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STOCKHOLM

TECHNICAL DATA

used by the

EUROPEAN VHF/UHF BROADCASTING CONFERENCE

STOCKHOLM

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TECHNICAL DATA USED BY THE EUROPEAN VHF/UHF

BROADCASTING CONFERENCE

STOCKHOLM, 1961

FOREWORD

This document, prepared for information purposes, is a collection of the technical data used by the European VHF/UHF Broadcasting Conference, Stockholm, 1961, in the establishment of the plans attached to the corresponding European Broadcasting Agreement.

The document consists, in the main, of a fusion of Document No. 64 of the Meeting of Experts of the C.C.I.R., Cannes, 1961, and Document No. 92 (Rev.) of the European VHF/UHF Broadcasting Conference, Stockholm, 1961.

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PART 1

PROPAGATION

1.1 Propagation curves for Bands I, II and III

1.1.1 The values of field strength are expressed in decibels relative to 1 μV/m for 1 kW effective radiated power, and apply to both vertically and horizontally polarized waves.

1.1.2 Figs. 1, 2 and 3 show the field strengths for 50% of receiving locations, and exceeded respectively for 50%, 10% and 1% of the time. The curves for values exceeded for 50% and 10% of the time apply to land paths and to sea paths in the North Sea area. The full-line curves for 1% of time apply to land paths, and the dotted lines apply to sea paths in the North Sea area. Experience shows that in the Mediterranean, particularly in the summer, field strengths may exceed the figures given by the curves for the North Sea area by as much as 20 db, for distances exceeding some 125 miles (200 km).

The full-line curves for distances from 200 up to about 700 km are those of C.C.I.R. Recommendation No. 312. Values of field strength obtained by extrapolation of these curves to greater distances should be used with circumspection.

1.1.3 The curves of Figs. 1, 2 and 3 apply to a receiving antenna height of 10 metres above ground at the receiving location, and to various transmitting antenna heights; the transmitting antenna height being somewhat arbitrarily defined as the height of the antenna above the average level of the ground between distances of 3 km and 15 km from the transmitter, over the sector in which it is required to know the magnitude of the interfering fields. From the data available, it is not considered possible to give a precise indication of the effect of changing the transmitting and receiving antenna heights but as a first approximation corrections may be applied on the following basis. To obtain the field strength at a distance of x km from the transmitter for transmitting and receiving antenna heights of h_1 and h_2 m, the curves for 300 m and 10 m should be read for a distance of $(x + 70 - 4.1\sqrt{h})$ km where $\sqrt{h} = \sqrt{h_1} + \sqrt{h_2} - \sqrt{10}$. This correction should not be applied, however, if the receiving point is near the horizon of the transmitter. (As given in C.C.I.R. Recommendation No. 312 and the Final Acts of the Special Regional Conference, Geneva, 1960.)

1.1.4 The field strengths given in Figs. 1 to 3 apply to 50% of receiving locations in the rolling irregular terrain found in many parts of Europe.

For such terrain the field strengths for other percentages of receiving locations may be obtained by using the distribution curve given in Fig. 4.

Neither the curves of Figs. 1 to 3 nor the distribution curve of Fig. 4 can be assumed to apply accurately in very hilly or mountainous regions. If data are available the field strengths actually measured in such regions are used.

1.1.5 Apart from the modification for the Mediterranean area, mentioned in para. 1.1.2, it is not considered necessary, for Bands I, II and III to introduce any other correction factor for differing climatic conditions in the European Broadcasting Area.

1.2 Propagation curves for Bands IV and V

1.2.1 The values of field strength are expressed in decibels relative to 1 µV/m for 1 kW effective radiated power, and apply to both vertically and horizontally polarized waves.

1.2.2 The influence of irregularities in the terrain is of greater importance in Bands IV and V than in Bands I, II and III. The parameter Δh is used to define the degree of irregularity: it is the difference in the heights exceeded for 10% and 90% of the propagation path in the range 10 km to 50 km from the transmitter. (See Fig. 5.)

1.2.3 Figs. 6, 7 and 9 show the field strengths for 50% of receiving locations, and exceeded respectively for 50%, 10% and 1% of the time. They refer to the kind of rolling irregular country found in many parts of Europe, for which a value of Δh of 50 m is considered representative. For greater values of Δh a correction should be applied to the curves. For distances up to 100 km, and if Δh lies between 100 and 200 m, the field strengths should be reduced by about 10 db; if Δh lies between 200 and 400 m the corresponding correction will increase to about 20 db. In the distance range 100 to 200 km these corrections should be progressively reduced to zero.

Values of field strength obtained by extrapolation of these curves to distances greater than about 700 km should be used with circumspection.

1.2.4 The curves of Figs. 7, 8 and 9 apply to a receiving antenna height of 10 m above ground at the receiving point, and to various transmitting antenna heights, the transmitting antenna height being somewhat arbitrarily defined as the height of the antenna above the average level of the ground between distances of 3 km and 15 km from the transmitter over the sector in which it is required to know the magnitude of the interfering fields. From the data available, it is not considered possible to give a precise indication of the effect of changing the transmitting and receiving antenna heights, but as a first approximation corrections may be applied on the following basis: to obtain the field strength at a distance x km from the transmitter for transmitting and receiving antenna heights of h_1 and h_2 m, the curves for 300 m and 10 m should be read for a distance, of $(x + 70 - 4.1 \sqrt{h})$ km where $\sqrt{h} = \sqrt{h_1} + \sqrt{h_2} - \sqrt{10}$. This correction should not be applied, however, if the receiving point is near the horizon of the transmitter. (As given in C.C.I.R. Recommendation No. 312 and in the Final Acts of the Special Regional Conference, Geneva, 1960.)

1.2.5 The field strengths given in Figs. 6, 7 and 8, relate to 50% of reception points for fairly rolling country, such as is frequently encountered in Europe. For this kind of country the field strengths for other percentages of receiving locations may be obtained by using the distribution curves given in Fig. 9.

1.2.6 These curves, which apply to long-term (several years) values, may be taken as representative of average climatic conditions throughout the European Broadcasting Area. It must be noted, however, that for short periods of time (perhaps a few hours, or even a few days) field strengths exceeding those in Figs. 6, 7 and 8 by some 10 db may occur.

1.2.7 The only data available relating to oversea propagation are for the North Sea and Mediterranean areas. In Fig. 10, the median curve up to about 80 km distance is the theoretical one for propagation over a smooth earth in a standard atmosphere: the curves for field strengths exceeded for 1%, 5%, 10% and 50% of the time for greater distances are based on measurements made in the North Sea area over a period of nearly eighteen months; limited measurements of the median field in the Mediterranean are in good agreement. There is evidence, however, that the field strengths exceeded for small percentages of time in the Mediterranean are even greater than those experienced in the North Sea area.

