 and A3 classes of emission, little information being available for other types of receivers (e.g. F1, F2, F3, pulse modulation, television, etc.) ;

*(b)* That such measurements as are available have been chiefly made by the single signal method, little information being available on measurements made by the two signal method ;

*(c)* That, in determining the selectivity of the receiver, that is to say its ability to separate the desired signal from undesired signals, there are cases where the determination of the usual selectivity curve (amplitude/frequency characteristic) is insufficient ;

*(d)* That, if the amplitude/frequency characteristic is such that the attenuation slope in the vicinity of the edqes of the pass-band is very high, then the phase/frequency and group-delay/frequency characteristics within the pass-band may consequently be non-linear and non-uniform respectively ;

*(e)* That cases, already numerous, where this is particularly true are those where the signal shape is of great importance (e.g. telegraphy, facsimile, television) ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The production of information on the single signal selectivity of types of receivers designed to receive classes of emission other than A1, A2, A3 ;
2. The production of complementary information on two-signal selectivity measurements on the various types of receivers, including those designed to receive classes of emission A1, A2, A3 and other types ;
3. The development of methods of measuring the phase/frequency or group-delay/frequency characteristics ;
4. The measurement and presentation, in cases such as are indicated in *(e)*, of the phase/frequency or group-delay/frequency characteristics, in addition to the amplitude/frequency characteristics.

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## STUDY PROGRAMME No. 43 (II) **

## PROTECTION AGAINST KEYED INTERFERING SIGNALS

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

CONSIDERING :

*(a)* That the reduction of interference between adjacent channels is a very important problem, the solution of which should be sought with great care by all possible means ;

*(b)* That for keyed telegraph transmissions a partial solution has already been reached by considering separately :

— the transmitter, by reducing the extent and amplitude of the spectrum (Recommendation No. 36 ***),

* This Study Programme replaces Study Programme No. 6. It does not refer to any Question under study.

** This Study Programme replaces Study Programme No. 7. It does not refer to any Question under study.

*** This Recommendation has been replaced by Recommendation No. 87.

— the receiver, by increasing the selectivity in regular operation (reduction of bandwidth and increase of slope on each side of the pass-band) (Recommendation No. 42 *);

That these measures are quite effective when applied simultaneously and have already led to important improvements, but do not fully solve the problem ;

*(c)* That, in practice, telegraphic emissions involve, outside the band necessarily occupied, components of levels in excess of that indicated in Recommendation No. 36 ** ; while even with the rounding of the keyed signals at present in use, the spectrum often still encroaches on the necessary band of an adjacent channel, thus preventing full advantage being realized from the high selectivity possible in receivers ;

*(d)* That, on the other hand, the envelope of the components of the emitted spectrum and the selectivity curve of the receiver obtained in normal or non-keyed operation are not the only factors involved ;

*(e)* That, for instance, Recommendation No. 36 ** indicates the limit-contour within which the amplitudes of the different components should be restricted ; but that the amplitude and phase of each individual component can vary in accordance with the manner in which the restriction is achieved ; the resulting distortion of the shape of the signal being able thus to vary also ;

*(f)* That the selectivity curve of receivers is not perfectly rectangular but there is some irregularity in the pass-band response and a limited slope on the sides of the pass-band so that each component of the signal suffers some change in amplitude ; furthermore, they suffer a phase change, usually of an indeterminate amount, but increasing with increasing slope of the sides of the pass-band. In recombining these components the resultant output signa differs in shape from the input signal ; this may result in amplitude distortion effects. Further distortion may be caused by non-linearity in other parts of the receiver;

*(g)* That it is difficult to calculate the distortions mentioned in *(e)* and *(f)* or the total distortion which results over the complete transmission system ; in particular, if the total distortion is fixed, that is, if the quality of the transmission is fixed at a predetermined level, it may be that the division of distortion between receiver and transmitter could modify the interference produced in adjacent channels ; in this case the division should be chosen so as to produce minimum interference. The theoretical optimum division might of course have to be modified in the light of technical difficulties or economic factors (relative costs of filter circuits at transmitter and receiver, etc.) and of propagation effects ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. Interference produced in receivers by keyed transmissions having such degrees of rounding as, for instance, are implied in Recommendation No. 36 **, including the investigation of the resulting transient effects in the receiver, which are influenced not only by the usual selectivity curve (amplitude/frequency characteristic), but also by the phase/frequency characteristic ;

2. Investigation of the receiver characteristics which will add the least possible distortion to that produced by the rounding of the dot at the transmitter, bearing in mind that the pass-band should be kept as small as possible ;

3. Investigation of the total permissible rounding of dots from the transmitter input to the output of the receiving apparatus on a system basis, in order to reduce interference to a minimum while retaining a maximum of intelligibility, with special attention to the best compromise on the fraction of the rounding to be assigned to the effects of the transmitter, of propagation and of the receiver respectively ;

4. Investigation of the relative degrees of protection provided by the various classes of emission (e.g. A1, A2, F1) ;

5. Methods of measurement most suitable for these investigations.

*Note.* — These studies may be extended in the future in connection with protection against other interfering signals of substantially square wave form signals, e.g. pulse-modulated signals.

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* This Recommendation has been replaced by Recommendation No. 95.
** This Recommendation has been replaced by Recommendation No. 87.

# Questions and Study Programmes assigned to Study Group No. III

## QUESTION No. 3 (III) *

## REVISION OF ATLANTIC CITY RECOMMENDATION No. 4

The C.C.I.R., (Stockholm, 1948)

CONSIDERING :

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

UNANIMOUSLY DECIDES :

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

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

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

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

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

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

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

AND UNANIMOUSLY DECIDES :

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

* Study Programmes Nos. 45 (III) and 46 (III) refer to this Question.

** Questions Nos. 1 (I), 2 (no longer under study) and 3 (III) arise from these Questions.

## STUDY PROGRAMME No. 44 (III) *

## EFFECT OF INTERFERENCE AND NOISE ON QUALITY OF SERVICE IN THE PRESENCE OF FADING

(Question No. 3 (III))

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

CONSIDERING :

*(a)* That a full and precise answer cannot yet be given to Question No. 3 ;

*(b)* That the effect of interference and noise on the quality of service is one of the factors to be determined ;

*(c)* That the percentage of time for which the signal-to-interference or signal-to-noise ratios can be less than the required value for stable conditions, is a factor to be determined for each type of service ;

*(d)* That there is an urgent need to determine the minimum permissible values for signal-to-noise and signal-to-interference protection ratios which are required for the various types of service indicated in Study Programme No. 45 (III) ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

Experimental determination of the values of minimum permissible ratios of hourly median values of field strengths of the wanted signal to the field strength of :

— unwanted signal subject to fading, and without any appreciable noise ;
— steady noise ;
— steady interference.

*Note.* — These studies should be carried out in conjunction with the tests specified in Recommendation No. 104, Question No. 82 (III), Study Programme No. 49 (III) and administrations should submit the results to the Director of the C.C.I.R. for publication as early as possible.

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## STUDY PROGRAMME No. 45 (III) **

## BANDWIDTHS AND SIGNAL-TO-NOISE RATIOS IN COMPLETE SYSTEMS

(Question No. 3 (III))

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

UNANIMOUSLY DECIDES that the following studies should be carried out, possibly with the help of the C.C.I.F. :

### 1. Minimum conditions required for satisfactory services.

1.1 TELEPHONY

1.1.1 What are the minimum values of :

— bandwidth ?
— signal-to-noise ratio (assumed to be stable) necessary at the output of the receiver for excellent service ?

* This Study Programme arises from Question No. 3 (III).

** This Study Programme replaces Study Programme No. 8. It arises from Question No. 3 (III).

1.1.2 What is the value of the same elements at the output of the receiver for just usable service ?

1.1.3 For what maximum duration and percentage of time can the signal-to-noise ratio at the output of the receiver be inferior to the value indicated by the reply to the question of point 1.1.2 above, assuming unstable conditions ?

1.1.4 To what extent can the radiation outside the necessary bandwidth be reduced for transmitters now in use ? Can a stricter limitation be imposed on transmitters installed in the future ?

1.1.5 Bearing in mind the replies to the preceding four questions, and the need for each transmission to occupy as narrow a spectrum as possible, what regulations should be proposed to the Administrative Radio Conference concerning :

— the limits to be imposed on the radiated spectrum of existing transmitters ;
— the limits to be imposed on the radiated spectrum of future transmitters ;
— the minimum selectivity characteristics to be provided for receivers ?

1.1.6 In the absence of interference, what minimum field (assumed to be stable) is necessary to obtain excellent reception ?

1.1.7 To what extent and for what percentage of time can the field be less than the value referred to in point 1.1.6, the circuit still being regarded as just usable ?

1.1.8 What allowance must be made for fading ?

1.1.9 To what extent can reception be improved by the use of :

— directional antennae ?
— diversity reception ?
— noise reducers ?

1.1.10 Bearing in mind the replies to points 1.1.6, 1.1.7, 1.1.8 and 1.1.9 what is the median field required for just satisfactory reception ?

*Note.* — All the studies advocated above should be made for all classes of emission and in particular for the classes mentioned below operating in the range of 10 kc/s to 30 000 kc/s.

*Telephony, double sideband, full carrier (A3) :*

Low grade
Commercial
High fidelity

*Telephony, single sideband, reduced carrier :*

A3a : single channel (commercial)
A3b : more than one channel (commercial)

*Broadcasting*

1.2 TELEGRAPHY

1.2.1 In the absence of noise and multipath effects, but with an input signal varying in amplitude between specified limits, what is the minimum bandwidth necessary at the output of the receiver in order that the distortion will not exceed a specified amount ?

1.2.2 For the bandwidths determined in point 1.2.1 above, what are the minimum signal-to-noise ratios (assumed to be stable) necessary at the output of the receiver for error free reception ?

1.2.3 For what minimum duration and percentage of time can the signal-to-noise ratios be inferior to those specified in point 1.2.2 for the circuits still to be just usable ?

1.2.4 To what extent can the radiation outside the necessary bandwidth be reduced for transmitters now in use ? Can a stricter limitation be imposed on transmitters installed in the future ?

1.2.5 Bearing in mind the replies to the preceding four questions, and the need for each transmission to occupy as narrow a spectrum as possible, what regulations should be proposed to the Administrative Radio Conference concerning :

- the limits to be imposed on the radiated spectrum of existing transmitters,
- the limits to be imposed on the radiated spectrum of future transmitters,
- the minimum selectivity characteristics to be provided for receivers.

1.2.6 In the absence of interference, what minimum field (assumed to be stable) is necessary to obtain error free reception ?

1.2.7 To what extent and for what percentage of time can the field be less than the value referred to in 1.2.6, the circuit still being regarded as just usable ?

1.2.8 What allowance must be made for :

- fading ?
- multipath effects ?

1.2.9 To what extent can reception be improved by the use of :

- directional antennas ?
- diversity reception ?

1.2.10 Bearing in mind the replies to points 1.2.6, 1.2.7, 1.2.8 and 1.2.9 what is the median field required for just satisfactory reception ?

*Note.* — All the studies advocated above should be made for all classes of emission and in particular for the classes mentioned below operating in the range of 10 kc/s to 30 000 kc/s.

*Telegraphy A1*

| | | |
|---|---|---|
| Hand speed | 8 | bauds |
| ,, ,, | 24 | ,, |
| Machine speed | 50 | ,, |
| ,, ,, | 120 | ,, |

*Telegraphy A2*

| | | |
|---|---|---|
| Hand speed | 8 | bauds |
| ,, ,, | 24 | ,, |
| Machine speed | 50 | ,, |
| ,, ,, | 120 | ,, |

*Telegraphy F1*

| | | |
|---|---|---|
| Speed | 50 | bauds |
| ,, | 120 | ,, |

*Facsimile A4*

*Hellschreiber*

*Multitone Telegraphy*

**2. Separation between frequencies of adjacent channels (telegraphy and telephony).**

2.1 What are the different factors to be taken into account in determining the minimum separation between frequencies of stations operating in adjacent channels ?

2.2* How is the effect of interference at the receiver output to be expressed ?

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* See Note 2, p. 306.

2.2.1 Some of the factors which should be taken into account are :

- the possibility that the effect of peaks of interference may involve the use of a factor based on experience as a correction to the signal-to-interference power ratio ;
- the fact that some types of interference occur as discrete elements in narrow bands of frequency within the radio spectrum ;
- the fact that specific parts of the audio frequency spectrum are more susceptible to interference ;
- that it may be necessary to make a distinction between " intelligible interference " and " unintelligible interference ".

Nevertheless, in the case of telephony, the effect of interference may be expressed, as a first approximation, as the ratio of signal to interference powers as in the case of noise.

2.2.2 In the case of machine telegraphy the effect of interference can be expressed as either :

- the percentage of faulty telegraph characters, or
- the percentage of signal elements which suffer distortion in excess of a given value.

The effect of interference can be measured in terms of the ratio (in db) by which the wanted signal in the presence of interference should be increased to obtain the same quality of service.

2.2.3 In the case of telephony the effect of interference can be expressed as either :

- the percentage loss of intelligibility of related words, or
- the percentage loss of intelligibility of unrelated words.

The effect of interference can be measured in terms of the ratio (in db) by which the wanted signal in the presence of interference should be increased to obtain the same quality of service.

2.2.4 All the foregoing methods of expression can be used for assessing the effects of noise, fading and adjacent channel interference.

2.3 When the wanted signal and the interference are both stable, what is the minimum signal-to-interference ratio for excellent reception ?

2.4 To what extent, for given values of the percentage of time of occurrence, can the signal-to-interference ratio be lower than that mentioned in 2.3 for the circuit still to be usable ?

2.5 How is the signal-to-interference ratio at the receiver output affected by the selectivity of the receiver and the separation between the frequency of the interfering signal and the frequency to which the receiver is tuned ?

2.6 How should the instability of transmitter and receivers be expressed and allowed for in determining the channel separation ?

2.7 To what extent would the use of directional antennae at the transmitter and the receiver improve the signal-to-interference ratio ?

2.8 Bearing in mind the replies to the questions in the preceding seven paragraphs and those in points 1.1.1 to 1.2.10, what is the minimum separation required between the frequencies of stations operating in adjacent channels ?

*Notes:*

1. All the studies advocated above should be made for all the types of service mentioned in the comments following points 1.1.10 and 1.2.10.

2. The factors enumerated above are equally relevant to the study of co-channel and adjacent-channel interference.

## QUESTION No. 43 (III) *

# VOICE FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(Study Group No. III)

(Geneva, 1951)

The VIth Plenary Assembly of the C.C.I.T., Brussels (May, 1948), submitted the following question for study by the C.C.I.R. :

What are the conditions which should be imposed on V.F. telegraph plant employing double current technique used on modulated radio transmission channels ?

*Note.* — To be studied in collaboration with the International Telegraph Consultative Committee (C.C.I.T. Study Group No. II : Establishment, operation and maintenance of telegraph channels).

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## STUDY PROGRAMME No. 46 (III) **

# VOICE FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(Question No. 43 (III))

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

CONSIDERING :

*(a)* That different methods are now in use for voice frequency telegraphy on radio circuits subject to fading :

— either using equipment normally designed for land line working and suitably adapted for radio ;
— or using equipment especially designed for radio working ;
(See Docs. Nos. 29, 195 of Geneva, and 5, 205, 273 of London) ;

*(b)* That studies carried out so far show that it is impossible to compare transmission systems in which marking and spacing are obtained by the two tone method and by the method of frequency-shift keying of a single oscillator without taking into account all the factors of the equipment (see more particularly Doc. No. 273 London) ;

*(c)* That the study of Question No. 43 (III) is to be continued in conjunction with the C.C.I.T. to obtain, if possible, unification of at least some of the component elements of voice-frequency equipment used on wire and radio ;

UNANIMOUSLY DECIDES that the following study should be carried out :

Comparison of the different systems used to transmit voice-frequency telegraphy on radio circuits subject to the effects of fading, particularly of the two methods :

— frequency-shift keying of one oscillator ;
— transmitting mark and space by the two-tone method ;

taking into account all the factors of the equipment.

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* Study Programme No. 46 (III) arises from this Question.

** This Study Programme replaces Study Programme No. 9. It arises from Question No. 43 (III).

*Note.* — In carrying out these studies it will be necessary to take into account the fact that the fading encountered on radio circuits affects markedly the build-up of the signal elements in the receiving filters. This determines the necessary bandwidth and it should be borne in mind that the available bandwidth is restricted by the use of equipment standardized for wire circuits.

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## QUESTION No. 44 (III) *

## COMMUNICATION THEORY

(Geneva, 1951)

At its Vth Session (Geneva, September 1950) the Administrative Council of the I.T.U. submitted the following question for study by the C.C.I.R. :

What technical methods may be adopted to transmit a given volume of information over a given telecommunication circuit :

*(a)* in a given time, using a minimum bandwidth ;

*(b)* with a given bandwidth, in a minimum time ?

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## STUDY PROGRAMME No. 47 (III) **

## COMMUNICATION THEORY

(Question No. 44 (III))

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

CONSIDERING :

*(a)* That in view of the increasing congestion of the radio spectrum and telecommunication circuits, it would be advantageous to discover technical methods of decreasing the bandwidth, the transmission time of a given quantity of information, or the transmitted power ;

*(b)* That present studies seek mainly to perfect established systems whereas recent theories seem to show that these systems occupy several times the bandwidth strictly necessary for the transmission ot the required information at the required speed ;

*(c)* That even with existing systems, it is not possible to reduce the bandwidth to that strictly necessary because of unpredictable noise, natural and man-made interference, and complex propagation conditions ; a margin of bandwidth is necessary to decrease distortion and the frequency of errors due to these phenomena ;

*(d)* That it is not certain that existing codes, at least some of which were not designed in the light of phenomena peculiar to radio propagation, are making the best use of the occupied bandwidth ;

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* Study Programme No. 47 (III) arises from this Question.

** This Study Programme replaces Study Programme No. 10. It arises from Question No. 44 (III).

*(e)* That a systematic study of methods such as referred to in § *(a)* can be made by generalizing the procedures in use for certain transmission systems or by applying the results of the general theory of communication to specific practical cases ;

*(f)* That the Secretariat of C.C.I.R. has assembled and published an indexed bibliography on publications regarding the theory and general practice of communications, as well as documentation on the characteristics of the various systems of modulation and transmission in practical use ;

*(g)* That Recommendation No. 7 of the Xth General Assembly of U.R.S.I. (Sydney, 1952) contains the following definition of the unit of quantity of information :

" The unit of quantity of information corresponds to a ' message unit ' consisting of a random choice between two equally probable signals " *.

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The dissemination by the Secretariat of the C.C.I.R. of periodic supplements to the bibliography and documentation already published and referred to in *(f)* above.

2. The study, in conjunction with U.R.S.I., of the suitability in practice of the unit of quantity of information as defined in consideration *(g)* above, and the study of methods of measuring this quantity.

3. The review of the various codes in use and the study of new codes leading to economy of bandwidth or transmission time for a given quantity of information, taking into account the phenomena peculiar to radio propagation, and, among other things, the comparison of the various existing systems of modulation, from the point of view of the bandwidth occupied versus the amount of information transmitted in a given time, for a given power **.

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## QUESTION No. 81 (III) ***

## DIRECTIVITY OF ANTENNAE AT GREAT DISTANCES

(Stockholm, 1948 — Geneva, 1951 — London, 1953)

The C.C.I.R.,

DECIDES to study the following question :

Experimental study, by administrations and various organizations, of the directivity of antennae realized at great distances (taking full advantage of existing transmissions) by any suitable method, for example, by use of mechanically or electrically steered antennae.

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* This unit may be designated by the word " Bit ".

** Relative to this study, it is useful to consider, in the case of radiotelephony, the determination of the relation between intelligibility and the shape and width of the pass-band of the receiver for signal-to-noise ratios, consistent with :

— just usable quality, operator to operator,
— marginally commercial quality,
— good commercial quality,

taking into account that :

1. In many cases the noise power is distributed uniformly over the audio frequency spectrum, while speech power is distributed unevenly in this spectrum.
2. When high noise levels are present in a communication system, and the signal-to-noise ratio is constant, the intelligibility might show a maximum as a function of the bandwidth and the distribution of the power corresponding to the frequencies it contains. This distribution of the power may vary with fading.

*** This Question replaces Question No. 48. Study Programme No. 48 (III) arises from this Question.

## STUDY PROGRAMME No. 48 (III) *

# IMPROVEMENT OBTAINABLE FROM THE USE OF DIRECTIONAL ANTENNAE

(Recommendation No. 46 ** — Question No. 48 *** — Study Programme No. 8 ****)

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

CONSIDERING :

*(a)* That the study indicated in Study Programme No. 8 **** requires the knowledge of values for the improvement of the signal-to-noise ratio as well as the signal-to-interference ratio that can be obtained by the use of directional antennae on long distance circuits ;

*(b)* That Recommendation No. 46 ** recommends that studies be made of the directivity of antennae at great distances, making use of, for example, the method proposed by Doc. No. 23 of Geneva ;

*(c)* That a study of the gain and discrimination of various types of antenna is necessary before it is possible to determine the minimum gain and discrimination that should be specified ;

*(d)* That to obtain the best results, it would be desirable to indicate to administrations the values of parameters (frequencies, differences of azimuth and path length) for which data would be the most useful ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

**1.** Determination of the :

- average signal power gain provided by practical directive antennae relative to a half-wave horizontal dipole at the same height ;
- average signal-to-noise gain relative to a half-wave horizontal dipole at the same height.