1.2.8 The curves of Fig. 10 refer to transmitting and receiving aerial heights of 300 m and 10 m respectively. The field strengths exceeded for small percentages of the time are not expected to be sensitive to appreciable changes in the transmitting aerial height; and the field strengths exceeded for 50% of the time may be adjusted for other aerial heights by the method given in para. 1.2.4.

1.2.9 During certain short periods of abnormal propagation (perhaps a few hours, or even a few days) the field strength values may approach 10 db greater than those given in Fig. 10. The periods of high field strength are often grouped together within the same month or season of the year, so that the fields exceeded during the same month or season in question may be higher by some 10 db than those indicated in Figs. 8 and 10 for long periods.

1.2.10 Insufficient data exist for determining field strength over mixed land and sea paths, but the calculation may be based on the following considerations:

(a) The field strength decreases, relative to the value for an all-sea path, in accordance with the distance from the receiving point to the coast, in the manner shown in Figure 11(a).

(b) The field strength decreases, relative to the value for an all-sea path in accordance with the distance from the transmitter site to the coast in manner shown in Figure 11(b).

(c) It should be noted that the corrections are zero if the coastal boundary is within the radio horizon from the receiving or transmitting aerials (for heights of 10 m and 300 m respectively). The total corrections must not exceed 45 db, 31 db or 22 db for the 1%, 5% or 10% time values respectively, because these corrections would reduce the field strength values to those for an overland path of the same total length.

(d) When there are more than two land/sea intersections along a propagation path, i.e. with one or more intervening portions of land, the calculation of field strength should normally be made as follows:

- the curves of Fig. 11(b) should be applied to the land-sea intersection nearest to the transmitter;

- the curves of Fig. 11(a) should be applied to the sum of the length of all the remaining land portions of the propagation path.

(e) Application of the method for the determination of field strength over mixed land and sea paths may lead to an erroneous result in certain special cases where either the length of a sea portion of the path is short or the percentage of the total path that is over sea is small. In such cases the method should be used with extreme caution and only after consultation between the Administrations concerned.

(f) When the transmitting aerial heights, as defined in para. 1.2.4 considerably exceeds 300 metres, the result obtained by the method of calculation described above should be compared with the result obtained by the assumption of an all-land path, the use of the curves of Figs. 8, 9 and 10 and the provisions of para. 1.2.4. The higher of the two results obtained should be adopted.

Note on paras. 1.1 and 1.2

A frequency plan had been drawn up for certain countries Members of I.B.T.O., it is based on the propagation curves in Figs. 12 to 16. These curves are valid only for propagation up to about 200 km over ground the topography of which is characteristic of the countries which submitted the regional plan to which they have agreed. The countries which did not appear in the I.B.T.O. Plan have used the curves in Figs. 1, 2, 3 and 6, 7 and 8 for distances up to about 200 km in the discussion of problems which are of interest both to themselves and to the I.B.T.O. countries. For distances greater than about 200 km, the curves in Figs. 1, 2 and 3 and 6, 7 and 8 have been used by all countries.

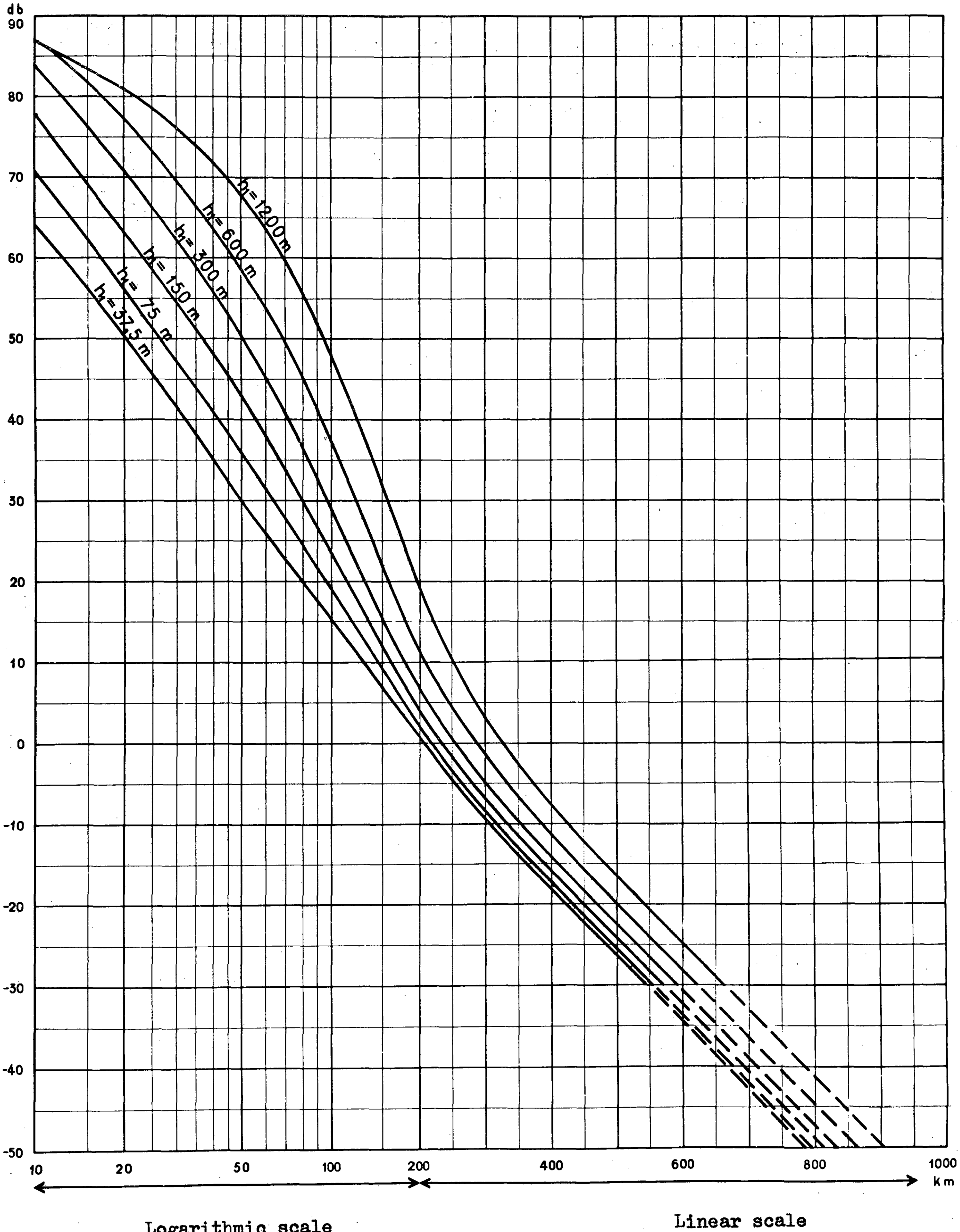
1.3 Aerial directivity in the reception of broadcast sound and television

The discrimination against interfering signals which may be obtained by the use of directional aerials is given in Fig. 17.