The tests should be made using emissions from a distant transmitter, with transmitting and receiving antennae which have optimum practicable vertical directivity.

**2.** Determination of the signal-to-interference protection afforded in practice by directional antennae, at azimuths relative to the main lobe, of about 10°, 15°, 20°, 30°, 45°, 60°, 90°, 135° and 180°.

*Note.* — It is desirable that the tests referred to above be made using the following nominal parameters :

- frequencies in the neighbourhood of 5, 7, 9, 12, 15, 19 and 23 Mc/s, with particular attention to the protection afforded at the optimum frequency and at the limits of the frequency range of the antennae ;
- path lengths of approximately 2000 or 4000, or $\geqslant$ 6000 or $\geqslant$ 18 000 km.

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* This Study Programme arises from Question No. 81 (III).

** This Recommendation has become Recommendation No. 102.

*** This Question has become Question No. 81 (III).

**** This Study Programme has become Study Programme No. 45 (III).

## QUESTION No. 82 (III) *

## INTERFERENCE EFFECTS OF ATMOSPHERIC NOISE ON RADIO RECEPTION

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

CONSIDERING :

*(a)* That the results of measurements of atmospheric radio noise show the intensity of noise in a given experimental equipment and that it is necessary to transform these results in order to ascertain to what extent the noise affects various services and various types of receiving equipment used ;

*(b)* That the r.m.s. value of atmospheric noise intensity, averaged over a period of several minutes, is not entirely adequate for the determination of the effect on radio reception ;

UNANIMOUSLY DECIDES that the following question should be studied :

Determination of the interfering effects of atmospheric noise on reception, as a function of the wave form and the amplitude distribution of instantaneous values of atmospheric noise over a period of several minutes.

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## STUDY PROGRAMME No. 49 (III) **

## INTERFERENCE EFFECTS OF ATMOSPHERIC NOISE ON RADIO RECEPTION

Question No. 82 (III))

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

CONSIDERING :

*(a)* That the C.C.I.R. curves giving seasonal median values of r.m.s. field intensity in a 1 kc/s bandwidth of atmospheric noise averaged over a period of a few minutes are expected to be prepared during the interval between the VIIth and VIIIth Plenary Assemblies ;

*(b)* That the wave-form and amplitude distribution of instantaneous values of atmospheric noise over a period of a few minutes must also be considered in determining the effects of noise on various classes of service ;

*(c)* That, while awaiting the results of studies being carried out by scientific research organizations, it will be useful to have experimental data on the points referred to in § *(b)* above ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

Experimental studies on the influence of atmospheric radio noise on the general operation of radio communication and in particular receiving equipment, bearing in mind the intended revision of existing documents relating to this problem.

These studies should be particularly concerned with the following service applications :

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* Study Programme No. 49 (III) arises from this Question.

** This Study Programme arises from Question No. 82 (III).

A. Aural services :

— A1 Telegraphy (24 bauds) ;
— A2 Telegraphy modulated at 1000 c/s (24 bauds) ;
— A3 Double sideband full carrier commercial telephony ;
— A3 High fidelity double sideband full carrier commercial telephony ;
— A3 Commercial telephony with reduced carrier, and having independent sidebands (from 1 to 4 telephone channels) ;
— A3 Broadcasting.

B. Telegraph services with automatic recording (undulator or machine telegraphy) with or without automatic repetition :

— A1 Telegraphy (120 to 180 bauds) ;
— A2 Telegraphy, modulated at 1000 c/s (120 bauds) ;
— F1 Frequency-shift telegraphy (120 to 480 bauds) ;

C. Other services :

— Facsimile ;
— Hellschreiber ;
— Voice-frequency telegraphy.

These studies should also be concerned with the following characteristics of receiving equipment and the results should be submitted in the form of tables or nomograms making it possible for each particular case to be considered, viz :

— Antenna ;
— Bandwidth of RF, IF and AF stages ;
— Time constant of automatic gain control ;
— Method of detection.

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## QUESTION No. 83 (III) *

## THE USE OF RADIO CIRCUITS IN ASSOCIATION WITH 5-UNIT START-STOP TELEGRAPH APPARATUS

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

CONSIDERING :

*(a)* That Art. 34, § 3 of the Telegraph Regulations (Paris Revision, 1949) recommends, except in special circumstances, the use of a 5-unit code in accordance with International Telegraph Alphabet No. 2, this being in the interest of speed and efficiency in the movement of telegraph traffic and furthering the development of a world-wide telecommunication network ;

*(b)* That it is therefore essential to be able to interconnect terminal start-stop apparatus employing International Telegraph Alphabet No. 2 by means of radio telegraph circuits ;

*(c)* That radio telegraph circuits are required to operate under varying conditions of radio propagation, atmospheric noise and interference that introduce varying degrees of distortion which may at times exceed the margin of the receiving apparatus ;

*(d)* That, in consequence, the transmission of 5-unit code signals over radio circuits is liable to errors and that such errors are not automatically detectable by the receiving apparatus ;

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* This Question replaces Question No. 19. Study Programme No. 50 (III) arises from this Question.

*(e)* That various means are available by which the number of errors resulting from transmission difficulties over the radio circuit may be reduced, such as by the use of synchronous 5 unit systems, error detecting and/or correcting codes, and special signalling arrangements ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. The effects of varying conditions of propagation (including multi-path propagation), atmospheric noise and interference on radiotelegraph circuits used to interconnect terminal apparatus employing the International Telegraph Alphabet No. 2 ;

2. The signal distortion and error rate that may be expected having regard to signal/noise ratio, propagation effects, type of transmission etc. ;

3. The use on the radio circuits of special types of transmission and the possible adoption of codes other than the 5-unit code ;

4. If other codes or special types of transmission are recommended, the equipment that should be used at the terminals of radio circuits to permit their interconnection with wire circuits using the International Telegraph Alphabet No. 2.

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## STUDY PROGRAMME No. 50 (III) *

## THE USE OF RADIO CIRCUITS IN ASSOCIATION WITH 5-UNIT START-STOP TELEGRAPH APPARATUS

(Question No. 83 (III)

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

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The comparison of the effects of varying radio propagation conditions, atmospheric noise and other interference, upon circuits employing :

   — 5-unit start-stop systems,
   — 5-unit synchronous systems,
   — synchronous error-detecting or error-correcting systems using two-condition signalling codes other than International Alphabet No. 2,
   — other systems using more than two signalling conditions ;

2. An assessment of the relative merits of systems that sample at critical instants the envelope of the impulses forming the character and of systems that integrate this envelope ;

3. The comparison of systems should be made in terms of the ratio of the undetected, or uncorrected, error rates achieved by the systems to the error rate of a 5-unit synchronous system using the same power and signalling speed, in words per minute, and operating under the same conditions. A 5-unit start-stop system may also be used as the reference system by regarding each mutilated signal as one error only. It is provisionally suggested that the ratio of the error rates should be expressed for two circuit conditions only, namely, when the improved system is subject to an average of one undetected, or uncorrected, error per 10 000 characters, and when it is subject to one such error per 1000 characters.

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* This Study Programme replaces Study Programme No. 27. It arises from Question No. 83 (III).

## QUESTION No. 84 (III) *

## DETERMINATION OF THE MAXIMUM INTERFERENCE LEVELS TOLERABLE IN COMPLETE SYSTEMS

(Question No. 3 (III))

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

CONSIDERING :

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

*(b)* That the harmonious co-existence of radio services with industrial installations producing radio oscillations involves close collaboration between organizations representing the manufacturers and users of these installations on the one hand, and the radio services on the other, for which the existing collaboration between the C.C.I.R. and the Special International Committee on Radio Interference (C.I.S.P.R.) provides ;

*(c)* That the C.I.S.P.R. has already extensively studied and continues to study the permissible signal/interference ratios for sound and television broadcasting, but has not yet made equivalent studies for other radio services ;

UNANIMOUSLY DECIDES that the following question should be studied :

Determination of the maximum level of interference caused by radiations from industrial, scientific and medical equipment producing radio oscillations, that can be tolerated in various frequency ranges by the types of system employed by radio services especially by the mobile services.

*Note.* — In this study the C.C.I.R. should keep itself informed on the results of the studies of the C.I.S.P.R. on the same subject, in order to avoid duplication of work.

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* See Question No. 75 (I).

# Questions and Study Programmes assigned to Study Group No. IV

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## QUESTION No. 6 (IV) *

## GROUND WAVE PROPAGATION

The C.C.I.R., (Stockholm, 1948 — Geneva, 1951)

CONSIDERING :

The continuing importance of the effect of the characteristics of the earth on the propagation of waves used for all types of radio communication and location, including directional transmission and direction finding ;

UNANIMOUSLY DECIDES that the following question be studied :

*Ground Wave Propagation*

That the 1938 C.C.I.R. curves of ground wave propagation be revised and extended to cover the whole of the radio frequency spectrum now in practical use, giving particular attention to :

1. Transmission over mixed paths, e.g. partly over land and partly over sea ;
2. The effect of hills and other obstacles in diffracting the waves in either the horizontal or vertical plane ;
3. The siting of aerials for very high frequencies ;
4. The relative effects obtained with horizontal and vertical polarization ;
5. The variations in phase of radio waves in transmission over the ground between two points.

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## STUDY PROGRAMME No. 51 (IV) **

## EFFECTS OF TROPOSPHERIC REFRACTION ON FREQUENCIES BELOW 10 Mc/s

(Question No. 6 (IV))

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

CONSIDERING :

*(a)* That the ground-wave propagation curves for frequencies below 10 Mc/s submitted with Recommendation No. 52, make no allowance for normal tropospheric refraction ;

* Study Programmes Nos. 51 (IV), 52 (IV), 53 (IV) and 54 (IV) arise from this Question.
** This Study Programme replace Study Programme No. 11. It arises from Question No. 6 (IV).

*(b)* That allowance is sometimes made for normal refraction by the assumption of an effective earth's radius of 4/3 times the actual value ;

*(c)* That the effect of normal tropospheric refraction is likely to decrease with decreasing frequency ;

*(d)* That some mathematical analyses relating to this subject have been completed and published *;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. Further measurements of ground-wave field strengths over a sufficiently long path of uniform conductivity, such as a sea path, to determine experimentally the modification of the ground-wave curves required to include the effects of tropospheric refraction at frequencies below 10 Mc/s ;

2. Interpretation of the mathematical analysis relating to ground-wave propagation to include the effects of tropospheric refraction on all frequencies below 10 Mc/s.

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## STUDY PROGRAMME No. 52 (IV) **

## TEMPORAL VARIATION OF GROUND-WAVE FIELD STRENGTHS

(Question No. 6 (IV))

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

CONSIDERING :

*(a)* That the existence of a temporal variation of ground-wave field strength at a fixed receiving point is now a well established phenomenon ;

*(b)* That such variations have been observed to correlate with various physical factors as described in Report No. 20 ;

UNANIMOUSLY DECIDES that the following study should be carried out :

The further investigation of this phenomenon with a view to determining its importance in the study of ground-wave propagation.

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## STUDY PROGRAMME No. 53 (IV) ***

## GROUND-WAVE PROPAGATION OVER MIXED PATHS

(Question No. 6 (IV))

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

CONSIDERING :

*(a)* That the problem of amplitude and phase variations in ground-wave propagation resulting from the non-uniformity of the electrical constants along the path is of great importance in connection with :

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* See for example : H. BREMMER, *Terrestrial Radio Waves, Theory of Propagation*, Part. II, p. 145, Formula 31.

** This Study Programme replaces Study Programme No. 12. It arises from Question No. 6 (IV).

*** This Study Programme replaces Study Programme No. 13. It arises from Question No. 6 (IV).

— the determination of the service areas of radio transmitters,
— the use of medium and low frequencies for navigational aids,
— the study of coastal refraction ;

*(b)* That, although the methods referred to in Recommendation No. 109 have given good agreement with experiment where they have been applied, they are nevertheless partly empirical ;

*(c)* That rigorous mathematical analysis has not yet been extended to include the effect of :

— several boundaries,
— curvature of the earth,
— propagation obliquely to a boundary,
— variations of the electrical constants of the ground in the vertical direction ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The obtaining of further experimental results for amplitude and phase over mixed paths under as wide a range of conditions as possible ;

2. The interpretation of these results in terms of the methods referred to in Recommendation No. 109 ;

3. The detailed examination of conditions in the neighbourhood of a boundary, especially of phase changes in various directions across a coastline ;

4. The further development of the mathematical analysis and its adaptation for engineering application to replace, if necessary, the existing empirical methods ;

5. The reduction of these empirical methods to as simple a form as possible ;

6. The extension of the experimental and theoretical work to take account of changes in the electrical constants of the ground in the vertical direction, e.g. where there is shallow water of variable depth ;

7. The possibility of using amplitude and phase measurements to detect and estimate changes in the electrical constants along a land path.

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## STUDY PROGRAMME No. 54 (IV) *

## GROUND-WAVE PROPAGATION OVER IRREGULAR TERRAIN

(Questions Nos. 6 (IV) and 7)

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

CONSIDERING :

*(a)* That it is of great importance to pursue the studies concerning propagation over irregular terrain ;

*(b)* That Report No. 21 has not given a complete answer to the problem ;

* This Study Programme replaces Study Programme No. 14. It arises from Question No. 6 (IV).

UNANIMOUSLY DECIDES that the following study should be carried out :

Propagation of waves over irregular terrain, with consideration of the following aspects :

1. Propagation over a specific path between fixed points, with particular reference to :
   - — propagation along valleys between mountains,
   - — propagation across valleys ;

2. Propagation over a specific area surrounding a transmitter, using statistical methods, with particular reference to propagation over very irregular terrain ;

3. Methods for the experimental determination of the best choice of site and the appropriate polarisation of antennae for the type of service to be obtained ;

4. The experimental study of the phase variations with distance, produced by irregularities of the terrain ;

5. The further development of the mathematical analysis and its practical application.

# Questions and Study Programmes assigned to Study Group No. V

## QUESTION No. 85 (V)

## PROPAGATION DATA REQUIRED FOR WIDE-BAND RADIO SYSTEMS

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

CONSIDERING :

*(a)* That in the planning of a communications network it is necessary to define the overall system performance achieved for given percentages of time ;

*(b)* That designers of radio systems in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands require to know, from the point of view of sustained satisfactory operation, the tropospheric propagation characteristics and the resulting signal strength that is exceeded for a high percentage of the time over comparatively short distances approximating to the normal working range for each particular frequency band (i.e. approximately optical distance for UHF (decimetric) and up to twice or three times the optical range for SHF (centimetric) and VHF (metric).;

*(c)* That the planning of multi-repeatered systems requires the knowledge of the seasonal distribution curves of such propagation characteristics ;

*(d)* That from the point of view of interference beyond the normal range it is necessary to know the value of received field likely to be exceeded for a small percentage of time, at distances of three or more times the optical range ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What is the distribution with time of the values of path attenuation over approximately optical paths in the UHF (decimetric) and SHF (centimetric) ranges, and particularly the values likely to be exceeded for 50%, 1% and 0.1% of the time ?

2. What is the distribution with time of the values of path attenuation over paths of lengths up to two or three times the optical distance in the VHF (metric) band, and particularly the values likely to be exceeded for 50%, 1% and 0.1% of the time ?

3. To what extent are these distributions dependent upon the season, length of path, geographical region and type of terrain over which the path passes ?

4. What is the value of path attenuation likely to be exceeded for 99% and 99.9% of the time at distances of three or more times the optical range for systems operating in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands ?

*Notes:*

1. The data accumulated in preparing C.C.I.R. Recommendation No. 55, (Geneva, 1951) may provide some information on § 4 and possibly on § 1 and 2 of this question. Since, however, the use of directional aerials and staggered paths can often avoid interference beyond the normal range, § 1 and 2 are regarded as more urgent than § 4.

2. In preparing answers to § 1 and 2, it may be valuable to obtain data on the variation with time of the values of the earth's effective radius.

3. It is hoped that the values of the distribution of path attenuation can be provided with particular reference to the frequency bands allocated to the Fixed Service in the Radio Regulations, Atlantic City, and that indication can be given of any major variations in those conditions likely to be experienced within any one of those bands.

4. The above questions should be brought to the attention of the U.R.S.I. by the Director of the C.C.I.R. with the view that these questions be taken into account in the scientific studies carried out by the U.R.S.I., special attention being drawn to the fact that the U.R.S.I. is preparing two special reports on tropospheric wave propagation (one on propagation within the optical horizon and the other on propagation beyond the optical horizon). These two reports are to be presented at the next General Assembly of the U.R.S.I. 1954.

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## QUESTION No. 86 (V)

## THE MEASUREMENT OF FIELD STRENGTH IN THE NEIGHBOURHOOD OF OBSTACLES

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

CONSIDERING :

*(a)* That it is often necessary for practical purposes to define and measure the field strength at the place where it is to be used ;

*(b)* That the conditions existing at such places are often very different from those described in Recommendation No. 66 *, particularly because of the presence of obstacles (buildings, lines, antennae, trees, etc.) ;

*(c)* That the apparatus commonly used for field strength measurements may be influenced by components other than that to be measured, giving rise to serious errors when the latter is relatively weak ;

UNANIMOUSLY DECIDES that the following question should be studied :

Since only limited use can be made of existing field strength measuring equipment, due, in particular, to the influence of field components other than that to be measured, how can the structure of the field be determined and its strength measured at a site in the neighbourhood of obstacles to establish a relation between these characteristics and those that would exist without such obstacles ?

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* This Recommendation has been replaced by Recommendation No. 114.

## STUDY PROGRAMME No. 19 (V) *

### MEASUREMENT OF FIELD STRENGTH OF RADIO SIGNALS

(Question No. 8)

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

CONSIDERING :

*(a)* That Question No. 8 of the C.C.I.R. has not yet received a complete reply ;

*(b)* That Recommendations Nos. 60, 61, 62, 63, 64, 65 and 66, as well as Reports Nos. 4, 5 and 6 reply in part to Question No. 8 ;

UNANIMOUSLY DECIDES that the following study should be made :

Study of the measurements of the field strength of radio signals in accordance with the programme proposed in Question No. 8, taking account of the Recommendations and Reports cited above.

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## STUDY PROGRAMME No. 55 (V) **

### TROPOSPHERIC PROPAGATION CURVES FOR DISTANCES WELL BEYOND THE HORIZON

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

CONSIDERING :

*(a)* That the curves given in Recommendation No. 111 are restricted to the frequency range 30 to 200 Mc/s, and that they give only a broad representation of the data on which they are based ;

*(b)* That they refer only to the average meteorological conditions for the specific areas stated in the text accompanying the curves ;

*(c)* That they specifically refer to transmission over land while conditions causing abnormal long distance tropospheric propagation may arise more frequently over sea ;

*(d)* That they refer only to median values with respect to geographical location ;

*(e)* That they take no account of the height of the transmitting aerial, nor of the directivity of the transmitting and receiving aerials ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

**1.** Continuous recording, for distances well beyond the horizon, of transmissions in the frequency range 30 to 4000 Mc/s in as many parts of the world as possible over a period of at least two years.

**2.** Particular investigation of the problem of oversea paths.

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* This Study Programme does not refer to any Question under study.

** This Study Programme replaces Study Programme No. 17. It does not refer to any Question under study.

3. The statistical analysis of the results of such experiments along the lines adopted in the production of the curves given in Recommendation No. 111.

4. Deduction from this analysis of the modification to those curves to allow for the different average meteorological conditions existing in different parts of the world.

5. Study of the variation of field strength at various distances from the transmitter.

6. Investigation over various transmission distances of the effect of changing the height of the transmitting aerial.

7. Investigation over various transmission distances of the effect of using directive aerials both for transmission and reception.

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## STUDY PROGRAMME No. 56 (V) *

## TROPOSPHERIC WAVE PROPAGATION

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

CONSIDERING :

*(a)* That widespread developments have taken place in the practical application of radio waves at frequencies above 30 Mc/s ;

*(b)* That the propagation of such waves is known to be greatly influenced by the meteorological conditions in the troposphere ;

*(c)* That progress in the investigation of such propagation has already led to Recommendation No. 111 ;

DECIDES that the following studies should be carried out :

1. Administrations and operating agencies should be encouraged to make operational radio data available to national laboratories which will co-ordinate the radio information with meteorological data and submit the results of their analyses to the C.C.I.R. The methods used in the analyses should be described.

2. Administrations and Operating Agencies should be encouraged to carry out, so far as possible, special investigations designed to supplement the information obtained in § 1.

3. Steps should be taken to devise a suitable standard nomenclature for this subject, and a uniform method of presenting both the radio and the meteorological results should be adopted. The method of presentation should take account of the periods of occurrence of standard, sub-standard and super-refracting conditions, and should indicate the geographical areas in which these conditions exist.

*Note.* — National administrations, the International Radio Scientific Union (U.R.S.I.), the World Meteorological Organisation (O.M.M.) and other international radio and meteorological organizations should be encouraged to pursue as a matter of great urgency the investigation of the propagation of radio waves through the troposphere.

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* This Study Programme replaces Study Programme No. 18. It does not refer to any Question under study.

## STUDY PROGRAMME No. 57 (V) *

## INVESTIGATION OF MULTIPATH TRANSMISSION THROUGH THE TROPOSPHERE

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

CONSIDERING :

That in systems using frequencies above 30 Mc/s, radio waves may travel from a transmitter to a receiver along several paths ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. Investigation of time and phase differences occurring in multipath transmissions ;
2. Determination of the percentage of time for which given time and phase differences occur, respectively ;
3. Statistical analysis of the relative strengths of signals occurring in multipath transmissions ;
4. Investigation of the manner in which the quantities measured vary with frequency over bands of the order of those used in television and wide band radio and television systems ;
5. Investigation of the manner in which the same quantities are affected by the use of space diversity systems.

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* This Study Programme does not refer to any Question under study.

# Questions and Study Programmes assigned to Study Group No. VI

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## STUDY PROGRAMME No. 58 (VI) *

## CHOICE OF A BASIC SOLAR INDEX FOR IONOSPHERIC PROPAGATION

(Question No. 53)

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

CONSIDERING :

*(a)* That the sun is generally accepted as the primary cause of many geophysical phenomena and in particular of the formation of the ionosphere and of most of its variations ;

*(b)* That when suitable smoothed averages are used the Wolf sunspot numbers provide an index of solar activity which shows a fairly good correlation with similarly smoothed ionospheric propagation data, but that these numbers are nevertheless subjective and empirical since they are obtained from an arbitrary formula based on the number of spots and of groups of spots observed on the sun's disc ;

*(c)* That determination of the Wolf numbers depends, moreover, on visual observations of the sun which can therefore be made only under favourable meteorological conditions ;

*(d)* That it has recently been shown that the intensity of solar radiation in the VHF (metric) and UHF (decimetric) bands is closely correlated with visible solar phenomena ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

**1.** The relationship between solar phenomena, other than sunspots expressed in Wolf numbers, which can be observed objectively, and ionospheric propagation conditions ;

**2.** The relationship between the intensity of solar radiation at radio frequencies, and ionospheric propagation conditions ;

**3.** The possibility of establishing an index of solar activity, based upon optical or radio observations, which can be usefully employed as a basic index for ionospheric propagation ;

**4.** The possibility of utilising, perhaps temporarily, some observations of terrestrial phenomena, such as of a geomagnetic or of an ionospheric character, so as to provide a suitable index of solar influence on ionospheric phenomena, for use in connection with ionospheric propagation studies.

*Note.* — The above Study Programme should be brought to the attention of the U.R.S.I. by the Director of C.C.I.R. with a view to encouraging that organisation to expedite its work bearing on these studies, requesting the U.R.S.I. to inform the C.C.I.R. of the results of its study.

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* This Study Programme does not refer to any Question under study.

## STUDY PROGRAMME No. 59 (VI) *

## IDENTIFICATION OF PRECURSORS INDICATIVE OF SHORT-TERM VARIATIONS OF IONOSPHERIC PROPAGATION CONDITIONS

(Question No. 53)

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

CONSIDERING :

*(a)* That it is desirable to have an index or indices suitable for short-term forecasts of ionospheric disturbances ;

*(b)* That long-term indices for ionospheric propagation may not be satisfactory for indicating short-term variations in the ionosphere ;

*(c)* That it is generally accepted that corpuscular radiation from the sun is the main cause of ionospheric propagation disturbances ;

UNANIMOUSLY DECIDES that the following study should be carried out :

The possibility of selecting particular kinds of solar observations, or observations of other phenomena, that can be made objectively, and which may be usefully employed for short-term predictions of ionospheric propagation conditions.

*Note.* — The above Study Programme should be brought to the attention of the U.R.S.I. by the Director of the C.C.I.R., with a view to encouraging that organisation to expedite its work bearing on these studies, requesting the U.R.S.I. to inform the C.C.I.R. of the results of its study.

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## STUDY PROGRAMME No. 60 (VI) *

## BASIC PREDICTION INFORMATION FOR IONOSPHERIC PROPAGATION

(Question No. 50)

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

CONSIDERING :

*(a)* That Question No. 50 cannot yet be fully answered ;

*(b)* That, nevertheless, extensive practical use is made of basic prediction information by radio operating services and administrations (see Report No. 23) ;

*(c)* That the application to specific operational problems, of basic prediction information, as supplied by various administrations and centres, has revealed occasional large discrepancies between basic prediction information and operational results, even though the solar activity may have been correctly forecast ; these may be attributed to such causes as the following :

- — different interpretations placed upon the basic ionospheric observations ;
- — different methods of converting basic ionospheric observational material into world prediction charts ;

* This Study Programme does not refer to any Question under study.

— over simplification of the prediction material resulting from the continuing use of the three-zone method of allowing for longitude effects in the characteristics of the F2 layer ;
— inadequate understanding and research for suitable allowance to be made for the role played by layers other than F2, notably the E layer, for the actual modes of propagation, and for the effects of ground scatter ;
— in the preparation of world prediction charts the necessity to adapt existing propagation data to extensive regions (oceans, etc.) from which no such data are available ;
— differences in the statistical significance of the operational data sampled, and in the methods of assessing circuit performance of the various classes of service ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The suitability of present methods for predicting oblique incidence MUF from vertical incidence data for both short and long paths ;

2. The extent to which basic prediction material now in use could be improved by the use of :

— two separate intermediate-zone (I-zone) world charts, possibly with modified zone boundaries, or,
— a set of world charts for every hour or two hours, U.T. ;

3. The role played by the E region in the determination of operational MUF for short and long paths both in summer and in winter ;

4. Practical means of introducing into prediction data, progagation modes and the related subject of angles of arrival and departure ;

5. Practical methods of introducing into monthly predictions the anticipated day-to-day spread of MUF.

*Note.* — This above study programme should be brought to the attention of the U.R.S.I. by the Director of C.C.I.R. with a view to encouraging that organisation to expedite its work bearing on these studies, requesting the U.R.S.I. to inform the C.C.I.R. of the results of its study.

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## STUDY PROGRAMME No. 61 (VI) *

## NON-LINEAR EFFECTS IN THE IONOSPHERE

(Question No. 5)

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

CONSIDERING :

*(a)* That numerous examples of intermodulation and of the generation of unwanted signals in the ionosphere have been observed in the very low, low and medium frequency bands, and may be possible in the high frequency bands ;

*(b)* That non-linear effects during ionospheric propagation can produce spurious modulation in radio communication (including broadcasting) ;

* This Study Programme replaces Study Programme No. 20. It does not refer to any Question under study.

*(c)* That these phenomena can impose limitations on the usefulness of radio communication and cause serious interference between different transmissions ;

*(d)* That the magnitude of these phenomena may increase with the signal intensity in the ionosphere and with the depth of modulation of the unwanted transmission ;

*(e)* That, in particular there are no quantitative data available on high frequency interaction ;

*(f)* That it is desirable to endeavour to find means for reducing to a minimum the disturbance due to these effects ;

UNANIMOUSLY DECIDES that the following study should be carried out :

The study by administrations and recognised operating agencies of the non-linear effects in the ionosphere, recording in particular the time and conditions of occurrence and the values of the frequencies on which they are observed, and of practical means of decreasing the effect on the efficiency of radio communications and radio broadcasting ; the Director of the C.C.I.R. should keep in touch with the U.R.S.I. with regard to any theoretical and experimental developments that may have important practical implications, so that the C.C.I.R. may be kept informed.

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## STUDY PROGRAMME No. 62 (VI) *

## USE OF SPECIAL MODULATION ON THE STANDARD FREQUENCY TRANSMISSIONS FOR ASSESSING THE RELIABILITY OF PROPAGATION FORECASTS

(Question No. 50)

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

CONSIDERING :

*(a)* That radio operating agencies are quite willing to take periodical note of the quality of the propagation observed on certain paths during their normal traffic ;

*(b)* That the data thus obtained are nevertheless inadequate for clear conclusions to be drawn concerning the actual propagation conditions and the accuracy of available forecasts ;

*(c)* That the method of continuously recording the field set up by continuously operating transmitters or by transmitters with transmissions evenly spaced in time seems at present to be a more efficient way of comparing forecasts with actual propagation conditions ;

*(d)* That it would be extremely difficult, if not impossible, to obtain assignments of sufficiently clear frequency channels, and of necessary transmitting facilities, for the specific purpose of obtaining more useful data for such comparisons ;

*(e)* That transmitters of standard frequencies and time signals were quite satisfactory for this purpose so long as they were few enough in number not to cause mutual interference, but that this is no longer the case ;

*(f)* That the study of propagation conditions using experimental transmitters does not in all cases require permanent emissions but merely transmissions lasting a few minutes repeated once or twice an hour ;

* This Study Programme does not refer to any Question under study.

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The possibility of providing special tone modulation on the various standard frequency transmitters, suitable for radio propagation measurements. Such modulation ought to provide, for example, one or more sidebands separated far enough from the carrier and other modulations of the carrier to allow the recording receiver to receive only the wanted modulation sideband. It should be noted that the total emission of the standard frequency transmitter must not fall outside the bands allocated to this service by Atlantic City ;

2. The feasibility of applying such additional modulation, for a period of a few minutes each hour or half-hour, to one transmitter at a time, on a given frequency, according to a prearranged sequence.

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## STUDY PROGRAMME No. 63 (VI) *

## RADIO PROPAGATION AT FREQUENCIES BELOW 1500 kc/s

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

CONSIDERING :

*(a)* That a large amount of work has now been done on the ionospheric propagation of waves at frequencies below 1500 kc/s ** ;

*(b)* That, nevertheless, propagation of radio waves on frequencies below 1500 kc/s under conditions in which it is controlled by the ionosphere is not yet fully understood ;

*(c)* That the mathematical analysis of this problem has been largely confined to ideal cases that are not sufficiently representative of practical conditions especially where long distance propagation is concerned ;

*(d)* That it is of interest to the I.F.R.B. to have available reliable curves of night-time propagation on these frequencies especially at the comparatively short distances for which the ground-wave predominates in day-time ;

DECIDES that the following studies should be carried out :

1. Continuation of measurements at vertical and oblique incidence on frequencies below 1500 kc/s of the type described in the documents referred to ;

2. With the participation of administrations and laboratories having suitable facilities, obtain results over as large a range of frequencies and geographical areas as possible ;

3. Carry out measurements at very great distances and very low frequencies in an effort to determine the manner of propagation of these waves to great distances ;

4. Effect, on the propagation of these waves, of disturbed conditions in the ionosphere, such as those associated with sudden phase anomalies and with magnetic storms ;

5. Influence of the earth's magnetic field ;

6. Development of the mathematical analysis to make it apply more closely to the general conditions of long distance propagation in which both the ionisation and the direction of the earth's magnetic field vary along the propagation path ;

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* This Study Programme replaces Study Programme No. 21. It does not refer to any Question under study.

** See Doc. No. 141 of Washington 1950, Docs. Nos. 69, 154 and 186 of Geneva 1951, Docs. Nos. 37 and 332 of London 1953 and in the review given in *Proc. I.E.E.* 100, Part III, 64, 1953, p. 100.

7. Possibility of revising the C.C.I.R. night-time curves (presented at Cairo, 1938) in the light of present knowledge, in view of the need of the I.F.R.B. to have available reliable curves, as expressed in *(c)* of Annex to Report No. 24.

*Note.* — The above Study Programme should be brought to the attention of the U.R.S.I. by the Director of C.C.I.R., with a view to encouraging that organisation to expedite its work bearing on these studies, requesting the U.R.S.I. to inform the C.C.I.R. of the results of its study.

## STUDY PROGRAMME No. 64 (VI) *

## IONOSPHERIC PROPAGATION OF WAVES IN THE BAND 30 TO 300 Mc/s

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

CONSIDERING :

*(a)* That frequencies in the 30 to 300 Mc/s band are of great importance for short distance radio links, for television, for broadcasting, and for other purposes ;

*(b)* That with the advent of more powerful transmitters and more directional aerials a new kind of ionospheric propagation has been discovered wihch results in transmission to distances somewhat in excess of 2000 km in the lower part of this frequency band ;

*(c)* That ionospheric propagation in this frequency band at least by the regular ionospheric layers, is known to be dependent upon the level of solar activity ;

UNANIMOUSLY DECIDES that the following study should be carried out :

The propagation of waves in the 30 to 300 Mc/s band by way of the ionosphere, with particular attention to results obtained during the present period of low solar activity. Progress made in this study as the solar cycle proceeds should be reported on at future Plenary Assemblies.

*Note.* — Report No. 7, together with Doc. No. 39 of London 1953, constitute the current summary of information on this subject. An extensive bibliography is given in Docs. No. 124 of Washington, 1950, No. 72 of Geneva, 1951, and No. 39 of London, 1953.

## STUDY PROGRAMME No. 65 (VI) **

## MEASUREMENT OF ATMOSPHERIC RADIO NOISE

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

CONSIDERING :

*(a)* That there is a continuing need for more information regarding atmospheric noise and its influence on radio systems ;

*(b)* That the objectives of Study Programme No. 23 have been only partially attained :

* This Study Programme replaces Study Programme No. 22. It does not refer to any Question under study.

** This Study Programme replaces Study Programme No. 23. It does not refer to any Question under study.

DECIDES that the following studies should be carried out :

**1.** Continued measurement of atmospheric noise at a number of locations by the Thomas method and by other methods in current use ;

**2.** Application, at a few locations, of methods of measurement of the Thomas type to classes of transmissions other than aural telegraphy ;

**3.** Development of other methods of measuring atmospheric noise intensities by objective means ;

**4.** Direct comparison of methods of measuring noise with a view to deciding the most appropriate method for future use ;

**5.** Extension of facilities (e.g. narrow-sector and cathode ray direction finders) for locating thunderstorm centres and comparison of results on different frequencies in the range 10 kc/s to 30 Mc/s ;

**6.** Further development and testing of devices for counting local lightning flashes, in accordance with Recommendation No. 121 ;

**7.** Determination, by experimental and theoretical means, of the form and other characteristics of atmospheric noise originating in distant thunderstorms ;

**8.** Relationship between the characteristics of noise at the input to a receiver and the interference to the intelligence at the output ;

**9.** Improvement of existing means for presenting atmospheric noise data ;

**10.** Determination of the spectral distribution of the radiated energy from lightning flashes ;

**11.** Relative importance of atmospheric noise compared with other types of noise, as a limiting factor in radio communication.

*Notes :*

1. The above Study Programme should be brought to the attention of the U.R.S.I. by the Director of C.C.I.R. with a view to encouraging that organisation to expedite its work bearing on these studies, requesting the U.R.S.I. to inform the C.C.I.R. of the results of its study.
2. A special clause relating to § 3 and 4 of the above Study Programme has been inserted in Recommendation No. 119.
3. The studies detailed in § 5, 6 and 7 should be carried out in close consultation with W.M.O. in order to avoid duplication of effort.

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## STUDY PROGRAMME No. 66 (VI) *

## STUDY OF FADING

(Questions Nos. 51 and 52 — Study Programme No. 24)

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

CONSIDERING :

*(a)* That the practical requirements of radio communication necessitate not only information on the median received field strength of radio transmissions, but also :

— data on the amplitude distribution and rapidity of field strength variations (with respect to the speed of transmission),

* This Study Programme does not refer to any Question under study.

— effects of equipment time constants,
— selective fading,

and that these informations are essential to Study Groups Nos. III, X and XII in assessing the allowances for fading ;

*(b)* That field strength variation involves phenomena of focusing, variation in direction of arrival, interference by components of a single mode, between different modes, and between the various magneto-ionic components, as well as variations of ionospheric absorption and scattering phenomena ;

*(c)* That variations of field strength may, as a first approximation, be divided into three types :

— irregular short period variations, assumed in general to result from interference and focusing, with an apparent period of occasionally as much as several minutes and dependent to a certain degree on the frequency. These variations should be allowed for in the assessment of a *fading safety factor* ;
— irregular variations of periodicity, large compared with the case above, i.e. hourly, daily or from one day to another, which may be due to fluctuating absorption or to prolonged large scale focusing or which may result from variations of arrival angle and polarisation. Allowance for them should be made in the assessment of an *intensity fluctuation factor* ;
— regular variations with time of day, season and solar activity, to which are added the variations of the two above types ;

*(d)* That it is important to have as much information as possible concerning the effects of fading on time, space, frequency and polarisation diversity reception ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

For the various frequency bands used in radiocommunication by means of the ionosphere :

**1.** The rapidity, severity and time distribution (for example, Rayleigh, normal and log-normal) of short period field strength variations i.e. of the order of $10^{-4}$ second, or occasionally even shorter, to several seconds or, sometimes, to as much as several minutes ;

**2.** The severity of day-to-day variations of hourly median field strengths i.e. for time intervals of one hour ;

**3.** The extent to which the above variations are dependent upon season, solar activity and geographical location ;

**4.** The effects produced by field strength variations on different receiving systems, such as time, space, frequency and polarisation diversity systems ;

**5.** The mechanisms which produce field strength variations ;

**6.** The extent to which any of the above studies are affected under modulation conditions.

*Notes :*

1. The above studies should be undertaken both from a theoretical and experimental viewpoint. When appropriate, consideration should be given to the time constants and other characteristics of the measuring equipment.
2. The above Study Programme should be brought to the attention of the U.R.S.I. by the Director of C.C.I.R. with a view to encouraging that organisation to expedite its work bearing on these studies, requesting the U.R.S.I. to inform the C.C.I.R. of the results of its study.

## STUDY PROGRAMME No. 67 (VI) *

# PULSE TRANSMISSION TESTS AT OBLIQUE INCIDENCE

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

CONSIDERING :

*(a)* That pulse transmission tests at oblique incidence are likely to be of considerable value in the investigation of the following problems :

— study of modes of transmission via the ionosphere ;
— study of angles of elevation and lateral deviation of rays arriving at different receiving points ;
— investigation of the nature of signals scattered from the ground and from off-path propagation resulting from this effect ;
— investigation of round-the-world signals ;

*(b)* That pulse transmission tests at oblique incidence would assist also in the studies of ionospheric absorption (Recommendation No. 115) and fading (Questions Nos. 51 and 52, Study Programme No. 24) ;

DECIDES that the following studies should be carried out :

**1.** The organisation of these experimental transmissions by Study Group No. VI by correspondence, in consultation with the Director of C.C.I.R. who shall request publication of the results in the *Telecommunication Journal*, the *Information Bulletin of the U.R.S.I.*, etc. Each of the following countries is invited to nominate a member to participate in the work and the Netherlands member will coordinate the work on behalf of the Chairman of Study Group No. VI :

Egypt, U.S.A., France, Italy, Japan, New Zealand, Norway, Netherlands, Federal German Republic, United Kingdom, Sweden, Syria, Yugoslavia.

The following types of transmitters should, if possible, be made available :

— ionospheric sounding stations for fairly short-range tests using sweep-frequency technique ;
— commercial and broadcast transmitters for long-range tests on fixed frequencies ;
— transmitters operated by research organisations ;

**2.** The need to use crystal-controlled synchronising systems in pulse transmitters and receivers, as well as the possibility of using international time signals as starting signals.

* This Study Programme does not refer to any Question under study.

# Questions and Study Programmes assigned to Study Group No. VII

## QUESTION No. 87 (VII) *

## STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Stockholm, 1948 — Geneva, 1951 — London, 1953)

The C.C.I.R.,

In accordance with App. B annexed to the Radio Regulations, and Recommendation No. 2 of the Atlantic City Administrative Radio Conference, 1947,

DECIDES that the following question should be studied :

The establishment and operation of a world-wide standard frequency and time signal Service.

## STUDY PROGRAMME No. 68 (VII) **

## STANDARD FREQUENCY TRANSMISSIONS AND TIME SIGNALS

(Question No. 54)

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

CONSIDERING :

*(a)* That the Atlantic City Radio Conference called for the study of the establishment and operation of a world-wide standard frequency and time service ;

*(b)* That large areas are not effectively served ;

*(c)* That, however, the use of more stations than are technically necessary to provide world-wide coverage would, by producing harmful interference, diminish the utility of the service ;

*(d)* That the information on service areas and on mutual interference, although considerable, is still very incomplete, and that the situation is continually changing ;

* This Question replaces Question No. 54. Study Programme No. 68 (VII) arises from this Question.
** This Study Programme replaces Study Programme No. 25. It arises from Question No. 87 (VII).