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

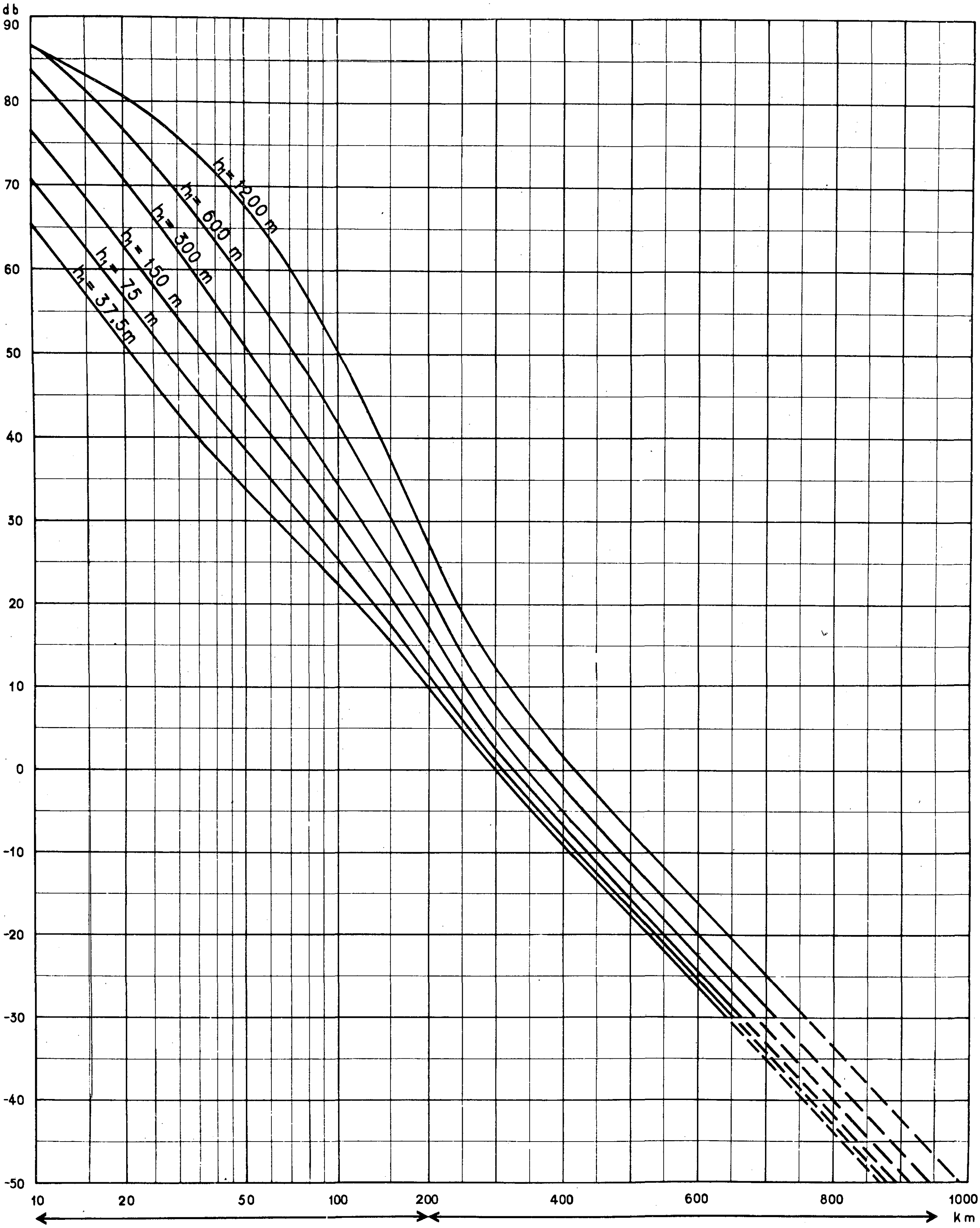
1.4 Orthogonal polarization in broadcasting

The protection which can be obtained by the use of orthogonal polarization is described in C.C.I.R. Report No. 122, and subsequent experience does not indicate that any modification to the Report, which is given in Annex I, is necessary.



Bands I, II and III - Land and sea - 50% of time - 50% of locations - $h_2 = 10$ m

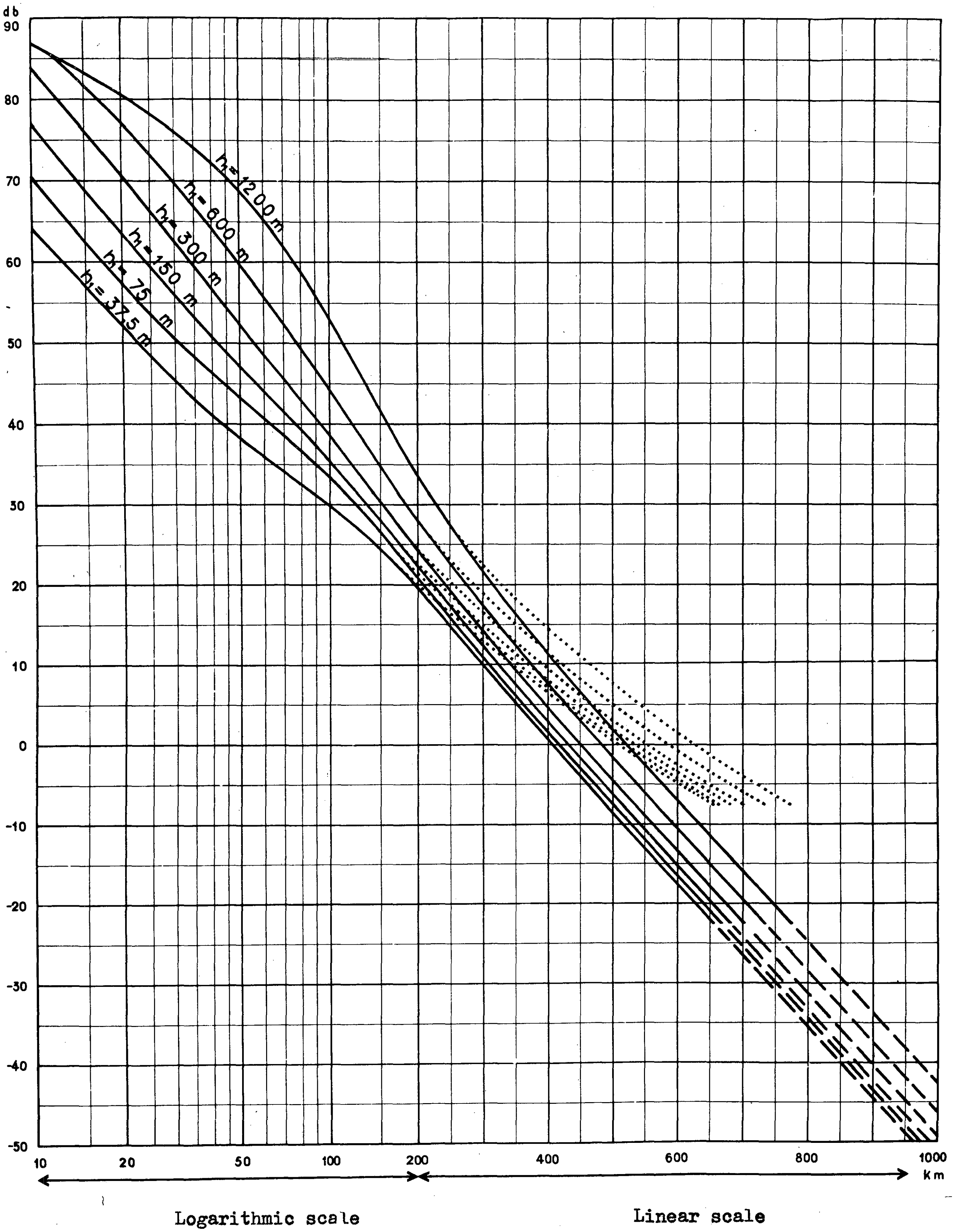
FIGURE 1



Logarithmic scale Linear scale

Bands I, II and III - Land and sea - 10% of time - 50% of locations - h_2 = 10 m

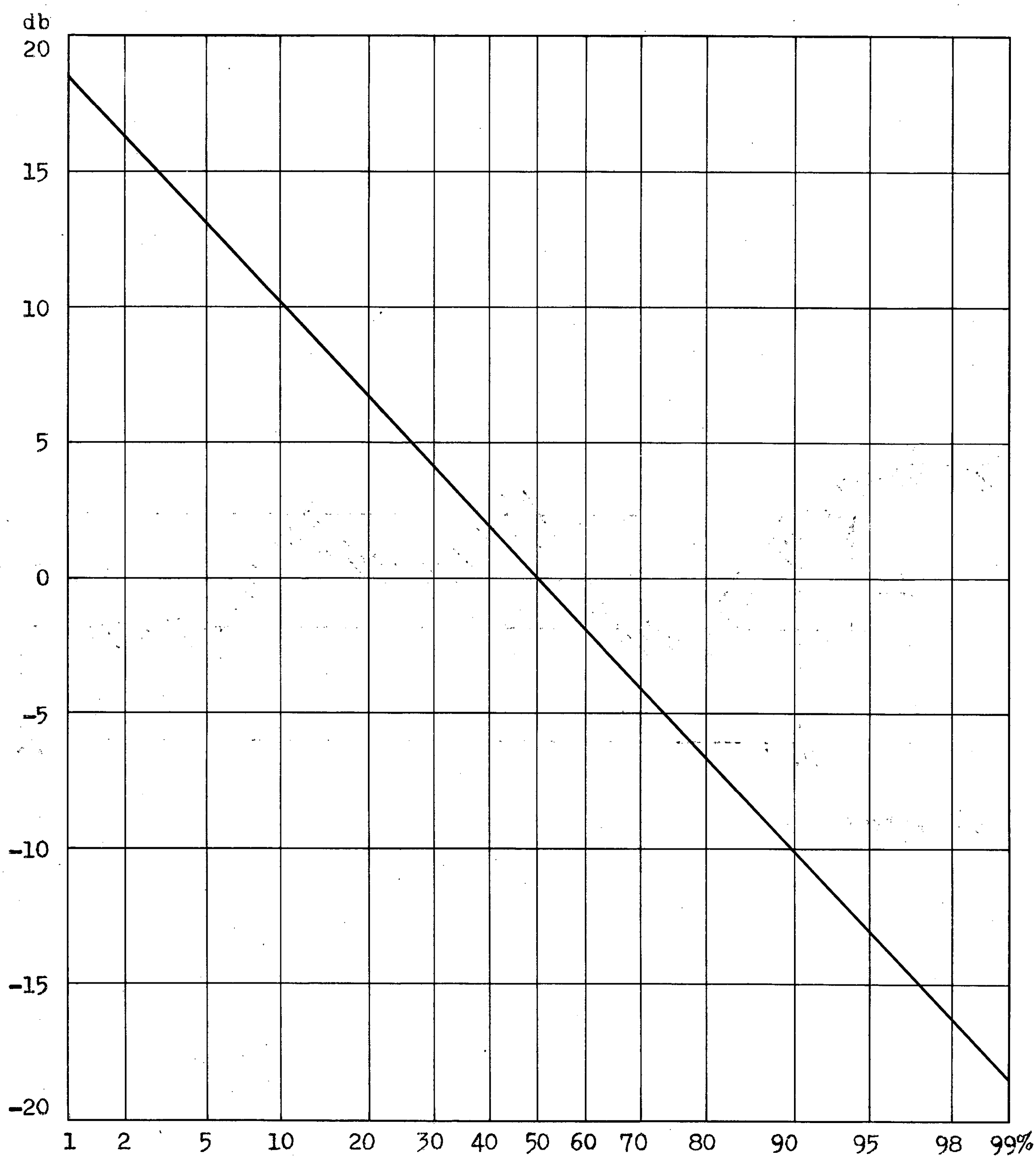
FIGURE 2



Bands I, II, III - Land and sea - 1% of time - 50% of locations - h_2 = 10 m

―――――― - - - - - Land ――――――.......... North Sea

FIGURE 3



Percentage of receiving locations

FIGURE 4

Ratio, in db, of the field strength for a given percentage of receiving locations, to the field strength for 50% of receiving locations