*(e)* That serious difficulties have sometimes been encountered by users wishing to make high-precision measurements ;

*(f)* That difficulties have sometimes been encountered in the use of the time signals, in the case of an additional audio modulation or of simultaneous reception of several transmissions ;

*(g)* That new methods of transmission might improve the service ;

DECIDES that the following studies should be carried out :

1. Improvement of the service in the badly served areas, particularly in Asia and in the Southern Hemisphere, by putting a limited number of new experimental stations into service ;

2. Collection and analysis by administrations operating standard frequency stations, of information on service areas and interference ;

3. Comparative tests between the types of time signals described in Recommendation No. 122, § 4, and new methods which might improve the use of time signals in the case of additional audio modulation or of simultaneous reception of several transmissions, for instance :

   — suppression of additional modulation during each time impulse,
   — constitution of the time signal by means of an interruption of the transmission,
   — constitution of the time signal by means of a carrier wave pulse preceded and followed by brief interruptions of the transmission ;

4. Efficiency of time sharing of programmes as a means of reducing harmful mutual interference ;

5. Application of independent-sideband technique of transmission to the standard frequency and time service ;

6. Possibility of modulating each of the transmitters in turn for several minutes per hour, or per half-hour with a high audio frequency (without exceeding the allocated band width) to facilitate propagation studies in accordance with Study Programme No. 62 (VI).

# Questions and Study Programmes assigned to Study Group No. VIII

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## QUESTION No. 88 (VIII)

## AUTOMATIC MONITORING OF OCCUPANCY OF THE RADIO FREQUENCY SPECTRUM

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

CONSIDERING :

*(a)* That the increasing demand for radio services requires the most efficient use of the radio-frequency spectrum ;

*(b)* That the most efficient use of the spectrum can be arranged only when its occupancy is known ;

*(c)* That the volume of data needed is now so large that it is necessary to supplement the monitoring undertaken by operators by the use of automatic equipment ;

DECIDES that the following questions should be studied :

**1.** What parameters characterising spectrum occupancy, including noise, need to be evaluated in order to ensure the most effective use of the radio frequency spectrum ?

**2.** Which of the parameters listed in the answer to the question in § 1 could be evaluated by wholly automatic monitoring equipment ?

**3.** Would an evaluation of the parameters listed in the answer to the question in § 2 be sufficient or valuable in adjusting the present use of the spectrum to exploit it more efficiently ?

**4.** If the answer to the question in § 3 is in the affirmative, what are the desirable characteristics of automatic monitoring equipment for determining the occupancy of the radio frequency spectrum ? One general form that such an equipment might take comprises a radio receiver tuned automatically and rhythmically over a predetermined frequency range (the swept range) and associated with a device to record some of the characteristics of the signals intercepted by the receiver. In such a case, among others the following should be studied :

— the total frequency range over which monitoring is required ;
— the swept frequency range, or ranges, to be covered by the automatic tuner ;

— the number of sweeps per hour ;
— the maximum rate of sweeping in kc/s per second ;
— the sensitivity, i.e. the minimum signal field intensity to be recorded, in microvolts/meter ; it may be useful to specify an adjustable sensitivity, or to switch the sensitivity in order to group the recorded signals according to intensity ;
— the resolving power, i.e. the minimum frequency separation between distinguishable signals ;
— the signal characteristics to be recorded, e.g. carrier frequency, bandwidth, signal strength ;
— the size and the general form of the records, methods of recording, and calibrating ;
— methods for the analysis of records, including automatic methods.

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## QUESTION No. 89 (VIII)

## FREQUENCY MEASUREMENTS ABOVE 50 Mc/s BY MONITORING STATIONS

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

CONSIDERING :

*(a)* That Recommendation No. 20 specifies the accuracy of frequency measurements by monitoring stations for frequencies between 10 kc/s and 50 Mc/s only ;

*(b)* That the use of frequencies above 50 Mc/s in the international service is increasing ;

*(c)* That it is important accurately to maintain frequency in order to prevent interference, to increase the efficiency of communications and to provide economical use of the radio spectrum above 50 Mc/s ;

*(d)* That there are advantages in measuring the frequencies of a large number of transmitting stations by means of a small number of fixed or mobile monitoring stations ;

UNANIMOUSLY DECIDES that the following questions should be studied :

**1.** What is the accuracy with which it is desirable to carry out at monitoring stations measurements of frequencies of emissions above 50 Mc/s ?

**2.** What equipment is to be preferred, what are the principles of circuit design to be used ? In the case of mobile stations what are the mechanical and electrical requirements ?

**3.** What are the preferred methods to be followed in making such measurements ?

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## STUDY PROGRAMME No. 69 (VIII) *

## ACCURACY OF FIELD STRENGTH MEASUREMENTS BY MONITORING STATIONS

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

CONSIDERING :

That Recommendation No. 123 : " Accuracy of Field Strength Measurements by Monitoring Stations " does not cover all aspects of the problem, and that it recommends that studies relating to methods and equipment for use at monitoring stations should be continued ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. The effect of equipment time constants (including, where appropriate, that caused by recording-pen drag) on the accuracy of absolute field strength measurement at monitoring stations using apparatus with or without automatic recorders, particularly when measuring emissions with interrupted or reduced carrier ;

2. The improvement in accuracy to be obtained by the use of various secondary voltage standards for the calibration of signal generators at monitoring stations.

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## STUDY PROGRAMME No. 70 (VIII) *

## SPECTRUM MEASUREMENT BY MONITORING STATIONS

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

CONSIDERING :

*(a)* That it is desirable that international monitoring stations should be able to measure the spectrum of emissions ;

*(b)* That Recommendation No. 88 is concerned only with measurements of spectrum made near the transmitter ;

*(c)* That although the methods of measurement and equipment used at monitoring stations for spectrum measurement may be generally similar to those used near the transmitter, nevertheless, additional factors will need to be considered (e.g., the effects of fading, noise and interference on the received signal and the necessity for making measurements on traffic rather than on periodic signals) ;

*(d)* That the accuracy possible or necessary at monitoring stations may differ from that possible for measurements made near the transmitter ;

DECIDES that the following studies should be carried out :

Determination of the most suitable equipment and methods for the measurement of spectrum of emissions by monitoring stations, taking into account :

1. The work of the C.C.I.R. concerning measurements of spectrum made near the transmitter ;

2. The necessity for monitoring stations to examine various classes of emission and to make measurements of a fading signal in the presence of noise and interference ;

3. The possible or necessary accuracy of measurements by monitoring stations.

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* This Study Programme does not refer to any Question under study.

# Questions and Study Programmes assigned to Study Group No. IX

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## QUESTION No. 90 (IX)

### INTERNATIONAL WIDE-BAND RADIO RELAY SYSTEMS OPERATING ON FREQUENCIES ABOVE ABOUT 30 Mc/s

#### Interconnection of multiplex systems

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

CONSIDERING :

*(a)* That the technical characteristics of multi-channel radio systems using time-division multiplex are being studied ;

*(b)* That the technical characteristics of multi-channel radio systems using frequency-division multiplex are being studied ;

*(c)* That frequency-division multiplex on wide-band landlines is widely used ;

*(d)* That, if both types of multiplexing are used in different networks, certain problems of interconnection will eventually arise ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What economic, technical, operational and maintenance problems are involved if both types of multiplex are used in radio relay systems forming part of an international network ?
2. What type or types of multiplex should be recommended for use on multi-channel radio, systems forming part of an international network if problems of interconnection are to be reduced to a minimum ?
3. When interconnection between two systems using different types of multiplex is necessary, what is the best arrangement to adopt ?

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## QUESTION No. 91 (IX)

### INTERNATIONAL WIDE-BAND RADIO RELAY SYSTEMS OPERATING ON FREQUENCIES ABOVE ABOUT 30 Mc/s

#### Transmission of telephony and television on the same system

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

CONSIDERING :

*(a)* That the technical characteristics of wide-band multi-channel radio telephone systems are being studied ;

*(b)* That the technical characteristics required for long distance transmission of television signals are also being studied ;

*(c)* That there may be advantages, both technical and economic, if wide-band radio relay systems are planned to permit the transmission of telephony and television, simultaneously or alternatively, on the same system ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What are the advantages, if any, if wide-band radio relay systems are planned to permit the transmission of telephony and television, simultaneously or alternatively, on the same system ?

2. If there are advantages, what essential technical characteristics of such systems should be studied and what are the values that should be assigned to such characteristics for international circuits ?

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## QUESTION No. 92 (IX)

## STANDARDIZATION OF MULTI-CHANNEL RADIO TELEPHONE SYSTEMS USING TIME DIVISION MULTIPLEX AND OPERATING AT FREQUENCIES ABOVE ABOUT 30 Mc/s

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

CONSIDERING :

*(a)* That a variety of types of multi-channel radio telephone systems using time division multiplex and operating at frequencies above about 30 Mc/s have been developed ;

*(b)* That in certain cases it is desirable to be able also to interconnect systems of different manufacture, particularly on international circuits ;

*(c)* That the lack of uniformity with regard to choice of the type and characteristics of modulation (for example, number of channels, pulse repetition frequency, synchronising methods, signalling and supervisory arrangements, etc.) in many cases makes direct interconnection impossible ;

*(d)* That direct interconnection would provide the most economical and, from a technical point of view, the most satisfactory solution ;

UNANIMOUSLY DECIDES that the following questions shall be studied :

1. What are the technical characteristics of time division multiplex radio telephone systems operating on frequencies above about 30 Mc/s which should be specified in order to be able to interconnect any two such systems ?

2. What specifications should be drawn up for such characteristics and should be recommended as standards for radio telephone systems using time division multiplex for use on international circuits ?

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## QUESTION No. 93 (IX)

## STANDARDISATION OF MULTI-CHANNEL RADIO SYSTEMS USING FREQUENCY DIVISION MULTIPLEX AND OPERATING AT FREQUENCIES ABOVE ABOUT 30 Mc/s

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

CONSIDERING :

*(a)* That a variety of types of multi-channel radio systems operating at frequencies above about 30 Mc/s use frequency division multiplex ;

*(b)* That in certain cases it is desirable to be able to interconnect systems of different types particularly on international circuits ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What are the radio or intermediate frequency characteristics of frequency division multiplex radio systems operating at frequencies above about 30 Mc/s which it is essential to specify in order to enable two such systems to be inter-connected ?

2. What specifications should be drawn up for such characteristics and should be recommended as standards for radio systems carrying frequency division multiplex for use on international circuits and operating at frequencies above about 30 Mc/s ?

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## QUESTION No. 94 (IX)

## FACSIMILE TRANSMISSION OF DOCUMENTARY MATTER OVER COMBINED RADIO AND METALLIC CIRCUITS

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

CONSIDERING :

*(a)* That increasing use is being made of facsimile telegraphy for the transmission of documentary matter ;

*(b)* That it is desirable to standardise the characteristics of the facsimile apparatus employed for this purpose ;

*(c)* That the C.C.I.T. has already undertaken the study of this matter (Question No. 46 - Arnhem refers) ;

UNANIMOUSLY DECIDES that the following question should be studied by the Joint Study Group of the C.C.I.T. and the C.C.I.R. in so far as radio transmission problems are concerned :

What should be the characteristics of apparatus for the transmission by facsimile of :

— telegrams in the public telegraph service ;
— business documents ;
— documents of large size such as, for example, meteorological charts ?

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## QUESTION No. 95 (IX)

### TRANSMISSION OF HALF-TONE PICTURES OVER RADIO CIRCUITS

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

CONSIDERING :

That, in the transmission of half-tone pictures over radio circuits, the direct frequency modulation of the radio carrier by the picture modulation frequencies would result in a greater signal-to-noise ratio than if the method of sub-carrier frequency modulation were used ;

UNANIMOUSLY DECIDES that the following question should be studied :

What are the desirable characteristics for a system transmitting half-tone pictures over radio circuits, in which direct frequency modulation of the radio frequency carrier is used ?

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## QUESTION No. 96 (IX)

### MAINTENANCE PROCEDURE FOR WIDE-BAND RADIO SYSTEMS

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

CONSIDERING :

That the operation of wide-band radio relay systems would be facilitated by co-ordinated maintenance procedures, similar to those in existence for line networks ;

UNANIMOUSLY DECIDES that the following question should be studied, as a first stage in the preparation of maintenance procedures :

What are the quantities that must be measured in order to maintain the quality of overall performance of radio links used in international networks, bearing in mind accepted line practice ?

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## QUESTION No. 97 (IX)

### HYPOTHETICAL REFERENCE CIRCUIT FOR WIDE-BAND RADIO SYSTEMS

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

CONSIDERING :

That the noise permissible in a radio system may be expected to depend to some extent on the length of the system, and that it may, therefore, be desirable for design purposes to specify a hypothetical reference circuit for radio systems analogous to that specified by the C.C.I.F. for coaxial systems (C.C.I.F. Yellow Book, Part IV, Paris 1949, pp. 39-40) ;

UNANIMOUSLY DECIDES that the following question should be studied :

The determination of a hypothetical reference circuit for the design and specification of radio systems, the elements appropriate to such a circuit and the proportions of the noise power appropriate to the complete circuit in the various circuit elements.

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## STUDY PROGRAMME No. 28 (IX) *

## WIDE-BAND RADIO SYSTEMS OPERATING IN THE VHF (METRIC), UHF (DECIMETRIC) AND SHF (CENTIMETRIC) BANDS

(Questions Nos. 29 and 41)

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

CONSIDERING :

*(a)* That wide-band radio systems suitable for operation in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands and for incorporation in networks carrying telephone, broadcast programmes, telegraph and television signals, present technical problems of concern to the C.C.I.F., the C.C.I.R. and the C.C.I.T. and in particular to the C.C.I.F. and the C.C.I.R. ;

*(b)* That Recommendation No. 40 ** approved by the VIth Plenary Assembly of the C.C.I.R. concerning radio telephone systems operating in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands is in terms of an objective to be attained and that consequently it is necessary to study many technical problems in detail, in order that suitable recommendations may be given to enable this objective to be achieved in specific cases ;

*(c)* That the best method of cooperation between the two C.C.I.s appears to be based on the broad principle that those aspects of a given problem concerning only one C.C.I. are dealt with solely by that C.C.I. while those aspects which concern both C.C.I.s are the responsibility of the C.C.I. most concerned, the other C.C.I. being adequately represented at all discussions and meetings ;

*(d)* That, as described in C.C.I.R. Doc. No. 188 of Geneva, some studies have already been carried out by the C.C.I.F. ;

UNANIMOUSLY DECIDES that the following studies shall be carried out and that the appropriate steps be taken to coordinate the work with the C.C.I.F. on the lines indicated below :

### 1. Questions for study by the C.C.I.F.

The overall transmission characteristics for the transmission of multi-channel telephone, broadcast programme, telegraph and television signals over land-line systems and over integrated systems including line and radio.

### 2. Questions for study by the C.C.I.R.

The studies referred to in this section should be carried out for the VHF (metric), UHF (decimetric) and SHF (centimetric) bands, and should include consideration of the transmission of telephone, broadcast programme, telegraph and television signals. These studies may include consideration of the following items :

* This Study Programme does not refer to any Question under study.

** Concerning Questions Nos. 29 and 41 see Doc. No. 423 of Geneva.

2.1 Transmission characteristics of radio systems ;

2.2 Radio propagation, fading, diversity reception, noise and interference ;

2.3 Considerations involved in choice of sites for radio stations ;

2.4 Modulation processes and methods of multiplexing ;
Consideration should be given to amplitude, frequency and pulse modulation and to frequency and time division systems ;

2.5 Radio equipment (transmitters, receivers, relays, aerials and transmission lines) ;

2.6 Methods of measurement on the radio system ;

**3. Questions for study by the C.C.I.F. with C.C.I.R. representatives.**

3.1 The equipment at the radio terminals to provide for connection to the land-line network.

3.2 The merits of the several possible systems of modulation and multiplexing in respect of the effective integration of line and radio systems ;

3.3 The addition to, and withdrawal of, channels from a relay system at intermediate stations ;

3.4 Transmission characteristics required for the transmission of multi-channel telephone, broadcast programme, and television signals ;

3.5 The provision of land-lines for the supervision and monitoring of radio systems ;

3.6 Monitoring and basic principles of maintenance and reliability of radio relay links integrated into the general network ;

3.7 Methods of measurement on overall line and radio systems.

**4. Questions for study by the C.C.I.R. with C.C.I.F. representatives.**

4.1 Supervisory and monitoring facilities on radio systems ;

4.2 The percentage of time during which the required transmission characteristics can be expected to be met for telephone, broadcast programme, telegraph and television signals.

*Note.* — In the above Study Programme an attempt has been made to outline the overall studies required, and while it is appreciated that these studies are a matter of some urgency it must be understood that in several respects the proposed studies are of the long-term type and that only with advances in the development of radio relay systems on waves of VHF (metric), UHF (decimetric) and SHF (centimetric) and with measurements of their performances will the necessary information become available.

# Questions and Study Programmes assigned to Study Group No. X

## QUESTION No. 23 (X)

## HIGH FREQUENCY BROADCASTING

### Directional Antenna Systems

(Stockholm, 1948)

*The reasons which justify the following question are given in the annex.*

It will be appropriate to organise the compilation of statistical measured results from 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 be studied :

What are the methods by which the formation of strong subsidiary lobes can be avoided, particularly when the directional antenna systems are fed asymmetrically to produce a slew of the main beam ?

### ANNEX

The characteristics of directional antenna systems used in broadcasting have been very completely studied from theoretical aspects, and a number of experimental investigations have been undertaken by various bodies on the actual measured performance *.

With a suitably designed antenna the power radiated in unwanted directions can be reduced to a small proportion of the power radiated in the wanted direction. An aerial system with 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.

* " The Measured Performance of Horizontal Dipole Transmitting Arrays ", by H. PAGE, *J.I.E.E.*, **92**, Part III, No. 18, June 1945.

*Radio Engineering*, by E.K. SANDEMAN, Chapman & Hall, page 674.

" The Empire Service Broadcasting Station at Daventry ", by L.W. HAYES and B.N. MACLARTY, *J.I.E.E.*, **85**, No. 513, September 1939.

" Aerial Characteristics ", by N. WELLS, *J.I.E.E.*, **89**, Part III, No. 6, June 1942.

*Restricted Range Sky Wave Transmission*, by J.E. HACKE Jr. and A.H. WAYNICK, Elec. Eng. Dept., Pennsylvania State College, P.A. U.S.A.

These abnormal signal strengths presumably result from a field which is a combination of a direct radiation in the given direction, and indirect radiation due to scattering of the main beam on reflection. Measurements of this phenomenon would clearly take a very considerable time, and could only be properly evaluated on a statistical basis. It appears possible, that the limitation to frequency sharing may be the scattering of the main beam of radiation.

It will, however, always be of utility to reduce the power radiated in unwanted directions and particularly in the subsidiary lobes of an antenna system.

Further study of this question is recommended, and in particular it is recommended that attention be given to the development of methods of avoiding the production of subsidiary radiation lobes under the conditions when a directional antenna is asymmetrically fed in order to produce a slew of the main lobe of radiation.

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## QUESTION No. 37 (X) *

## HIGH FREQUENCY BROADCASTING

### Justification for use of more than one frequency per programme

(Geneva, 1951)

The International High Frequency Broadcasting Conference, Mexico City,

CONSIDERING :

That it has not been possible to make a complete study of a number of questions mentioned in the Report of the Committee on Technical Principles and Standards (Doc. No. 635 **) ;

DRAWS THE ATTENTION of the C.C.I.R. to the technical data contained therein and REQUESTS the C.C.I.R. to undertake the further study of the following questions :

The technical conditions under which, because of the urgent need for economy in the use of frequencies for broadcasting, it would be possible to justify the use of more than one frequency for the transmission of one programme to one reception area. This study should be linked with a study of the question of an appropriate definition of " geometric reception area ".

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## STUDY PROGRAMME No. 71 (X) ***

## HIGH FREQUENCY BROADCASTING

### Justification for use of more than one frequency per programme

(Question No. 37 (X))

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

CONSIDERING :

*(a)* That there are technical conditions which would justify the use of more than one frequency for the transmission of one programme to one reception area ;

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* Study Programmes Nos. 71 (X) and 72 (X) arise from this Question.

** Of Mexico.

*** This Study Programme arises from Question No. 37 (X).

*(b)* That the conditions for the use of one or more frequencies for one reception area could possibly be determined by using an overall reliability factor, for instance, such as that suggested in Ann. B of Doc. No. 188 (London);

DECIDES that the following studies should be carried out:

**1.** The possibility of the use of an experimental method of using an overall reliability index under actual conditions of operation.

Administrations and operating agencies should collect necessary data for comparison with any of the existing methods used for selection of frequencies. The study should take into account and furnish information on:

— signal strength measured or reported according to the internationally adopted code;
— fading, noise, interference and overall merit estimated according to the internationally adopted method;
— type of transmitting aerial used, its electrical characteristics and polar diagram;
— power radiated;
— location of the measuring position relative to the area to be served;
— type of receiver and aerial used and their performance characteristics.

**2.** Methods of subjective tests, including those under practical listening conditions, and their correlation with objective measurements.