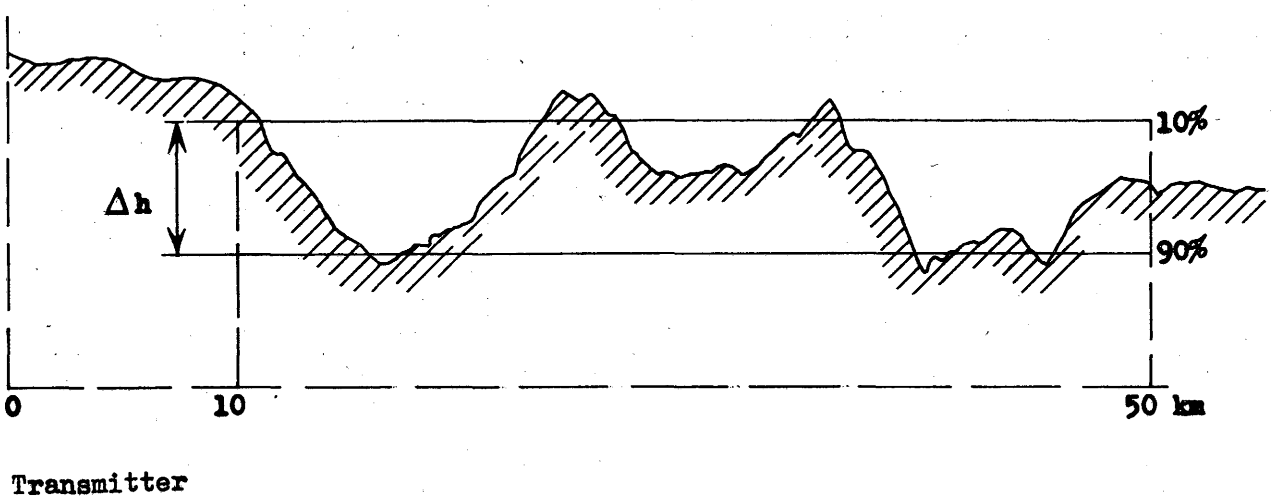
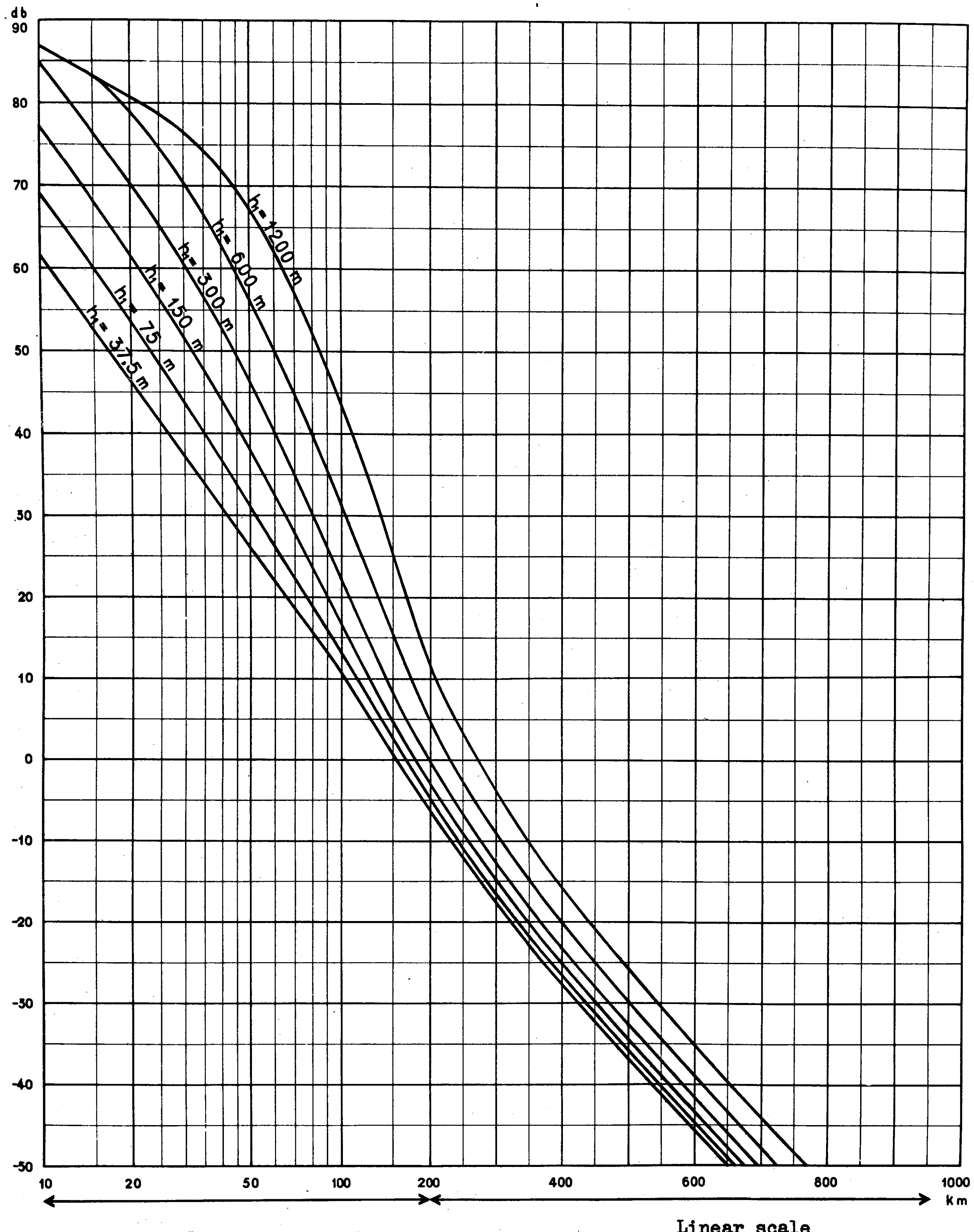
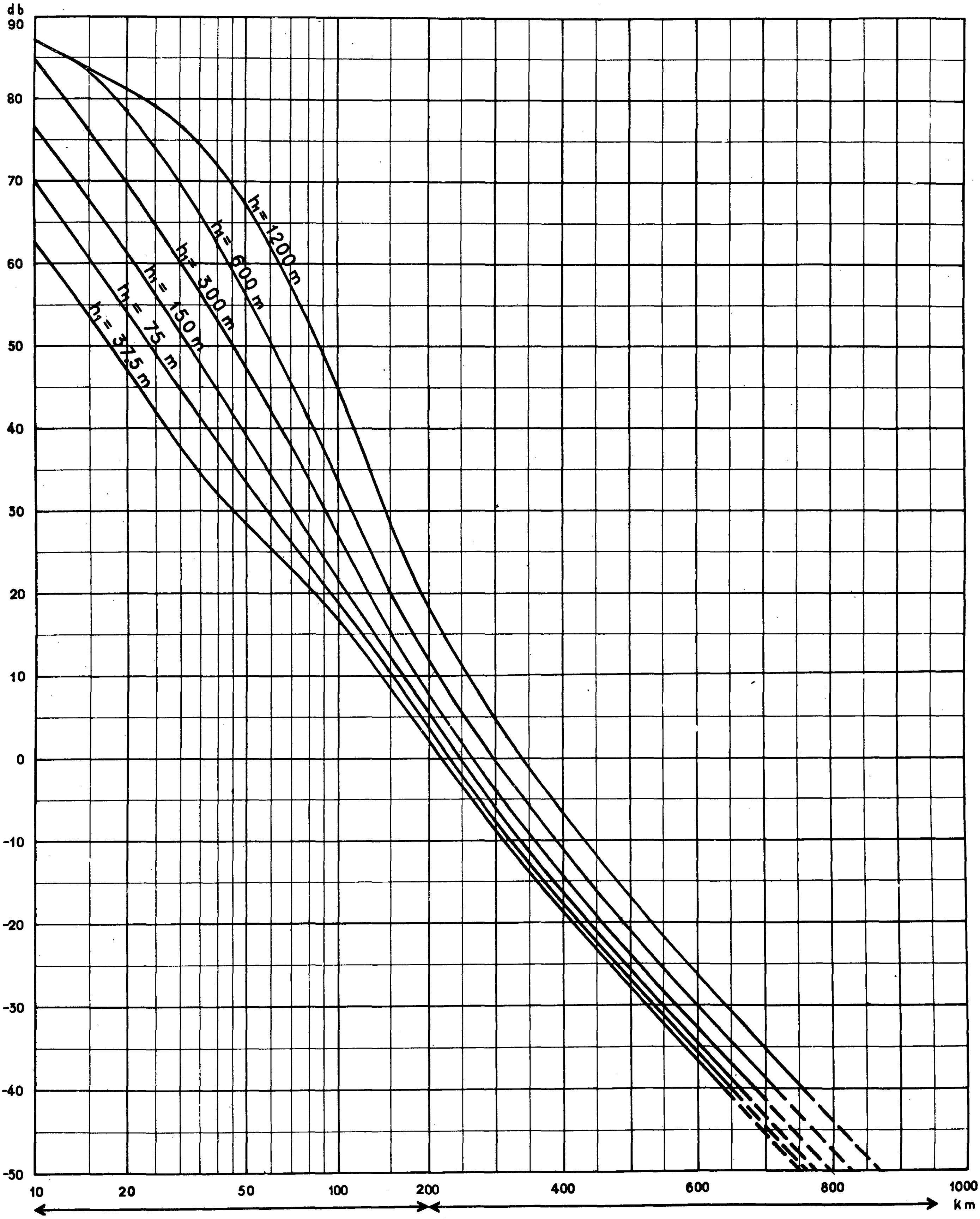


FIGURE 5



Bands IV, V - Land - 50% of time - 50% of locations - h_2 = 10 m - Δh = 50 m

FIGURE 6

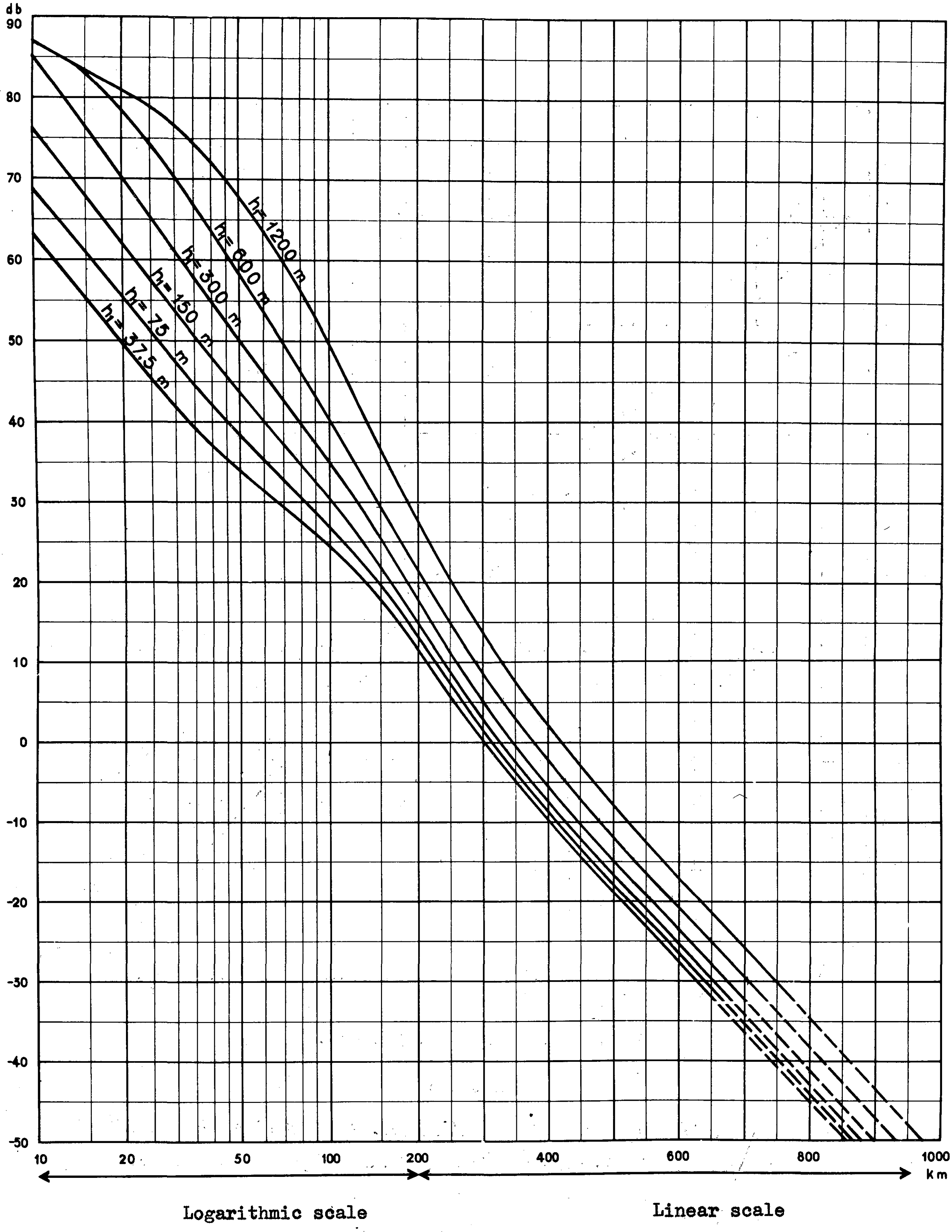


Logarithmic scale

Linear scale

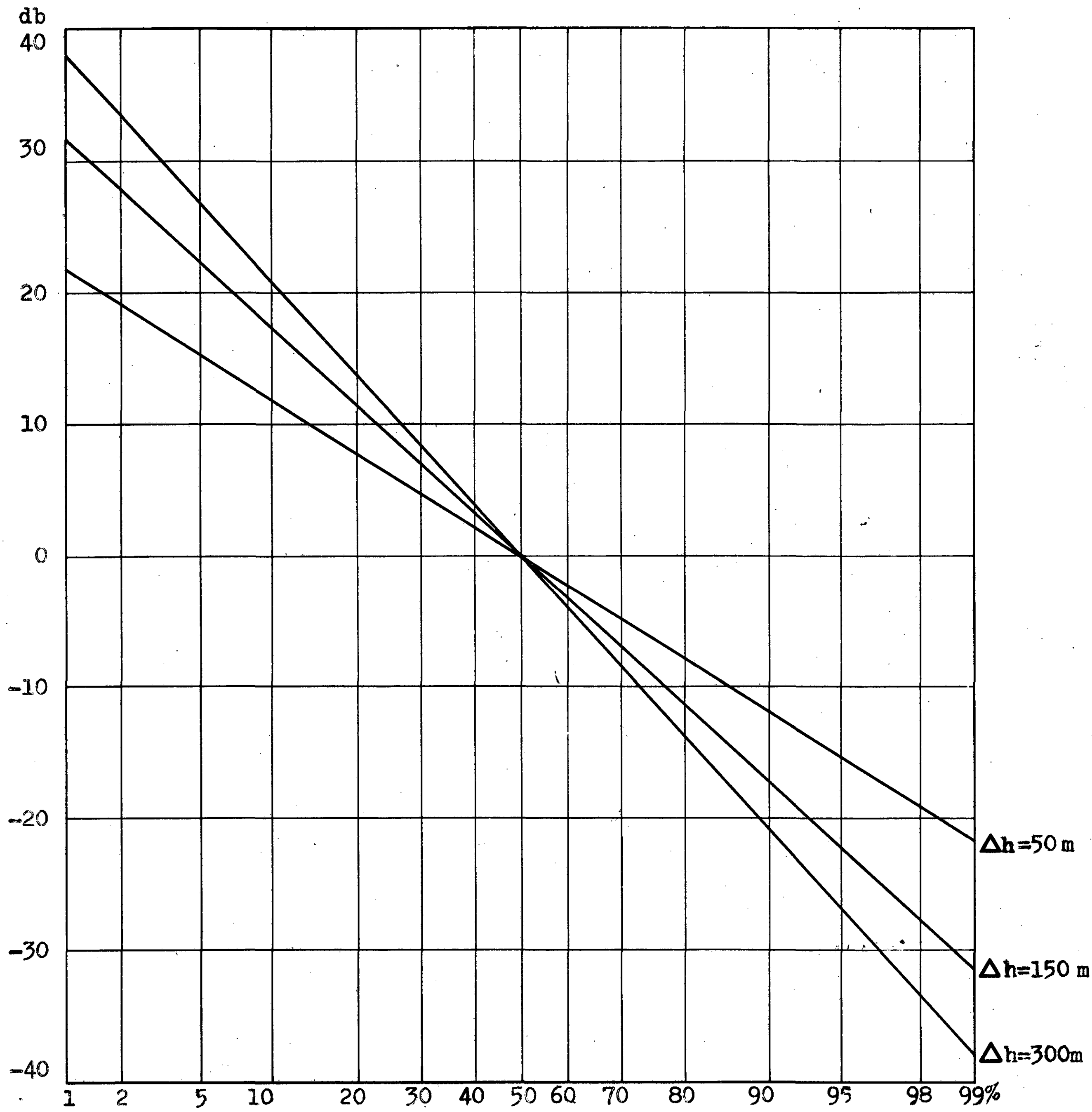
Bands IV, V - Land - 10% of time - 50% of locations - h_2 = 10 m - Δh = 50 m