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## STUDY PROGRAMME No. 72 (X) *

## HIGH FREQUENCY BROADCASTING

### Use of synchronized transmitters

(Question No. 37 (X))

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

CONSIDERING:

That the information obtained under Study Programme No. 30 and embodied in Recommendation No. 137 is incomplete;

UNANIMOUSLY DECIDES that the following studies should be carried out:

To determine experimentally whether satisfactory reception can be obtained when two HF (decametric) broadcasting transmitters, carrying the same programme, are:

**1.** At the same site, driven by the same oscillator, and having reception areas that overlap and are at distances from the transmitters greater than 1500 km;

**2.** At different sites; in this case, the study should include reception at all distances in areas both overlapping and non-overlapping, and should cover conditions in which:

— the transmitters are synchronized as accurately as possible (methods of achieving this and of ensuring correct phasing should be taken into consideration);
— the difference between the frequencies of the two transmitters is constant and of the order of 5 to 20 c/s, the audio-frequency phasing being correct.

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* This Study Programme arises from Question No. 37 (X).

## QUESTION No. 39 (X) *

### HIGH FREQUENCY BROADCASTING

### Conditions for satisfactory reception

(Geneva, 1951)

The International High Frequency Broadcasting Conference, Mexico City,

CONSIDERING :

That it has not been possible to make a complete study of a number of questions mentioned in the *Report of the Committee on Technical Principles and Standards* (Doc. No. 635 **) ;

DRAWS THE ATTENTION of the C.C.I.R. to the technical data contained therein and REQUESTS the C.C.I.R. to undertake the further study of the following questions :

The technical and practical questions, such as the desirable modulation bandwidth, fading, and the various forms of distortion, related to the subjective aspects of quality of reception.

In making this study, particular attention should be given to the question of the corrections that should be made to take account of long and short term fading in determining :

*(a)* The average level of the signal necessary to ensure satisfactory reception in the presence of noise or other interference having a fixed level ;

*(b)* The average level of the signal necessary to ensure satisfactory reception in the presence of atmospheric noise ;

*(c)* The ratio required between the average levels of wanted and unwanted signals.

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## STUDY PROGRAMME No. 73 (X) ***

### HIGH FREQUENCY BROADCASTING

### Conditions for satisfactory reception

(Question No. 39 (X))

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

CONSIDERING :

*(a)* That the International High Frequency Broadcasting Conference, Mexico City, requested the C.C.I.R. to undertake further study of the technical and practical questions related to the subjective aspects of quality of reception, such as : the desirable modulation bandwidth, fading, and the various forms of distortion ;

*(b)* That it is desirable to establish a method of assessing the overall index of quality of the received signal, taking into account those factors that depend on the conditions of propagation and characteristics of listening, but disregarding factors depending on the quality of the transmitting and receiving equipment ;

* Study Programme No. 73 (X) arises from this Question.
** Of Mexico.
*** This Study Programme arises from Question No. 39 (X).

UNANIMOUSLY DECIDES that the following studies should be carried out:

1. The value that can be assigned to an acceptable ratio of:
   — signal to atmospheric noise,
   — signal to " noise from electrical equipment ",
   — signal to " interfering signals " ;

   indicating how the method of measurement of these factors takes into account subjective aspects of the problem and their variations with time ;
2. The values that can be assigned for making appropriate allowances for fading, taking into account depth of fading, frequency of fading and frequency selective fading and their statistical distribution, taking also into account subjective factors encountered in reception. The study should include the determination of the importance of such factors and their variation with time ;
3. The possibility of assigning values to the maximum tolerable group delay for any component of a received high-frequency signal, taking into account subjective factors, and the variation with time of such delays. The study should include the determination of the importance of such factors and their acceptable values ;
4. Effect of modulation depth on the distortion caused by fading or group delay and values that might be assigned to a desirable modulation depth to keep the distortion within tolerable limits ;
5. The usefulness of attempting to combine any of the above factors into a single index of quality of reception and the manner of specifying such an index (see London Doc. No. 185) ;
6. The possibility of establishing the relative importance of the factors in § 1, 2 and 3, so that, for example, excessive power is not used in an attempt to achieve an acceptable signal-to-noise ratio when the signal may already be unacceptable because of selective fading.

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## QUESTION No. 98 (X)

## H.F. (DECAMETRIC) BROADCASTING

### Modification of receivers for closer spacing between carrier frequencies

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

CONSIDERING :

*(a)* The urgent need to economise in the use of the radio spectrum ;

*(b)* The fact that in the present state of the broadcasting art it has been found necessary to conclude the study of Question No. 62 ;

DECIDES that the following questions should be studied :

1. What modifications would be necessary in the design of HF (decametric) broadcast receivers to permit reduced frequency spacing between double sideband transmissions without appreciably degrading the subjective quality of reception under practical conditions ?
2. How could such modifications be introduced into :
   — existing receivers ?
   — new receivers ?

*Note.* — If the results obtained from the study of this Question by Study Group No. X prove positive, the further detailed study of receiver design will be carried on in conjunction with Study Group No. II.

## QUESTION No. 99 (X)

## FREQUENCY MODULATION BROADCASTING IN THE VHF (METRIC) BAND

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

CONSIDERING :

*(a)* The increasing extent to which the VHF (metric) band is being used for frequency-modulation sound broadcasting ;

*(b)* That the degree of adjacent channel interference will be influenced by the maximum frequency deviation and the pre-emphasis characteristic used ;

*(c)* The importance of arriving at practical values for the co-channel and adjacent channel protection ratio required for such transmissions ;

UNANIMOUSLY DECIDES that the following questions should be studied :

**1.** What characteristics are currently used or are being considered for F.M. sound broadcasting in the VHF (metric) band ?

— for maximum frequency deviation ?
— for the pre-emphasis characteristic ?

**2.** What protection ratio is required for F.M. sound broadcasting in the VHF (metric) band ?

**3.** What values of field-strength are required for satisfactory reception of F.M. sound broadcasting in the VHF (metric) band ?

## QUESTION No. 100 (X)

## SOUND RECORDING ON FILM FOR THE INTERNATIONAL EXCHANGE OF TELEVISION PROGRAMMES

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

CONSIDERING :

*(a)* The increasing interest in the interchange of picture/sound recordings on film for television ;

*(b)* That methods and characteristics for the types of sound recording used for this purpose are not included in existing C.C.I.R. Recommendations or Questions ;

UNANIMOUSLY DECIDES that the following question should be studied :

What method or methods should be used for the sound recording of composite sound and vision programmes used for the international exchange of television programmes on film and to what technical characteristics should this method or these methods conform ?

# STUDY PROGRAMME No. 74 (X) *

## STANDARDS OF SOUND RECORDING FOR THE INTERNATIONAL EXCHANGE OF PROGRAMMES

(Question No. 42)

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

DECIDES that the following studies should be carried out :

**1.** Investigation of methods for measuring " wow " and " flutter " for both disc and magnetic tape recording and reproducing, and of the values which may be allowed.

Meanwhile, any quoted values of " wow " and " flutter " should be accompanied by a statement of the method of measurement used, together with a statement of any frequency weighting that has been used, and whether the values are peak, peak to peak, mean or r.m.s.

**2.** Further study of disc recording, and reproducing, styli.

**3.** Further investigation of methods of absolute measurement of the characteristics of the signal recorded on a magnetic tape in order to define and measure, over as wide a range of wavelengths on the tape as possible, the absolute level of a recorded signal independently of the particular magnetic properties of each type of tape.

To facilitate the practical application of standardization of magnetic recording, the members of the C.C.I.R. should carry out before the 1st July 1954, a systematic exchange of test tapes recorded according to the standards given in Recommendation No. 111 and communicate the results of these comparisons to the Director of the C.C.I.R. for earliest possible publication.

**4.** Further investigation of the technique of sound recording to extend and improve the recommendations already made.

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* This Study Programme replaces Study Programme No. 31. It does not refet to any Question under study.

# Questions and Study Programmes assigned to Study Group No. XI

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## STUDY PROGRAMME No. 32 (XI) *

## THE REQUIREMENTS FOR THE TRANSMISSION OF TELEVISION OVER LONG DISTANCES **

(Question No. 40)

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

CONSIDERING :

*(a)* That it is necessary to transmit television signals over long distances ;

*(b)* That the C.C.I.F. needs information upon which to plan circuits ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Determination (see Ann. II) of the values and tolerances for the following factors for the satisfactory transmission of television signals over long distances :

A. *Input and output impedance of the transmission circuit*
Value, whether balanced or unbalanced, tolerance.

B. *Polarity of signal*
Polarity and whether A.C. or D.C.

C. *Amplitude of signal*
Value from peak white to tip of synchronizing pulses.

D. *Picture signal to synchronizing signal ratio*
Value to be used for feeding into and out of transmission circuit.

E. *Non linearity*
The tolerable change of slope of the output-to-input amplitude characteristic.

F. *Stability of overall transmission circuit*
The tolerable change of overall gain at a reference frequency over :
*(a)* short periods, e.g. of 1 second,
*(b)* medium periods, e.g. of 1 hour
*(c)* long periods, e.g. of 1 month ;

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* This Study Programme does not refer to any Question under study.

** See draft Report, p. 268.

G. *Signal-to-noise ratio*

The tolerable signal-to-noise ratio for :

*(a)* random uniform noise,

*(b)* periodic noise,

*(c)* impulsive noise ;

In order to simplify the comparison of the results of the tests carried out in the various countries, it is suggested that the ratios should be quoted in db and that the ratio should be :

$$\frac{\text{peak-to-peak value of the picture signal}}{\text{peak-to-peak value of the noise}}$$

and the synchronizing signal should not be considered as being part of the picture signal. It should be understood that the ratio can be measured in other terms and a suitable correction factor applied ; in this case the correction factor should be stated, for example the crest factor in the case of random uniform noise ;

H. *Attenuation and phase characteristics*

The limits which can be allowed on :

*(a)* the attenuation frequency characteristic,

*(b)* the phase frequency characteristic,

*(c)* the transient response *.

## ANNEX I

### Proposals of the C.C.I.F. for the Transient Tests to be made on Television Systems

It is proposed that the following two types of recurrent pulses should be used :

*(a)* *A square wave* of fundamental frequency equal to the vision field-frequency, and of unity mark/space ratio, for the purpose of indicating the waveform distortion which corresponds to attenuation/frequency and phase/frequency distortions in the lower part of the effectively transmitted frequency range ;

*(b)* *A sine-squared (or raised sine) pulse*, of repetition frequency equal to the vision line-frequency. This pulse is intended to indicate attenuation and phase distortions in the upper part of the frequency range. Its half-amplitude width should be equal to one half of the period corresponding to the nominal upper cut-off frequency of the television system.

*Remark.* — The line and field synchronising signals may possibly be inserted in between two such pulses, if it is desired to use the same time bases in the cathode ray oscilloscopes used for these tests and in those employed for monitoring the television transmission.

## ANNEX II

### General Requirements for a 405 Line 3000 kc/s Video Band System

The figures in this Annex are given merely for information and do not represent a transmission specification.

A. *Input and output impedance of the transmission circuit*

75 ohms unbalanced and a return loss of not less than 30 db at any frequency between 10 kc/s and 3000 kc/s ;

* For the transient response study, attention is drawn to the proposals made by the C.C.I.F. and reproduced in Annex I.

B. *Polarity of signal*

The video signal for transmission to line has positive polarity ; i.e. its amplitude will increase in proportion to the brillance of the corresponding point of the picture. The D.C. component is not transmitted ;

C. *Signal amplitude*

About 1 volt peak-to-peak ;

D. *Picture signal to synchronizing signal ratio*

About 70/30 ;

E. *Non linearity*

For the complete signal from the tip of the synchronizing pulse to peak white, slope should not vary more than 0.9 to 1.1, relative to the ideal ;

F. *Stability of overall transmission circuit*

*(a)* ±0.3 db,
*(b)* ±0.5 db,
*(c)* ±2 db ;

G. *Signal-to-noise ratio*

*(a)* 45-50 db,
*(b)* 40-55 db, depending upon frequency,
*(c)* 35-40 db, if not more than one pulse in a 10 second period ;

H. *Attenuation and phase characteristics*

*(a)* flat to within ±1 db, and free from numerous and marked changes of slope from 20 c/s to 3000 kc/s,
*(b)* substantially linear and free from numerous and marked changes of slope ; variation of group delay between 200 kc/s and 3000 kc/s should not exceed a value of about 0.1 microsecond for a 100 kc/s interval,
*(c)* 0.16 microsecond for 10 to 90% *.

*Limits for overshoot and echoes* *

| Time after response has reached 50% ideal amplitude | Limits of rapid variation of response % of ideal amplitude |
|---|---|
| 0.2 to 0.5 microseconds | ± 4 |
| 0.5 to 1.0 microseconds | ± 1 |
| 1.0 microsecond or longer | ± 0.5 |

## QUESTION No. 64 (XI) **

## TELEVISION STANDARDS

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

CONSIDERING :

*(a)* That the interchange of television programmes between countries is desirable ;

*(b)* That the interchange of such programmes should be done in an economical manner ;

* Using a square waveform with a rise time of 0.1 microsecond.
** Study Programmes Nos. 33 (XI), 34 (XI), 35 (XI), 36 (XI) and 37 (XI) arise from this Question.

*(c)* That the economical interchange of television programmes would be facilitated by the adoption of agreed standards for certain characteristics of transmissions ;

*(d)* That technical standards should be coordinated, insofar as possible, to permit such interchange to facilitate the utilization of receiving equipment, and to minimize mutual interference between television services ;

*(e)* That the adoption of such standards will result in the most rapid expansion of the television service, by making more readily available a wider variety of programmes and, in addition, giving a reduction in programme costs ;

*(f)* That it is desirable that world-wide agreement be obtained on those standards which would permit interchange of programmes, both direct and recorded ;

*(g)* That the interchange of programmes will be effected by radio relay and cable links for direct programmes, and by film for recorded programmes. With interchange between different linguistic groups the sound channel characteristics are of secondary importance, and primary attention needs to be placed on the vision signal ;

*(h)* That the question of programme interchange is also linked with the desirable technical characteristics necessary to provide :

1. a satisfactory service in the home at reasonable cost,
2. a reasonable service in the home at minimum cost ;

*(i)* That in consideration of these problems account should be taken of the following factors :

1. the available bandwidth allocated to television is limited,
2. importance is to be attached principally to the cost of receivers rather than that of transmitting equipment,
3. the proposed standards should not preclude in due course the possibility of reception, by the addition of a suitable frequency converter, of the following :

   monochrome pictures on a " black and white " receiver of the transmissions from a " colour " transmitter,

   monochrome pictures on a " colour " receiver of transmissions from a " black and white " transmitter ;

*(j)* That the adoption of transmission standards on as wide a basis as possible will result in the most rapid expansion of the television service, in that it will facilitate the production of receivers at lower cost ;

*(k)* That a factor of prime importance in arriving at world standards is the problem of operating a television service in which the frame repetition rate is not integrally related to the power supply frequency ;

*(l)* That it is inevitable that there will be considerable channel sharing in the existing television bands, and therefore, in view of long distance propagation effects, it is desirable that the standards proposed should be such as to minimize interference between stations ;

RECOMMENDS :

That there be undertaken the study of, and publication of Recommendations on the technical factors which would assist in achieving :

— interchange of programmes on the widest possible scale,

— coordination of standards to permit the use of a receiver on transmissions differing in a minor degree.

The factors which appear of major importance are :

**1.** For the interchange of direct programmes :

*(a)* frame repetition rate ;

*(b)* frame interlacing ;

*(c)* number of lines ;

*(d)* aspect ratio.

**2.** For the interchange of recorded programmes :

*(a)* the programmes should be recorded in such a manner as to make them capable of being reproduced on standard 35 or 16 mm motion picture sound equipment ;

*(b)* the effects of pattern interference due to transmission of a film on a television system having a different number of lines from that on which the film was recorded ;

Among other factors which should be studied to permit interchange of receivers are the following :

*(a)* polarity of modulation for vision signal ;

*(b)* distribution of channels in the available spectrum space ;

*(c)* relative frequencies of sound and vision carriers and the positioning of these carriers and associated sidebands within the channel ;

*(d)* type of vision transmission, e.g. double sideband, single sideband, etc. ;

*(e)* type of modulation of sound channel ;

*(f)* form of synchronizing signal ;

*(g)* non-integral relationship between frame repetition rate and power frequency.

*Notes :*

1. Several of the points *(a)* to *(f)* are referred to in question No. 25.
2. It is realised that due to certain technical factors such as different power supply frequencies and different frequency allocations to television in the various regions, world-wide standardisation may be delayed for a considerable time, but in view of the rapid development expected for television in the next few years urgent attention should be given to the solution of the problems on as wide a geographical basis as possible, with a view to the early formulation of agreed standards.
3. It is recommended that in respect of the characteristics of international circuits for television programme transmissions the C.C.I.F. should coordinate its work with that of the C.C.I.R.

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## STUDY PROGRAMME No. 33 (XI) *

## TELEVISION FIELD FREQUENCY

(Question No. 64 (XI))

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

CONSIDERING :

*(a)* That two different values of field frequency are in use in various television systems ;

*(b)* That it is desirable to determine the lower limit of field frequency for satisfactory performance, in relation to the properties of long-persistence phosphors ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

**1.** The relation between maximum brightness and field frequency for absence of flicker, for field frequencies of the order of 50 to 60 fields per second, taking into account the decay time of the different colours ;

* This Study Programme arises from Question No. 64 (XI).

2. In considering the perceptible and tolerable conditions of flicker, particular attention should be given to the effect of:
   - — a wide range of ambient illuminations falling at various angles of incidence upon the viewing screen;
   - — the use of neutral density filters over this range of ambient illuminations;
   - — the use of long-persistence phosphors providing nominally white light;

3. In the event of these phosphors comprising components of different colours, the effect of colour fringing should be investigated and, in any event, the subjective sharpness of images in motion should be determined.

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## STUDY PROGRAMME No. 34 (XI) *

## PICTURE AND SOUND MODULATION

(Question No. 64 (XI))

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

UNANIMOUSLY DECIDES that the following study shall be carried out:

The respective advantages and disadvantages of positive and negative picture modulation and of amplitude and frequency sound modulation taking into account the following points:

— effect of noise on picture;
— effect of noise on synchronisation;
— automatic gain control;
— inter-carrier sound reception.

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## STUDY PROGRAMME No. 35 (XI) *

## REDUCTION OF THE BANDWIDTH FOR TELEVISION

(Question No. 64 (XI))

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

CONSIDERING:

*(a)* The great technical or financial difficulty encountered in obtaining the required bandwidth in transmiting television signals, both in broadcasting and in transmission over intermediate links;

*(b)* The potential value of various techniques, such as dot-interlace or rapid-transition (" crispening ") circuits in improving the resolution of television images without increasing the bandwidth;

*(c)* The possibility of reducing flicker by the use of long-persistence phosphors;

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* This Study Programme arises from Question No. 64 (XI).

UNANIMOUSLY DECIDES that the following studies shall be carried out :

1. The methods which can be used to reduce the bandwidth occupied by the transmission and broadcasting of a television picture without reducing the picture quality, especially its sharpness ;

2. The possibility of transmitting a standard signal from point to point by converting that signal into an intermediate signal (e.g., the dot-interlace type of signal), the bandwidth of the intermediate signal being smaller than that of the terminal signal ;

3. The effect of the field frequency and the use of long-persistence phosphors on inter-dot flicker and inter-dot crawl.

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## STUDY PROGRAMME No. 36 (XI) *

## CONVERSION OF A TELEVISION SIGNAL FROM ONE STANDARD TO ANOTHER

(Question No. 64 (XI))

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

UNANIMOUSLY DECIDES that the following studies shall be carried out :

Methods of converting a television signal from one standard to another :

— when the field frequency is identical in the two standards, but the number of lines differs ;
— when both field frequency and number of lines are different in the two standards.

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## STUDY PROGRAMME No. 37 (XI) *

## BLACK-AND-WHITE AND COLOUR TELEVISION

(Question No. 64 (XI))

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

CONSIDERING :

*(a)* That many countries will introduce a colour system after having an established black-and-white system in operation ;

*(b)* That a number of alternative systems of colour television have been proposed ;

*(c)* That factors which will influence the choice of a colour system will include :

— picture quality,
— the cost of receivers and possibly converters,
— bandwidth ;

* This Study Programme arises from Question No. 64 (XI).

*(d)* That where a black-and-white system is already in operation the foregoing considerations will be affected by the need to avoid making existing receivers obsolete, and to avoid increasing unduly the programme costs ;

UNANIMOUSLY DECIDES that the following study shall be carried out :

Ascertain what methods can be used to achieve the best combination of black-and-white and of colour television systems, from the point of view of picture quality, programme costs and the cost of receivers or converters.

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## QUESTION No. 65 (XI) *

## ASSESSMENT OF THE QUALITY OF TELEVISION PICTURES

(Question No. 64 (XI))

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

CONSIDERING :

*(a)* That appreciable discrepancies may exist between different experts' assessments of the quality of the pictures given by the television systems now in use or proposed ;

*(b)* That these discrepancies are to be attributed to the fact that it is usually impossible to obtain simultaneous viewing of the pictures under comparison, to possible variations in quality between apparatus nominally using the same system and to alterations that may occur with time in the characteristics of the equipment used ;

*(c)* That consequently it would be eminently desirable to have some standard method of gauging or even measuring television picture quality which would permit objective comparison of the results obtained in different places and would serve as a guide to the efficient and uniform working of the equipment in service ;

UNANIMOUSLY DECIDES that the following question shall be studied :

The development of standardized methods of accurately and objectively assessing the quality of the pictures given by television systems.

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## STUDY PROGRAMME No. 75 (XI) **

## MEASUREMENT OF THE QUALITY OF TELEVISION PICTURES

(Question No. 65 (XI))

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

CONSIDERING :

*(a)* That a sufficient amount of information is not yet available to give a final answer to Question No. 65 ;

*(b)* That as a means of increasing the available information it would be of considerable advantage to know what methods are currently adopted by the various countries for the purpose of assessing the quality of television pictures ;

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* Study Programme No. 75 (XI) arises from this Question.

** This Study Programme arises from Question No. 65 (XI).

UNANIMOUSLY DECIDES that the following studies should be carried out :

1. A study of the influence on the quality of a television picture of the various relevant factors, such as :

— resolution,
— contrast range,
— contrast law,
— geometry,
— colour response,
— colour fidelity (where applicable) ;

including such defects as :

— noise (random, impulsive, periodic),
— shading,
— streaking,
— overshoots,
— excessive memory,
— colour " cross-talk " where applicable ;
— colour mis-registration where applicable ;
— colour break-up where applicable ;

2. A study of the methods by which the influence of such factors on the quality of a television picture may be measured objectively.

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## QUESTION No. 66 (XI)

## TELEVISION RECORDING

(Question No. 64 (XI))

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

CONSIDERING :

The desirability of perfecting methods for recording television signals for subsequent reproduction ;

UNANIMOUSLY DECIDES that the following question shall be studied :

What are the desirable characteristics of equipment for recording television signals and the corresponding sound ?

*Note.* — It is recommended that the line-broadening (spot-wobble) technique should be investigated with a view to minimizing the line structure when recording on film.

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## QUESTION No. 67 (XI)

## RATIO OF THE WANTED TO THE UNWANTED SIGNAL IN TELEVISION

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

CONSIDERING :

*(a)* That the satisfactory operation of a television service renders it necessary to specify the maximum field-strength of interfering or unwanted signals which can be tolerated without unduly affecting the reception of television programmes ;

*(b)* That the frequency bands allotted for television broadcasting services are so limited that it is essential for more than one transmitting station to operate in the same channel ;

*(c)* That, on the frequencies used for television, radio waves in certain cases travel to distances far in excess of the normal service area ;

*(d)* That the varying propagation of such waves, under different conditions, is the major factor in determining the geographical distances separating television transmitting stations to avoid mutual interference ;

DECIDES that the following question shall be studied :

The determination of the minimum admissible ratio of wanted to unwanted signal, when two television transmitters are operating :

— in the same channel,
— in adjacent channels,
— with dissimilar but partially overlapping bandwidths.

*Note.* — The answer to the question should state the hours of service it is desired to protect, and the proportion of the programme time for which the stated degree of interference must be avoided. Separate answers may be required for various grades of service area, each of which should be defined in terms of the field strength of the wanted signal.

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## QUESTION No. 68 (XI) *

## RESOLVING POWER AND DIFFERENTIAL SENSITIVITY OF THE HUMAN EYE

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

CONSIDERING :

*(a)* That those responsible for a regular television service must have an exact knowledge of the physiological properties of the human eye, the demands of which they are endeavouring to satisfy ;

*(b)* That, among these properties, the most important are the resolving power by means of which regular fields and fine details are perceived, the differential sensitivity to brilliance and the differential sensitivity to a change in the shade of the same colour ;

*(c)* That the results of the numerous physiological studies already undertaken on this subject cannot, a priori, be assumed to be equally valid for the observation of television pictures, because of the special nature of such pictures ;

UNANIMOUSLY DECIDES that the following question shall be studied :

What is the value for the human eye of :

— the resolving power expressed in minutes of angle,
— the differential sensitivity to brilliance,
— the differential sensitivity to a change of shade in the same colour,

for values of contrast, brilliance, colour and distance normally encountered when observing photographs and television pictures ?

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* Study Programme No. 76 (XI) arises from this Question.

## STUDY PROGRAMME No. 76 (XI) *

## RESOLVING POWER AND DIFFERENTIAL SENSITIVITY OF THE HUMAN EYE

(Question No. 68 (XI))

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

CONSIDERING :

*(a)* That a sufficient amount of information is not yet available to provide a complete and useful answer to Question No. 68 (XI) ;

*(b)* That the resolution threshold of the human eye has been measured under specified conditions for test objects in black-and-white as well as in colour ;

*(c)* That, taking into account the special nature of television pictures, it is not yet certain over what range of conditions the measured values apply to television ;

*(d)* That the subjective sharpness of a picture may not be uniquely related to resolution ;

*(e)* That measurements must be made to provide information concerning the differential sensitivity of the human eye under conditions relevant to television viewing ;

UNANIMOUSLY DECIDES that the following studies should be carried out :

**1.** A study of the extent to which data on the resolving power of the human eye can be usefully employed in deciding upon the necessary requirements of a television picture.

**2.** A study of suitable methods of measuring the differential sensitivity of the human eye to a spatial and temporal change of brilliance and to a spatial and temporal change of shade of the same colour under conditions normally encountered when viewing television pictures.

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## QUESTION No. 101 (XI)

## ADVANTAGES TO BE OBTAINED FROM CONSIDERATION OF POLARIZATION IN THE PLANNING OF BROADCASTING SERVICES IN THE VHF (METRIC) AND UHF (DECIMETRIC) BANDS

**(Television and sound)**

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

CONSIDERING :

*(a)* That a receiving aerial designed for reception of horizontally polarized waves will in general discriminate against vertically polarized waves and vice-versa ;

*(b)* That in the planning of broadcasting services in the VHF (metric) and UHF (decimetric) bands (television and sound) there may be occasions when it is important to take full advantage of this discrimination ;

* This Study Programme arises from Question No. 68 (XI).

(c) That tropospherically propagated waves at VHF (metric) and UHF (decimetric) particularly at great distances from the transmitter or after propagation over irregular terrain or re-radiating structures, may no longer retain their original polarization ;

UNANIMOUSLY DECIDES that the following question should be studied :

In planning television and sound broadcasting services in the VHF (metric) and UHF (decimetric) bands, what allowance, if any, can be made for the decrease in the minimum tolerable ratio of wanted to unwanted field strengths at the receiving aerial when one transmission uses vertical polarization and the other horizontal polarization, as compared with the case in which both transmissions use the same polarization. All the pertinent factors, including the following, should be taken into account :

— frequency,
— type of terrain,
— type and height of transmitting and receiving aerials,
— distances between transmitters and receivers,
— variations in tropospheric propagation conditions with time and climate.

# Questions and Study Programmes assigned to Study Group No. XII

## QUESTION No. 102 (XII) *

## INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING **

(Stockholm, 1948 — Geneva, 1951 — London, 1953)

The C.C.I.R.,

CONSIDERING :

Recommendation No. 8 of the International Radio Conference (Atlantic City, 1947) and the studies pursued at the Vth, VIth and VIIth Plenary Assemblies of the C.C.I.R. ;

DECIDES that the following question should be studied :

1. What is the minimum permissible protection ratio for broadcasting signals, when measured at the output of a receiver fitted with a filter having an audio frequency cut-off of 5 kc/s and to what minimum value of the wanted field should this ratio be maintained ? ***

### ANNEX

1. The permissible frequency tolerances for broadcasting stations would permit variations in frequency of broadcasting stations up to about 250 c/s until 1953 and up to about 150 c/s after that date. The corresponding tolerances for fixed stations would allow maximum frequency changes of about 500 c/s and 150 c/s respectively. The tolerances permitted to mobile stations would be initially about 2500 c/s and later about 1000 c/s. These tolerances are very large in relation to the possible spacing between broadcast carrier frequencies in the shared bands and, for a consideration of the problem, it is therefore necessary to assume a frequency spacing between such broadcast carriers.

2. If it is assumed that the stations of other services will be located only on frequencies centrally located between the broadcast carriers, and if it is further assumed that the broadcast carrier frequencies will be separated by not more than 10 kc/s, then the maximum frequency spacing between a fixed or mobile station and a broadcasting station would be 5 kc/s. From this consideration it will be seen that the permissible tolerances represent a very large proportion of the spectrum space between a broadcasting carrier and a sharing service carrier and that

* This Question replaces Question No. 4. Study Programmes No. 38 (XII) and 77 (XII) refer to this Question.

** The reasons justifying this question will be found in the annex.

*** Practical consideration of the frequency separation of adjacent channels requires the use of an audio frequency cut-off of 5 kc/s in the measurement, in preference to 6.4 kc/s, appropriate corrections being applied, if considered necessary, to correspond to an audio frequency cut-off of 6.4 kc/s.

the possible heterodyne frequency will be such that a receiver giving adequate broadcasting reception would not eliminate it. At the present time, it would seem very difficult greatly to increase the stability of mobile transmitters and it is therefore suggested that a case exists for recommending to administrations in tropical zones that the minimum number of mobile stations should be assigned in the shared bands. For fixed stations it would seem that since by 1953 fixed stations in these bands will have to maintain the same frequency tolerances as broadcasting stations, as specified in App. 3 to the Atlantic City Radio Regulations, that 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 entirely to eliminate mobile stations from the shared bands in the tropical zones, then it might be recommended that every effort should be made to eliminate the use of mobile stations using A3 type of transmission in these bands. As in other services, fully adequate telephony quality is maintained with a reduced audio frequency bandwidth, it might be recommended that the audio bandwidth transmitted by mobile stations when operating in the tropical zones should be limited to 3000 c/s.

4. In the Vth Plenary Assembly of the C.C.I.R. Doc. No. 110 *, 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 required for an adequate signal on a broadcast 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 the C.C.I.R. Doc. No. 110 *.

5. A recommendation might be made in accordance with Art. 13, § 3 of the Atlantic City Radio Regulations that the use of directive antennae be followed in all possible cases in order to reduce mutual interference between services.

6. As is pointed out in the Vth Plenary Assembly of the C.C.I.R. Doc. No. 21 * on page 5, the permissible interference level for ordinary telephony with noise reducers is +32 db and for ordinary telephony without noise reducers +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 the C.C.I.R. Doc. No. 110 *. It is considered, therefore, that it is not justifiable to specify limits of interference more stringent than that imposed by a protection ratio between wanted service and interference of 40 db. 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 band-pass of 6.4 kc/s is less than 40 db below the desired signal level within the defined service area of the broadcasting station.

7. To minimize the effect of interference, a recommendation might be made that spurious radiation, key-clicks, sideband spread and other forms of interference producing radiation should be kept to a minimum in all transmitters used in tropical zones on the shared bands.

8. While it is considered that, under normal conditions, a modulation band of 6400 c/s is desirable in the interests of quality, it is recognised that, in the tropical zones, the levels of atmospheric noise in the tropical broadcasting bands and the possibilities of interference due to the difficulty of accommodating all stations in these bands are such that a modulation band of 5000 c/s may have to be accepted.

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* Of Stockholm.

# STUDY PROGRAMME No. 38 (XII) *

## SHORT DISTANCE HIGH FREQUENCY BROADCASTING IN THE TROPICAL ZONE (TROPICAL BROADCASTING) **

(Questions Nos. 4 and 27 — Recommendations Nos. 47 and 84)

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

CONSIDERING :

*(a)* That there is little data on the determination of the power required for a given grade of tropical broadcasting service ;

*(b)* That it would be helpful in the planning of new tropical broadcasting services to have more reliable data ;

*(c)* That more reliable data would be helpful in the organization of services in the bands shared with tropical broadcasting (See Art. 9, No. 244 of the Radio Regulations, 1947) ;

UNANIMOUSLY DECIDES that the following studies shall be carried out :

**1.** The experimental determination of the signal-to-noise ratio and the signal-to-interference ratio that should be adopted as representative of an acceptable tropical broadcasting service. The observations should be made with aerials and receivers that are representative of those normally used for tropical broadcasting reception. The reports on this study should indicate as fully as possible the conditions of measurement, the characteristics of the equipment and the methods used, so that the results may be correlated with those of other observers. In particular, the bandwidth of the receiver employed should be given.

**2.** A practical examination of whether the provisional power limits in Recommendation No. 84 are satisfactory or whether they should be changed to give an acceptable tropical broadcasting service. The reports on this study should include all the relevant factors concerned and, in particular, information on the following points :

— the area and the day, month and year for which observations are made ;
— the distance from the transmitter to the point of observation ;
— the carrier power of the transmitter and its depth of modulation ;
— the details of the transmitting and receiving aerials ;
— the characteristics of the receiver used ;

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

* This Study Programme arises from Question No. 102 (XII).
** As this service is defined in the considerations of Question No. 27 reproduced in Annex.

equipment. Particular attention should be paid to those frequency bands allocated to broadcasting below 16 Mc/s which could be used for broadcasting in the tropical zone and to the normal broadcast listening hours (approximately 0600 to 2400 local time).

**4.** The study of the field strength produced by tropical broadcast transmitters.

Reports should, if possible, be evaluated on a statistical basis, and should give, in particular, the following information :

— method of measurement employed ;
— method of analysis ;
— location of transmitter ;
— distance from transmitter at which measurements are made ;
— radiated carrier power ;
— polar diagram of transmitting aerial (or equivalent data) ;
— period during which measurements are made ;
— radio frequency used.

It might be convenient to carry out this study in conjunction with those outlined in § **1** and **2** above. If it is possible to make measurements of the field strength produced outside the service area of the tropical broadcasting station, the resulting information would also be helpful in determining the degree of interference produced to other services which share frequency bands with tropical broadcasting.

ANNEX

Considerations of Question No. 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 No. 77 (XII) *

## INTERFERENCE IN THE BANDS SHARED WITH BROADCASTING

(Recommendation No. 50 ** — Question No. 4 ***)

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

CONSIDERING :

*(a)* That Recommendation No. 50** does not provide a final answer to Question No. 4***, § 6, 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 ;

* This Study Programme arises from Question No. 102 (XII).

** This Recommendation has become Recommendation No. 138.

*** This Question has become Question No. 102 (XII).

(*b*) That sufficient data is at present not available in order to answer C.C.I.R. Question No. 4, § 6 ;

DECIDES that the following study should be carried out :

**1.** Experimental determination of a 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 equal to the sum of the permissible frequency tolerances of the tropical broadcasting services and the other services, as laid down in the Atlantic City Radio Regulations (App. 3).

1.2 Measurements should be carried out at the output of a receiver fitted with a filter having an audio frequency cut off of 5 kc/s *.

**2.** Experimental determination of the minimum field strength to which a protection ratio as defined in § **1** above should relate, taking into account the nature, intensity and distribution of noise levels in different parts of the tropical zone.

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## QUESTION No. 69 (XII)

## BEST METHOD FOR CALCULATING THE FIELD STRENGTH PRODUCED BY A TROPICAL BROADCASTING TRANSMITTER **

(Question No. 27)

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

CONSIDERING :

(*a*) The importance of being able to calculate the power required to produce a given field strength under given conditions for tropical broadcasting ;

(*b*) That reliable methods of calculation would assist the planning of new tropical broadcast services and the allotment of frequencies to services in the tropical zone ;

(*c*) That, for the tropical zone, little basic data exists concerning ionospheric absorption and its dependence upon the time of day, the season and the sunspot cycle ;

(*d*) That the relation of ionospheric absorption at oblique incidence to that at vertical incidence is not yet fully understood ;

(*e*) That there is no internationally agreed method of examining the nature of the multiple reflections and of calculating the resultant field strength occurring at the intermediate distances involved in tropical broadcasting ;

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* If considered necessary, appropriate correction to the results of measurements could be applied to correspond to an audio frequency cut off of 6.4 kc/s.

** As this service is defined in the considerations of Question No. 27 reproduced in Annex to Study Programme No. 38 (XII), page 366.

DECIDES that the following question shall be studied :

1. What is the best method that may be used for calculating the field strength produced at the earth's surface by the indirect ray, at various distances between 0 and 800 km and between 800 and about 4000 km, by a transmitter situated in the " tropical zone " (as defined in App. 16 of the Radio Regulations, 1947) radiating a power of 1 kW from a half wavelength dipole situated $^1/_4$ and $^7/_{16}$ths of a wavelength above ground respectively, and operating in any of the frequency bands used for tropical broadcasting (i.e. the " shared bands " listed in Art. 9, No. 244, and the general broadcasting bands below 15 450 kc/s listed in the Table of Frequency Allocations, Art. 5, Radio Regulations, 1947), at any season, and for sunspot numbers of about 5, 60 and 125, respectively, during normal listening hours (approximately 0600 to 2400 local time) ?

1.1 What is the probable error in the proposed method of calculation ?

1.2 What basic data should be used in the proposed method of calculation ?

1.3 What is the probable statistical distribution of the fading of the signal ?

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## QUESTION No. 71 (XII)

## DETERMINATION OF NOISE LEVEL FOR TROPICAL BROADCASTING *

(Question No. 27)

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

CONSIDERING :

*(a)* That the determination of the transmitter power required depends upon the value of the signal-to-noise ratio regarded as being the minimum for an acceptable broadcasting service in the tropical zone and it is necessary to have as precise a knowledge as possible of atmospheric noise levels in this zone ;

*(b)* That present knowledge of the atmospheric noise levels in the tropical zone and for tropical broadcasting frequencies has no agreed scientific significance and is insufficient for practical use ;

*(c)* That the methods at present in use for the measurement of atmospheric noise are of a subjective nature, likely to be misinterpreted if applied to broadcasting :

*(d)* That it, therefore, seems desirable to develop an objective method of measuring atmospheric noise levels for possible application to broadcasting, in particular to tropical broadcasting, and to relate such a method to the subjective effect on the listener ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. What parameters, characterising atmospheric noise would determine the response of a broadcast receiver to atmospheric noise and the effect of such noise on the grade of reception ?

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* As this service is defined in the considerations of Question No. 27 reproduced in Annex to Study Programme No. 38 (XII), page 366.

**2.** Subsequent to the question in § **1**, what characteristics of noise can be measured directly, what range of values should be covered by the measuring apparatus and how are these values related to the above mentioned parameters ?

**3.** What is the best method of atmospheric noise measurement for the specific conditions of tropical broadcasting, with particular regard to type of service, geographical zones, frequencies used and climatic conditions ?

3.1 Can a suitable objective method of noise measurement be developed in the near future ?

3.2 Can the subjective method, at present in use, be modified to obtain as soon as possible an approximate result for the type of service concerned ?

3.3 Is it possible and under what conditions, to correlate the results obtained by a subjective method of noise measurement and those which may be expected from the application of an objective method ?

**4.** How should the recommended measuring apparatus be designed for the specific conditions imposed by tropical climates and how should it be used to obtain results which can be correlated for the various parts of the tropical zone ?

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QUESTION No. 103 (XII)

## DESIGN OF TRANSMITTING AERIALS FOR TROPICAL BROADCASTING

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

CONSIDERING :

*(a)* That the average radius of a tropical broadcasting service area is about 800 km ;

*(b)* The necessity for further study of the design of transmitting aerials for tropical broadcasting for the purpose of concentrating the energy transmitted by reflection from the ionosphere as much as possible into the desired service area ;

*(c)* That the use of efficient aerials for transmission 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. 244 and 253 of the Radio Regulations (Atlantic City, 1947) ;

*(e)* The provisions of No. 374 of the Radio Regulations (Atlantic City, 1947) ;

UNANIMOUSLY DECIDES that the following question should be studied :

**1.** What factors determine the best position for the transmitting aerials, with respect to the area to be served, in order to concentrate the energy received by reflection from the ionosphere within the desired service area and to 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 aerials for tropical broadcasting, in order 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 ?

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# Questions and Study Programmes assigned to Study Group No. XIII

## QUESTION No. 104 (XIII) *

## IDENTIFICATION OF RADIO STATIONS

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

CONSIDERING :

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

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

*(c)* That the Atlantic City Radio Regulations (Chap. V, Art. 13, Section V, § 10) set forth requirements for transmissions of radio call signs, and state that each radio station provided with a call sign from the international series must, unless the Atlantic City Radio Regulations provide otherwise, transmit this call sign during the course of their transmission as frequently as is practicable and reasonable ;

*(d)* That certain types of radio stations are exempted from the necessity of having an international call sign, for example, stations which are easily identified by other means and whose signals of identification, or characteristics of emission, are published in international documents ;

*(e)* That the problem of accomplishing identification of multi-channel telephone and telegraph transmission, except for single-sideband systems, is particularly difficult without the use of costly special apparatus ;

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

DECIDES that the following question should be studied :

The possibility of ensuring the convenient identification of stations utilising multi-channel synchronised systems, high speed machine systems, facsimile systems, or other special systems of transmission, in the most effective manner without the necessity of interrupting the transmissions of such stations, or of increasing the transmissions of such stations, or of increasing the bandwidth of the emissions. The increased costs to the monitoring and transmitting stations which would be incurred by the recommended solutions should be borne in mind.