FIGURE 7



Bands IV, V - Land - 1% of time - 50% of locations - h_2 = 10 m - Δ h = 50 m

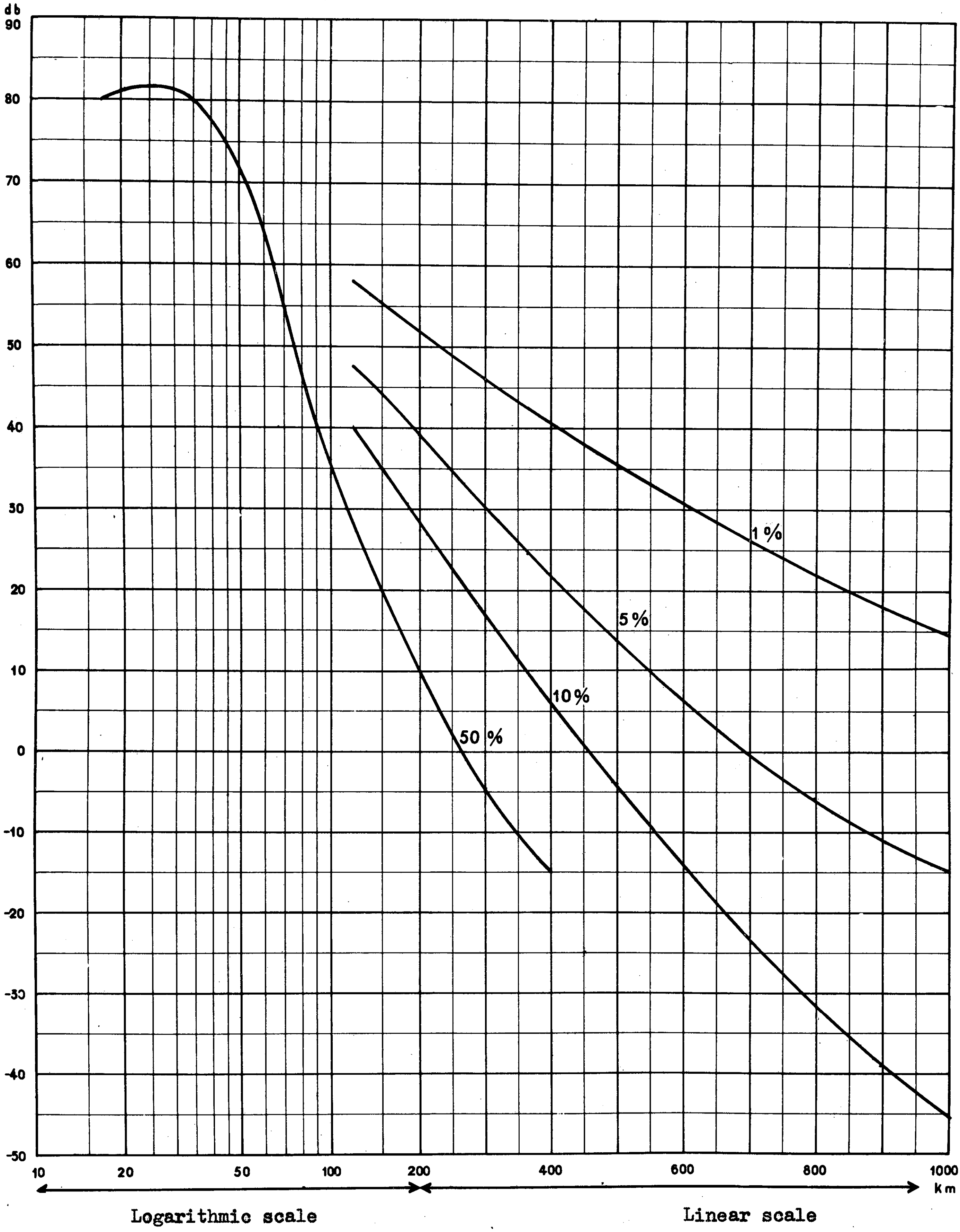
<u>FIGURE 8</u>



Percentage of receiving locations

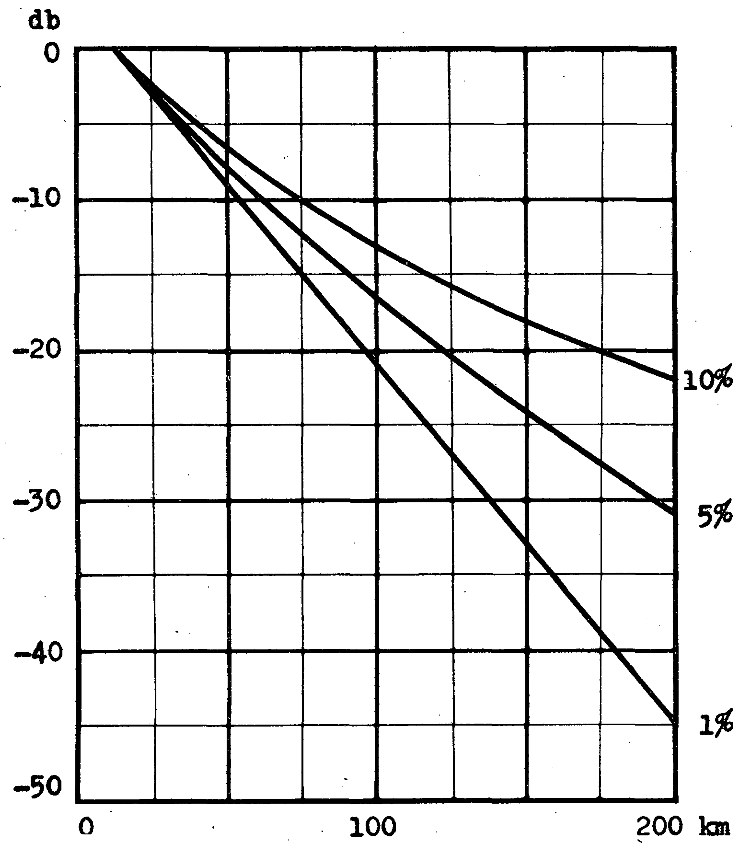
<u>FIGURE 9</u>

<u>**Ratio, in db, of the field-strength for a given percentage of receiving locations, to the field-strength for 50% of receiving locations**</u>