*Note.* — This study should be carried out urgently.

* This Question replaces Question No. 17. Study Programme No. 78 (XIII) refers to this Question.

# STUDY PROGRAMME No. 78 (XIII) *

## IDENTIFICATION OF RADIO STATIONS

(Question No. 17)

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

CONSIDERING :

*(a)* That Recommendation No. 132 does not cover all aspects of the problem ;

*(b)* That the development and general use of satisfactory means for the identification of radio stations is required as a matter of urgency by international monitoring stations, and would be of assistance to the I.F.R.B. ;

*(c)* The desirability of not interrupting the flow of traffic, nor appreciably increasing the bandwidth of the emissions, nor increasing the costs which would be incurred by the monitoring and transmitting stations as a result of adopting the recommended solutions ;

DECIDES that the following studies should be carried out :

**1.** The range of levels between which the amplitude of the reduced carrier or other pilot frequency of a single or independent sideband transmission should be keyed in accordance with § 3.2 of Recommendation No. 132.

**2.** The problem of applying low-power amplitude modulation or developing other methods of superimposing an acceptable identification signal on frequency-shift transmissions ;

**3.** The problem of transmitting call signals in multi-channel synchronous, and other special telegraph systems, not using single-sideband transmission.

*Notes:*

1. These studies are to be carried out urgently.
2. Doc. No. 56, London, is of interest in the study of this problem.

## STUDY PROGRAMME No. 79 (V) *

# TROPOSPHERIC PROPAGATION ACROSS MOUNTAIN RIDGES

(Question No. 85 (V))

The C.C.I.R.,

CONSIDERING :

*(a)* That Question No. 85 (V) para. 3 seeks information on, amongst other things, the influence on the time distribution of the values of path attenuation, caused by the type of terrain over which the signal passes ;

*(b)* That it would be of interest to study a particular type of path crossing a high mountain ridge so situated that it is in optical range of both the transmitter and the receiver ;

*(c)* That there is already some evidence that signals reaching the receiver over such a ridge may, under certain conditions, be stronger than they would be in the absence of the ridge, and that, at the same time, they may show a reduced range of fading ;

DECIDES, that the following studies should be carried out :

1. The time distribution of the values of path attenuation (as mentioned in Sections 2 and 3 of Question No. 85 (V)) for a signal path as described in *(b)* above ;
2. The manner in which the reduction in path attenuation depends upon the directional and other properties (e.g. height) of the transmitting and receiving antenna systems.

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* This Study Programme arises from Question No. 85 (V).

## STUDY PROGRAMME No. 80 (XI) *

## STANDARDS FOR VIDEO COLOUR TELEVISION SIGNALS **

The C.C.I.R., *(Approved at Brussels, 1955)*

DECIDES that the following studies should be carried out :

1. The preferred colorimetric parameters for representing the television picture ;
2. The scanning standards that can be recommended, e.g. sequential (field, line, dot), simultaneous or mixed ;
3. Comparison of the various methods of coding and decoding the colour picture information ;
4. The minimum acceptable bandwidths for the signal components corresponding to these parameters.

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## STUDY PROGRAMME No. 81 (XI) ***

## STANDARDS FOR RADIATED COLOUR TELEVISION SIGNALS

The C.C.I.R., *(Approved at Brussels, 1955)*

DECIDES that the following study should be carried out :

Comparison of different colour television systems in terms of the criteria listed in the text of Question No. 118 (XI). These comparisons should pay particular attention to colour television systems which are either in operation, or which are or have been the subject of experiment.

*(c)* That, consequently, an exact definition of gain—a most important factor in television transmission—is required ;

*(d)* That, moreover, to avoid misunderstanding an agreement for an international method of measurement is desirable ;

DECIDES that the following question should be studied :

1. How can the gain of a television transmission circuit, between the video input and video output terminals, be defined ?

   *Notes:*

   *(a)* Different gain values are obtained according to whether low, medium or high frequency sine waves, or a television signal containing a fairly wide frequency spectrum are used for the measurement. In addition the terminating impedances, used during the measurement, should be defined ;

   *(b)* Since most of the energy of a television signal is concentrated in the low and medium frequencies, a gain definition taking special account of the lower portion of the video frequency spectrum should be sought ;

2. What method of measuring can be recommended for determining the gain of a television transmission circuit ?

## QUESTION No. 105 (XIII)

## MARINE IDENTIFICATION DEVICE

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

CONSIDERING :

*(a)* That a commercially adaptable, rapid and positive all-weather marine identification device might be expected to aid in the reduction of marine casualties and facilitate the safe movement of vessels in congested narrow waters ;

* This Study Programme replaces Study Programme No. 26, and arises from Question No. 104 (XIII).

*(b)* That there is need for information on the nature and extent of identification intelligence required to facilitate short-distance contact between vessels for safety, navigation and communication purposes ;

UNANIMOUSLY DECIDES that the following question should be studied :

1. Can a response on a radar display be automatically identified by a distinctive characteristic in such a way that it can be associated with the appropriate telegraph or telephone transmission ?

2. Are any existing systems capable of offering the desired facility ?

3. What economic and practical factors, including provisions required to make the device effective, affect the problem ?

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## QUESTION No. 106 (XIII)

## BEARING AND POSITION CLASSIFICATION FOR HF (DECAMETRIC) AND VHF (METRIC) DIRECTION-FINDING

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

CONSIDERING :

*(a)* That the procedure specified in App. 15, Section 6 (estimate of accuracy) of the Atlantic City Radio Regulations deals exclusively with direction-finding bearings and positions in the medium frequency range ;

*(b)* That the standards of classification and accuracy of bearings used for medium frequencies may not apply to other frequency ranges ;

DECIDES that the following question should be studied :

1. What accuracies of determination of bearing and position are probable for direction-finding on HF (decametric) and VHF (metric), under various conditions and over various distances ?

2. How should the accuracies be classified, assuming that not more than three classes of accuracy are adopted, and what factors should be taken into account by an operator in assessing the class of bearing or position ?

3. What revision of Recommendation No. 72 is required, if any, concerning the duration of the signal to be transmitted for HF (decametric) direction-finding ?

4. What type of signal should be sent for the purpose of VHF (metric) direction-finding and what is the minimum time for which it should be sent ?

*Note.* — In studying this Question the work that has been done or is being done by I.C.A.O. should be taken into account.

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## QUESTION No. 107 (XIII)

## TECHNICAL CHARACTERISTICS OF FREQUENCY MODULATED VHF (DECAMETRIC) MARITIME EQUIPMENTS

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

CONSIDERING :

*(a)* That the Atlantic City Radio Regulations, Chap. XIII, Art. 34, Nos. 830 to 834, stipulate the general procedure for the world-wide use by the maritime mobile service of the frequency 156.8 Mc/s and neighbouring frequencies ;

*(b)* That according to Regulation No. 833 " the use of frequency modulation is compulsory in Region 2 and its use is strongly recommended in other regions " ;

*(c)* That it would be desirable to reach agreement upon the essential technical characteristics for frequency modulated VHF (metric) radio telephone equipments for use in international maritime services in order to expedite the international use of such equipments ;

*(d)* That the use of VHF (metric) equipments on board ships could reduce the use of MF (hectometric) maritime bands and thus tend to reduce congestion in these heavily loaded bands ;

*(e)* That the early introduction of the world-wide use of equipments operating on the frequency of 156.8 Mc/s and neighbouring frequencies could contribute to the safety of life at sea, for example, in facilitating short range communication between vessels equipped with radar ;

DECIDES that the following question should be studied :

What are the technical conditions determining the values of the following parameters for frequency modulated VHF (metric) radio telephone equipments for the international maritime mobile services operating on the frequency of 156.8 Mc/s and neighbouring frequencies :

— frequency deviation ;
— plane of polarization ;
— protection ratio for common-channel operation ;
— minimum frequency separation between adjacent channels ;
— minimum frequency channel separation for duplex working ;
— means for selective calling ;
— such other parameters as may be necessary ?

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## QUESTION No. 108 (XIII)

## TESTING OF 500 kc/s RADIOTELEGRAPH AUTO-ALARM RECEIVING EQUIPMENT ON BOARD SHIPS

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

CONSIDERING :

*(a)* That in Chap. IV, Regulation 7 of the International Convention for the Safety of Life at Sea (London 1948), it is laid down that on board all ships to be fitted with radiotelegraph equipment under the Convention, continuous watch shall be maintained when the ship is at sea, on the radiotelegraph distress frequency of 500 kc/s ;

*(b)* That in most ships such radio watch will be maintained, for certain periods, by means of auto-alarm apparatus ;

*(c)* That specifications for radiotelegraph installations on board ships are laid down in Chap. IV, Regulation 10 of the said Convention ;

*(d)* That a specification for radiotelegraph auto-alarms is laid down in Chap. IV, Regulation 11 of the said Convention ;

*(e)* That, in practice, administrations may have difficulty in ensuring that the whole auto-alarm receiving installation (including the aerial) is always in good working order on board ships at sea ;

*(f)* That, in particular, there is some doubt whether the technical measures prescribed in the said Convention are sufficient to ensure that the auto-alarm receiving installation (including the aerial) is in good working order ;

UNANIMOUSLY DECIDES that the following question should be studied :

What measures, in addition to those prescribed in the Convention for Safety of Life at Sea (London 1948), can be recommended to ensure that radiotelegraph auto-alarm receiving installations (including the aerial) are always in good working order on board ships at sea ?

# Questions and Study Programmes assigned to Study Group No. XIV

## QUESTION No. 72 (XIV)

## DECIMAL CLASSIFICATION

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

CONSIDERING :

That it is advisable to standardize the classification of documents and articles on radio so as to facilitate librarians' work and make it possible for anyone to find the documents required without delay ;

UNANIMOUSLY DECIDES that the following question shall be studied :

The classification of documents and articles on radio by means of a decimal index, to be made, if possible, within the framework of the universal decimal classification (U.D.C.) and in agreement with the International Federation of Documentation.

# QUESTIONS SUBMITTED BY THE C.C.I.R. TO THE C.C.I.T. AND THE C.C.I.F.

## QUESTION No. 109

### THE USE OF RADIO CIRCUITS IN ASSOCIATION WITH 5-UNIT START-STOP TELEGRAPH APPARATUS

**Signals other than those specified in the International Telegraph Alphabet No. 2**

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

CONSIDERING :

The problems raised in Question No. 83 (III) ;

UNANIMOUSLY DECIDES that the following question should be submitted to the C.C.I.T. :

Is it necessary in radio circuits used in association with 5-unit start-stop apparatus to provide for the transmission of signals other than those specified by the International Telegraph Alphabet No. 2, e.g. in the International Telex Service. If so, what are the characteristics and tolerances of such signals, which are required to be transmitted over radio circuits ?

## QUESTION No. 110

### THE USE OF RADIO CIRCUITS IN ASSOCIATION WITH 5-UNIT START-STOP TELEGRAPH APPARATUS

**Maximum tolerable signal error rates**

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

CONSIDERING :

*(a)* That the transmission difficulties present on certain types of radio circuits make some errors in telegraph transmission inevitable ;

*(b)* That the type of telegraph system selected for a particular use over a radio circuit may depend upon the proportion of errors that can be tolerated ;

UNANIMOUSLY DECIDES that the following question should be submitted to the C.C.I.T. :

What are the maximum tolerable signal error rates for various types of telegraph service ?

## QUESTION No. 111

## SIGNAL AMPLITUDES IN INDIVIDUAL CHANNELS OF MULTI-CHANNEL TELEPHONE SYSTEMS

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

CONSIDERING :

*(a)* That in multi-channel telephone systems for line or radio transmission, interference due to harmonics and intermodulation is an important limitation ;

*(b)* That mathematical studies of various aspects of this interference have been published ;

*(c)* That data on the statistical distribution of signal amplitudes with time are an essential basis for such studies ;

*(d)* That studies of such data have been published in various countries ;

UNANIMOUSLY DECIDES that the following question should be submitted to the C.C.I.F. :

What is the statistical distribution with time of the instantaneous signal amplitudes on individual telephone channels which can be regarded for practical purposes as representative of normal operating conditions at a point of zero reference level ?

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## QUESTION No. 112

## INFORMATION REQUIRED ON THE TRANSMISSION CHARACTERISTICS OF LINES SYSTEMS FOR USE IN THE DESIGN OF WIDE-BAND RADIO RELAY SYSTEMS

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

UNANIMOUSLY DECIDES that the following question should be submitted to the C.C.I.F. :

1. For what percentage of the time are the specified transmission characteristics attained in existing line systems ;

2. To what extent are these characteristics affected by the transmission of either multi-channel V.F. telegraph traffic or V.F. signalling tones over these line systems ?

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## QUESTION No. 113 (IX)

### PROCEDURE FOR INTERNATIONAL CONNECTIONS BETWEEN RADIO-RELAY SYSTEMS WITH DIFFERENT CHARACTERISTICS

The C.C.I.R., (Approved by correspondence, 1954.)

CONSIDERING :

*(a)* That international connections between radio-relay systems with different characteristics will necessitate special arrangements at the junction ;

*(b)* That the C.C.I.F. Study Group 3 proposes to the XVIIth Plenary Assembly of the C.C.I.F. that, where different types of coaxial system are directly connected across a frontier, each Administration concerned should accept on the receive side the conditions of transmission normal to the incoming system ;

DECIDES that the following question should be studied :

Whether, where different types of radio-relay systems are directly connected across a frontier, each Administration concerned should accept on the receive side the conditions of transmission normal to the incoming system.

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## QUESTION No. 114 (IX)

### FREQUENCY TOLERANCES FOR TRANSMITTERS USED IN WIDE-BAND RADIO-RELAY SYSTEMS OPERATING AT FREQUENCIES ABOVE ABOUT 30 Mc/s

The C.C.I.R., (Approved by correspondence, 1954)

CONSIDERING :

*(a)* That the frequency stability of the transmitters used in wide-band radio-relay systems, on the one hand, needs to be of a relatively high order, so as to avoid waste of the radio-frequency spectrum and, on the other hand, must not be so high as to require uneconomical designs of equipment ;

*(b)* That the frequency stability must be sufficient to avoid difficulty in the reception of such transmissions, particularly when international connections at radio-frequency are involved ;

*(c)* That relatively close frequency tolerances may be desirable in order to avoid interference between different radio-relay systems ;

*(d)* That the International Radio Regulations, Atlantic City, 1947, Appendix 3, p. 227, state that the tolerances applicable to transmitters operating in the frequency range 500 to 10,500 Mc/s are 0.75% and that no closer tolerances can be specified in the Regulations until C.C.I.R. opinion is available ;

*(e)* That this tolerance is much wider than corresponds to the needs referred to under *(a)*, *(b)* and *(c)* above and is, in any case, substantially wider than present techniques permit ;

DECIDES that the following question should be studied :

What are the frequency tolerances that it is practicable and desirable to adopt at the present time for the transmitters of wide-band radio-relay systems operating at frequencies above about 30 Mc/s, particularly above 500 Mc/s ?

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## QUESTION No. 115 (IX)

## METHODS FOR THE COMPUTATION OF INTERMODULATION NOISE DUE TO NON-LINEARITY IN RADIO-RELAY SYSTEMS

The C.C.I.R., (Approved by correspondence, 1954)

CONSIDERING :

*(a)* That intermodulation noise may at times constitute an appreciable part of the total noise in an audio channel at the output of a radio-relay system ;

*(b)* That precise methods for computing intermodulation noise due to non-linearity in radio-relay systems have not yet been developed, particularly as regards the combination of the noise contributions from individual radio-relay stations with the object of determining the overall intermodulation noise ;

DECIDES that the following question should be studied :

1. In what way is it possible to compute precisely the intermodulation noise due to the circuit elements at each station ?
2. How may the contributions from the circuit elements at each individual station, and for the stations as a whole, be combined as precisely as possible to determine the overall noise at the output of the system ?

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# QUESTION No. 116 (IX) *

## OPERATIONAL CARACTERISTICS OF LONG DISTANCE RADIO RELAY SYSTEMS

(Provisional text)

Having regard to the agreed diversity of types of equipment which already exist on radio relay systems, in order to enable (for example), Administrations or operating agencies to make arrangements to select the most suitable systems for inclusion in the International Telecommunication Network, and in order that the C.C.I.R. in its studies of standardization of radio relay systems may define adequately the general characteristics of long distance systems, it is necessary to set up a preliminary classification of the various types of radio relay system in the manner shown below.

(1) *Radio relay systems using individual voice channels:*

- Number of channels.
- Methods of use, numbers of channels for telephone transmission, one or more channels of telegraph transmission.
- Upper limit of frequencies transmitted by system.
- Maximum spacing for relay stations measured under topographical conditions and typical propagation.
- Maximum permissible number of modulation and demodulation stages.
- Various types of interconnection achievable at relay stations.

(2) *Radio relay systems capable of transmitting wide bandwidth modulation. (Video circuit or carrier frequency channel on the radio system.)*

- Number of channels on a radio relay system (a channel is a video circuit after modulation to radio frequency or to intermediate frequency).
- Video circuit, corresponding to each channel and the nature of the signals which can be transmitted over this channel.
- Upper limit of the modulation frequency accepted by the system.
- Maximum spacing of relay stations, for example, under typical propagation and topographical conditions.
- Maximum permissible number of modulation and demodulation stages.
- The various types and arrangements of interconnection that can be achieved at a relay station.

Each Administration should study the necessary terminology and make proposals for choice of standard terms corresponding to the more important characteristics used in radio relay systems, for example :

- " channel ", " video circuit ", etc.

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* Question No. 15 of C.C.I.F. Study Group No. 5, and to be studied in collaboration with that Study Group.

## QUESTION No. 117 (XI) *

## SINGLE VALUE OF SIGNAL-TO-NOISE RATIO FOR DIFFERENT TELEVISION SYSTEMS

(Provisional text)

Will it be possible to recommend a single value of the signal/noise ratio for all types of erratic, continuous " noise " and for all television systems, by using a curve which gives a " weighting " to each narrow frequency band in the noise spectrum ?

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* Question No. 14 of C.C.I.F. Study Group No. 3, and to be studied in collaboration with that Study Group.

# QUESTION No. 118 (XI) *

## COLOUR TELEVISION STANDARDS

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING :

*(a)* That Question No. 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 :

*(a)* Satisfactory picture (colour and monochrome) and sound quality ;

*(b)* Economical use of bandwidth ;

*(c)* Reliable receivers of reasonable cost ;

*(d)* Operation of studio, transmitting and relaying equipment ;

*(e)* Susceptibility to interference ;

*(f)* Compatibilities ** ;

*(g)* Frequency planning ;

*(h)* International exchange of programmes ;

*(i)* Scope for development ;

*(j)* The differences between Bands I and III as compared with Bands IV and V.

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* Study Programmes Nos. 80 (XI) and 81 (XI) arise from this Question.

** 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 the bandwidths of the colour and monochrome systems may be the same or different.

QUESTION No. 119 (XI) ****

## RATIO OF THE WANTED TO THE UNWANTED SIGNAL IN TELEVISION

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING :

*(a)* That the satisfactory operation of a television service renders it necessary to specify the maximum field-strength of interfering or unwanted signals which can be tolerated without unduly affecting the reception of television programmes ;

* This Study Programme arises from Question No. 118 (XI).

** The answers to Question No. 68 with studies and experience of colour television systems should be taken into account.

*** This Study Programme arises from Question No. 118 (XI).

**** The text of this Question differs from that of Question No. 67 (XI) only in the wording of the "*Note*".

*(b)* That the frequency bands allotted for television broadcasting services are so limited that it is essential for more than one transmitting station to operate in the same channel ;

*(c)* That, on the frequencies used for television, radio waves in certain cases travel to distances far in excess of the normal service area ;

*(d)* That the varying propagation of such waves, under different conditions, is the major factor in determining the geographical distances separating television transmitting stations to avoid mutual interference ;

DECIDES that the following question should be studied :

The determination of the minimum admissible ratio of wanted to unwanted signal, when two television transmitters are operating :

— in the same channel,

— in adjacent channels,

— with dissimilar but partially overlapping bandwidths.

*Note.* — The reply to the question should give the protection ratios required when the transmitters are both radiating monochrome signals, both radiating 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, and the proportion of the programme time for which the stated degree of interference must be avoided. Separate answers may be required for various grades of service.

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## QUESTION No. 120 (XI)

## EXCHANGE OF TELEVISION PROGRAMMES

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING :

*(a)* That it is desirable to exchange television programmes between countries,

*(b)* That a variety of television standards is in use ;

DECIDES that the following question should be studied :

What methods can be used to enable television programmes to be exchanged between countries :

1. When the nominal field frequencies are the same, but the numbers of lines are different, or vice-versa ;
2. When the nominal field frequencies as well as 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 synchronising 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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## QUESTION No. 121 (XI) *

## THE TRANSMISSION OF MONOCHROME AND COLOUR TELEVISION SIGNALS OVER LONG DISTANCES

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING :

*(a)* That all the information required by the C.C.I.R. and the C.C.I.F. 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 of 2500 km length for the presentation of the results of studies, as proposed by the C.C.I.F. 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 in order 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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## QUESTION No. 122 (XI)

## THE GAIN OF A TELEVISION TRANSMISSION CIRCUIT

The C.C.I.R., *(Approved at Brussels, 1955)*

CONSIDERING :

*(a)* That C.C.I.F. 3rd Study Group in cooperation with the C.C.I.R., O.I.R. and E.B.U. has submitted an urgent question (Question No. 13) for study in 1955-1957, concerning the definition of attenuation for television transmission circuits, and the measurement methods applicable thereto ;

*(b)* That the gain of television transmission circuits must be maintained so as to remain as constant as possible (see Study Programme No. 32, § F) ;

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* Study Programme No. 32 (XI) arises from this Question.

# ALLOCATION OF REPORTS, RESOLUTIONS, QUESTIONS AND STUDY PROGRAMMES TO THE STUDY GROUPS OF THE C.C.I.R.

*Note.* — In this list, in conformity with the instructions of the VIIth Plenary Assembly, the Questions are followed by the relevant Study Programmes. The Study Programmes which are not derived from any Question at present under study are marked with an asterisk.

## STUDY GROUP No. I
(Transmitters)

*Chairman:* Dr. Ernst METZLER (Switzerland)
*Vice-Chairman:* Colonel Jean LOCHARD (France)

| | |
|---|---|
| Report No. 16 | Telegraphic distortion |
| Report No. 17 | Harmonics and parasitic emissions |
| Report No. 18 | Frequency stabilisation of transmitters |
| Question No. 1 (I) | Revision of Atlantic City Recommendation No. 4 |
| Study Programme No. 2 (I) | Harmonics and parasitic emissions |
| Study Programme No. 3 (I) | Frequency stabilisation of transmitters |
| Study Programme No. 39 (I) | Bandwidth of emissions |
| Study Programme No. 40 (I) | Methods of measuring emitted spectra in actual traffic |
| Question No. 18 (I) | Telegraphic distortion |
| Question No. 20 (I) | Frequency shift keying |
| Study Programme No. 41 (I) | Frequency shift keying |
| Question No. 74 (I) | Arrangement of channels in multi-channel telegraph systems for long-range radio circuits operating on frequencies below about 30 Mc/s |
| Question No. 75 (I) | Limitation of unwanted radiation from industrial installations |

## STUDY GROUP No. II
(Receivers)

*Chairman:* Mr. Pierre DAVID (France)
*Vice-Chairman:* Mr. P. ABADIE (France)

| | |
|---|---|
| Question No. 76 (II) | Sensitivity and noise factor |
| Question No. 77 (II) | Frequency stability of receivers |
| Question No. 78 (II) | Choice of intermediate frequency and protection against undesired responses of super-heterodyne receivers |
| Question No. 79 (II) | The responses of radio receivers to quasi-impulsive interference |
| Question No. 80 (II) | Undesired emissions from receivers |
| *Study Programme No. 42 (II) | Selectivity of receivers |
| *Study Programme No. 43 (II) | Protection against keyed interfering signals |

## STUDY GROUP No. III

(Complete radio systems employed by the different services)

*Chairman:* Dr. H.C.A. van DUUREN (Netherlands)
*Vice-Chairman:* Mr. J. SMALE (United Kingdom)

| | |
|---|---|
| Report No. 19 | Voice frequency telegraphy on radio circuits |
| Question No. 3 (III) | Revision of Atlantic City Recommendation No. 4 |
| Study Programme No. 44 (III) | Effect of interference and noise on quality of service in the presence of fading |
| Study Programme No. 45 (III) | Bandwidths and signal-to-noise ratios in complete systems |
| Question No. 43 (III) | Voice frequency telegraphy on radio circuits |
| Study Programme No. 46 (III) | Voice frequency telegraphy on radio circuits |
| Question No. 44 (III) | Communication theory |
| Study Programme No. 47 (III) | Communication theory |
| Question No. 81 (III) | Directivity of antennae at great distances |
| Study Programme No. 48 (III) | Improvement obtainable from the use of directional antennae |
| Question No. 82 (III) | Interference effects of atmospheric noise on radio reception |
| Study Programme No. 49 (III) | Interference effects of atmospheric noise on radio reception |
| Question No. 83 (III) | The use of radio circuits in association with 5-unit start-stop telegraph apparatus |
| Study Programme No. 50 (III) | The use of radio circuits in association with 5-unit start-stop telegraph apparatus |
| Question No. 84 (III) | Determination of the maximum interference levels tolerable in complete systems |

## STUDY GROUP No. IV

(Ground wave propagation)

*Chairman:* Professor L. SACCO (Italy)
*Vice-Chairman:* Mr. G. MILLINGTON (United Kingdom)

| | |
|---|---|
| Report No. 3 | Review of publications on propagation (ground-wave) |
| Report No. 20 | Temporal variation of ground-wave field strengths |
| Report No. 21 | Ground-wave propagation over irregular terrain |
| Resolution No. 10 | Extension of the C.C.I.R. propagation curves below 300 kc/s |
| Resolution No. 11 | Publication of ground-wave propagation curves between 30 and 300 Mc/s |
| Question No. 6 (IV) | Ground-wave propagation |
| Study Programme No. 51 (IV) | Effects of tropospheric refraction on frequencies below 10 Mc/s |
| Study Programme No. 52 (IV) | Temporal variation of ground-wave field strengths |
| Study Programme No. 53 (IV) | Ground-wave propagation over mixed paths |
| Study Programme No. 54 (IV) | Ground-wave propagation over irregular terrain |

## STUDY GROUP No. V

(Tropospheric propagation)

*Chairman:* Dr. R.L. SMITH-ROSE (United Kingdom)
*Vice-Chairman:* Mr. E.W. ALLEN (United States)

| | |
|---|---|
| Report No. 4 | Methods of measuring field strength |
| Report No. 5 | Measurement of field strength (respective merits of the two main types of equipment now in use) |

| | |
|---|---|
| Report No. 22 | Field-strength measurements (merits of a standard noise generator as the source of the locally-generated signal) |
| Question No. 85 (V) | Propagation data required for wide band radio systems |
| Question No. 86 (V) | The measurement of field strength in the neighbourhood of obstacles |
| *Study Programme No. 19 (V) | Measurement of field strength of radio signals |
| *Study Programme No. 55 (V) | Tropospheric propagation curves for distances well beyond the horizon |
| *Study Programme No. 56 (V) | Tropospheric wave propagation |
| *Study Programme No. 57 (V) | Investigation of multipath transmission through the troposphere |
| Study Programme No. 79 (V) | Tropospheric propagation across mountain ridges |

STUDY GROUP No. VI

(Ionospheric propagation)

*Chairman:* Dr. J.H. DELLINGER (United States)

*Vice-Chairman:* Dr. NEWBERN SMITH (United States)

| | |
|---|---|
| Report No. 7 | Long distance propagation of waves of 30 to 300 Mc/s by way of ionization in the E and F regions of the ionosphere |
| Report No. 9 | Interference to radio reception at sea due to atmospheric causes |
| Report No. 23 | Practical uses and reliability of ionospheric propagation data |
| Report No. 24 | Questions submitted by the I.F.R.B. |
| Report No. 25 | Choice of a basic index for ionospheric propagation |
| Report No. 26 | Exchange of information for the preparation of short-term forecasts and the transmission of ionospheric disturbance warnings |
| Report No. 27 | Fading of high frequency and medium frequency signals propagated by the ionosphere |
| Report No. 28 | Centralizing agencies for the rapid exchange of information on propagation |
| Resolution No. 12 | Usage and meaning of MUF |
| Resolution No. 13 | Preparation of short-term forecasts of ionospheric disturbances |
| Resolution No. 14 | Investigation of circularly polarized emitted waves propagated via the ionosphere |
| *Study Programme No. 58 (VI) | Choice of a basic solar index for ionospheric propagation |
| *Study Programme No. 59 (VI) | Identification of precursors indicative of short-term variations of ionospheric propagation conditions |
| *Study Programme No. 60 (VI) | Basic prediction information for ionospheric propagation |
| *Study Programme No. 61 (VI) | Non-linear effects in the ionosphere |
| *Study Programme No. 62 (VI) | Use of special modulation on the standard frequency transmissions for assessing the reliability of propagation forecasts |
| *Study Programme No. 63 (VI) | Radio propagation at frequencies below 1500 kc/s |
| *Study Programme No. 64 (VI) | Ionospheric propagation of waves in the band 30 to 300 Mc/s |
| *Study Programme No. 65 (VI) | Measurement of atmospheric radio noise |
| *Study Programme No. 66 (VI) | Study of fading |
| *Study Programme No. 67 (VI) | Pulse transmission tests at oblique incidence |

## STUDY GROUP No. VII

(Radio time signals and standard frequencies)

*Chairman:* Mr. B. Decaux (France)
*Vice-Chairman:* Professor M. Boella (Italy)

| | |
|---|---|
| Report No. 29 | Standard frequency transmissions and time signals |
| Question No. 87 (VII) | Standard frequency transmissions and time signals |
| Study Programme No. 68 (VII) | Standard frequency transmissions and time signals |

## STUDY GROUP No. VIII

(International monitoring)

*Chairman:* Mr. A.H. Cannon (Australia)
*Vice-Chairman:* Mr. J. Campbell (Australia)

| | |
|---|---|
| Question No. 88 (VIII) | Automatic monitoring of the radio frequency spectrum |
| Question No. 89 (VIII) | Frequency measurements above 50 Mc/s by monitoring stations |
| *Study Programme No. 69 (VIII) | Accuracy of field strength measurements by monitoring stations |
| *Study Programme No. 70 (VIII) | Spectrum measurement by monitoring stations |

## STUDY GROUP No. IX

(General technical questions)

*Chairman:* Mr. H. Stanesby (United Kingdom)
*Vice-Chairman:* Mr. G. Pedersen (Denmark)

| | |
|---|---|
| Report No. 30 | The use of radio circuits in association with 5-unit start-stop telegraph apparatus |
| Report No. 31 | Wide-band radio systems operating in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands |
| Resolution No. 15 | Standardisation of facsimile apparatus for use on combined radio and metallic circuits |
| Question No. 90 (IX) | International wide-band radio relay systems operating on frequencies above about 30 Mc/s : Interconnection of multiplex systems |
| Question No. 91 (IX) | International wide-band radio relay systems operating on frequencies above about 30 Mc/s : Transmission of telephony and television on the same system |
| Question No. 92 (IX) | Standardization of multi-channel radiotelephone systems using time division multiplex and operating on frequencies above about 30 Mc/s |
| Question No. 93 (IX) | Standardization of multi-channel radio systems using frequency division multiplex and operating on frequencies above about 30 Mc/s |
| Question No. 94 (IX) | Facsimile transmission of documentary matter over combined radio and metallic circuits |
| Question No. 95 (IX) | Transmission of half-tone pictures over radio circuits Fa |
| Question No. 96 (IX) | Maintenance procedure for wide-band radio systems |
| Question No. 97 (IX) | Hypothetical reference circuit for wide-band radio systems |
| *Study Programme No. 28 (IX) | Wide-band radio systems operating in the VHF (metric), UHF (decimetric) and SHF (centimetric) bands |
| Question No. 113 (IX) | Procedure for international connections between radio-relay systems with different characteristics |
| Question No. 114 (IX) | Frequency tolerances for transmitters used in wide-band radio-relay systems operating at frequencies above about 30 Mc/s |
| Question No. 115 (IX) | Methods for the computation of intermodulation noise due to non-linearity in radio-relay systems |
| Question No, 116 (IX) | Operational characteristics of long distance radio relay systems |

## STUDY GROUP No. X

(Broadcasting including questions relating to single sideband)

*Chairman:* Mr. Neal Mc NAUGHTEN (United States)
*Vice-Chairman:* Mr. A. Prose WALKER (United States)

| | |
|---|---|
| Report No. 13 | The minimum number of frequencies necessary for the transmission of a high frequency broadcasting programme |
| Report No. 14 | High frequency broadcasting reception |
| Report No. 32 | High frequency broadcasting, directional antenna systems |
| Report No. 33 | Questions Nos. 14 and 15 of the C.C.I.F. |
| Resolution No. 16 | Standards of sound recording for the international exchange of programmes (cine type spools) |
| Resolution No. 17 | The use of the 26 Mc/s broadcasting band |
| Question No. 23 (X) | High frequency broadcasting, directional antenna systems |
| Question No. 37 (X) | High frequency broadcasting, justification for use of more than one frequency per programme |
| Study Programme No. 71 (X) | High frequency broadcasting, justification for use of more than one frequency per programme |
| Study Programme No. 72 (X) | High frequency broadcasting, use of synchronized transmitters |
| Question No. 39 (X) | High frequency broadcasting, conditions for satisfactory reception |
| Study Programme No. 73 (X) | High frequency broadcasting, conditions for satisfactory reception |
| Question No. 98 (X) | High frequency broadcasting, modification of receivers for closer spacing between carrier frequencies |
| Question No. 99 (X) | Frequency modulation broadcasting in the VHF (metric) band |
| Question No. 100 (X) | Sound recording on films for the international exchange of television programmes |
| *Study Programme No. 74 (X) | Standards of sound recording for the international exchange of programmes |

## STUDY GROUP No XI

(Television including questions relating to single sideband)

*Chairman:* Mr. Erik ESPING (Sweden)
*Vice-Chairman:* Mr. G. HANSEN (Belgium)

| | |
|---|---|
| Report No. 34 | Ratio of the wanted to the unwanted signal in television |
| Report No. 35 | Television systems |
| *Study Programme No. 32 (XI) | The requirements for the transmission of television over long distances |
| Question No. 64 (XI) | Television standards |
| Study Programme No. 33 (XI) | Television field frequency |
| Study Programme No. 34 (XI) | Picture and sound modulation |
| Study Programme No. 35 (XI) | Reduction of the bandwidth for television |
| Study Programme No. 36 (XI) | Conversion of a television signal from one standard to another |
| Study Programme No. 37 (XI) | Black-and-white and colour television |
| Question No. 65 (XI) | Assessment of the quality of television pictures |
| Study Programme No. 75 (XI) | Measurement of the quality of television pictures |
| Question No. 66 (XI) | Television recording |

| | |
|---|---|
| Question No. 67 (XI) | Ratio of the wanted to the unwanted signal in television |
| Question No. 68 (XI) | Resolving power and differential sensitivity of the human eye |
| Study Programme No. 76 (XI) | Resolving power and differential sensitivity of the human eye |
| Question No. 101 (XI) | Advantages to be obtained from consideration of polarization in the planning of broadcasting services in the VHF (metric) and UHF (decimetric) bands (television and sound) |
| Question No. 117 (XI) | Single value of signal-to-noise ratio for different television systems |
| Question No. 118 (XI) | Colour television standards |
| Question No. 119 (XI) | Ratio of the wanted to the unwanted signal in television |
| Question No. 120 (XI) | Exchange of television programmes |
| Question No. 121 (XI) | The transmission of monochrome and colour television signals over long distances |
| Question No. 122 (XI) | The gain of a television transmission circuit |

## STUDY GROUP No. XII
(Tropical broadcasting)

*Chairman:* Mr. B.V. Balica (India)
*Vice-Chairman:* Dr. M.B. Sarwate (India)

| | |
|---|---|
| Report No. 36 | Design of aerials for tropical broadcasting |
| Question No. 102 (XII) | Interference in the bands shared with broadcasting |
| Study Programme No. 38 (XII) | Short distance high frequency broadcasting in the tropical zone (tropical broadcasting) |
| Study Programme No. 77 (XII) | Interference in the bands shared with broadcasting |
| Question No. 69 (XII) | Best method for calculating the field strength produced by a tropical broadcasting transmitter |
| Question No. 71 (XII) | Determination of noise level for tropical broadcasting |
| Question No. 103 (XII) | Design of transmitting aerials for tropical broadcasting |

## STUDY GROUP No. XIII
(Operation questions depending principally on technical considerations)

*Chairman:* Mr. J.D.H. van der Toorn (Netherlands)
*Vice-Chairman:* Mr. J. Söberg (Norway)

| | |
|---|---|
| Resolution No. 18 | Publication of service codes in use in the international telegraph service |
| Resolution No. 19 | Identification of radio stations |
| Question No. 104 (XIII) | Identification of radio stations |
| Study Programme No. 78 (XIII) | Identification of radio stations |
| Question No. 105 (XIII) | Marine identification device |
| Question No. 106 (XIII) | Bearing and position classification for HF (decametric) and VHF (metric) direction-finding |
| Question No. 107 (XIII) | Technical characteristics of frequency modulated VHF (metric) maritime equipments |
| Question No. 108 (XIII) | Testing of 500 kc/s radiotelegraph auto-alarm receiving equipment on board ships |

## STUDY GROUP No. XIV
(Vocabulary)

*Chairman:* Professor Tullio Gorio (Italy)
*Vice-Chairman:* Mr. R. Villeneuve (France)

| | |
|---|---|
| Report No. 37 | Decimal classification |
| Resolution No. 5 | Means of expression (definitions, vocabulary, graphical and letter symbols) |
| Question No. 72 (XIV) | Decimal classification |

## QUESTIONS SUBMITTED TO OTHER CONSULTATIVE COMMITTEES

(Art. 7, § 2, International Telecommunication Convention, Buenos Aires, 1952)

(a) *Submitted to the C.C.I.T.*

| | |
|---|---|
| Question No. 109 | The use of radio circuits in association with 5-unit start-stop telegraph apparatus : Signals other than those specified by the International Telegraph Alphabet No. 2 |
| Question No. 110 | The use of radio circuits in association with 5-unit start-stop telegraph apparatus : The maximum tolerable signal error rates |

(b) *Submitted to the C.C.I.F.*

| | |
|---|---|
| Question No. 111 | Signal amplitudes in individual channels of multi-channel telephone systems |
| Question No. 112 | Information required on the transmission characteristics of line systems for use in the design of wide band radio relay systems |

# VARIOUS ORGANISATIONS MENTIONED IN THIS VOLUME

The name of each organisation in this list is followed by the reference numbers of the texts in which the organisation is mentioned.

The numbers of the texts most closely connected with the organisation are shown in *italics*.

Bureau International de l'Heure (B.I.H.)
Recommendation No. *122*.

International Telegraph Consultative Committee (C.C.I.T.)
Recommendations Nos. 92, 93, 127, 144.
Reports Nos. 16, *19*, 37.
Resolutions Nos. *15*, *18*.
Questions Nos. *18 (I)*, *43 (III)*, *76 (II)*, *94 (IX)*, *109*, *110*.
Study Programmes Nos. 28 (IX), 46 (III).

International Telephone Consultative Committee (C.C.I.F.)
Recommendations Nos. 40, 75, 77, 87, 91, 127, 144.
Reports Nos. *31*, *33*, 37.
Questions Nos. 64 (XI), 97 (IX), *111*, *112*.
Study Programmes Nos. *28 (IX)*, 32 (XI), 45 (III).

International Frequency Registration Board (I.F.R.B.)
Recommendations No. 19, 20.
Rapport No. *24*.
Resolutions Nos. *10*, 19.
Study Programmes Nos. 63 (VI), 78 (XIII).

International Radio Maritime Committee (I.R.M.C.)
Question No. 78 (II).

Special International Committee of Radio Interference (C.I.S.P.R.)
Recommendations Nos. *27*, *131*.
Questions Nos. *75 (I)*, *79 (II)*, *80 (II)*, *84 (III)*.

International Electrotechnical Commission (I.E.C.)
Recommendations Nos. 27, 131, 143, 144.
Question No. 76 (II).

Joint Study Group C.C.I.T.-C.C.I.R.
Recommendation No. 127.
Resolution No. *15*.
Question No. *94 (IX)*.

International Federation of Documentation (F.I.D.)
Report No. 37.
Question No. 72 (XIV).

International Civil Aviation Organization (I.C.A.O.)
Question No. 106 (XIII).

World Meteorological Organization (W.M.O.)
Recommendation No. *121*.
Study Programmes Nos. *56 (V)*, *65 (VI)*.

European Broadcasting Union (E.B.U.)
Question No. 78 (II).

International Scientific Radio Union (U.R.S.I.)
Recommendations Nos. *59*, *107*, *115*, *120*, *122*.
Reports Nos. 4, 7, 26.
Resolutions Nos. *12*, *14*.
Questions Nos. *79 (II)*, 80 (II), *85 (V)*.
Study Programmes Nos. *47 (III)*, *56 (V)*, *58 (VI)*, *59 (VI)*, *60 (VI)*, *61 (VI)*, *63 (VI)*, *65 (VI)*, 66 (VI), 67 (VI).

# ALPHABETICAL INDEX

In this list each of the texts relating to a subject is given in numerical order preceded by one of the following abbreviations:

Rec. for a Recommendation
Rep. for a Report
Rès. for a Resolution
Qu. for a Question
S.P. for a Study Programme

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