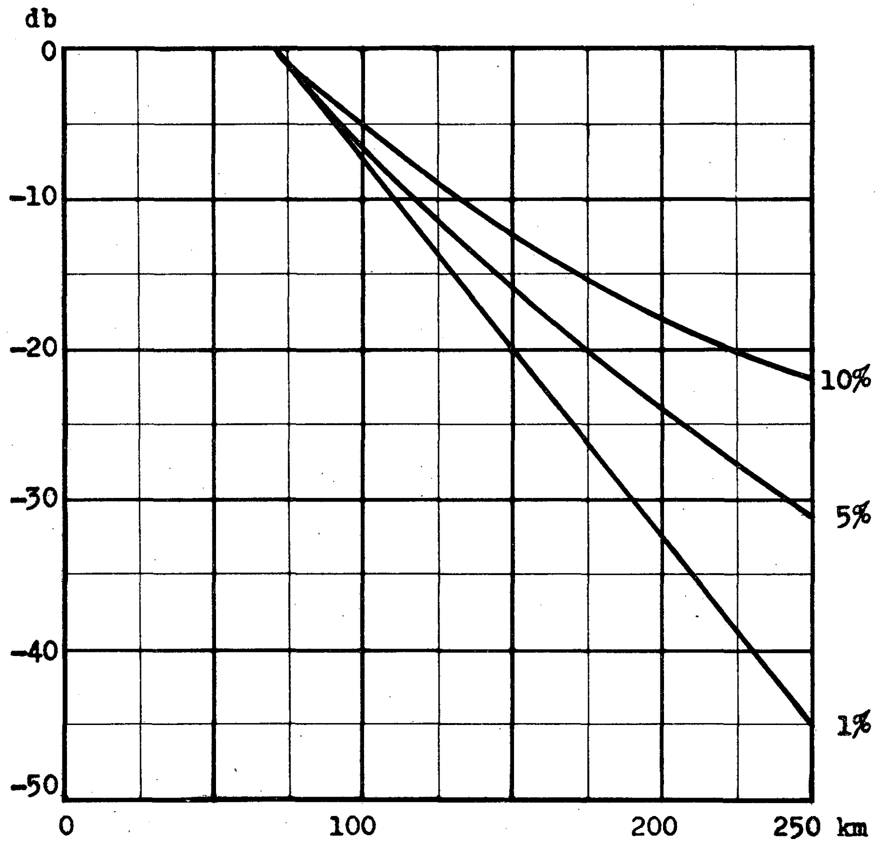
Bands IV, V - Sea - 50%, 10%, 5%, 1% of time -
50% of locations - h_1 = 300 m - h_2 = 10 m

FIGURE 10



Distance from Receiver to coast

FIGURE 11(a)

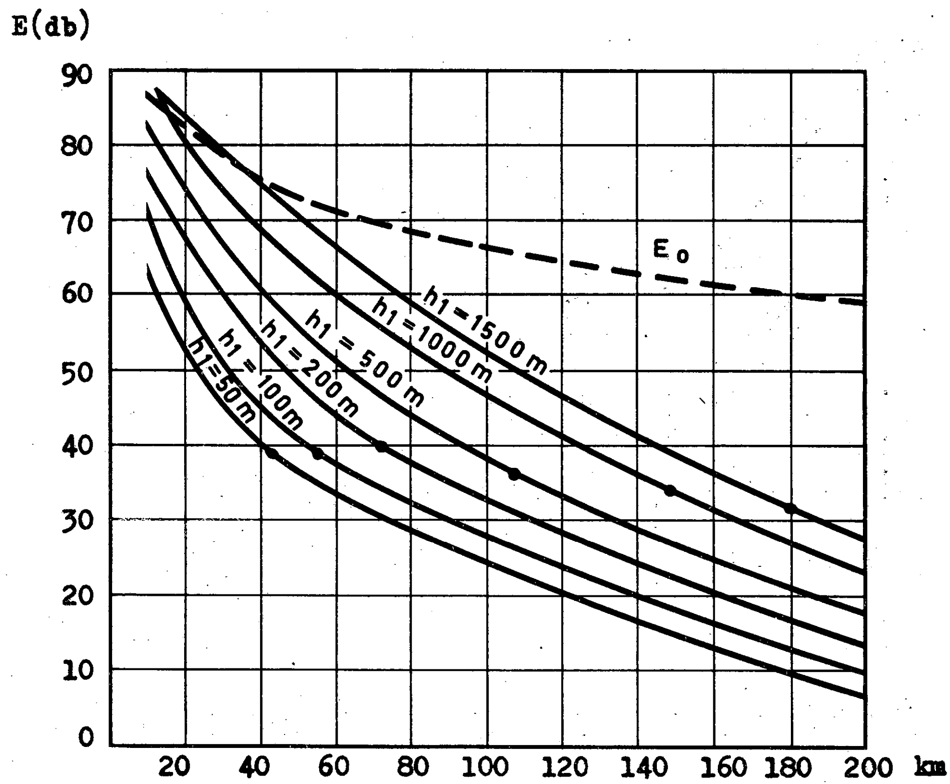


Distance from Transmitter to coast

FIGURE 11(b)

FIGURE 11

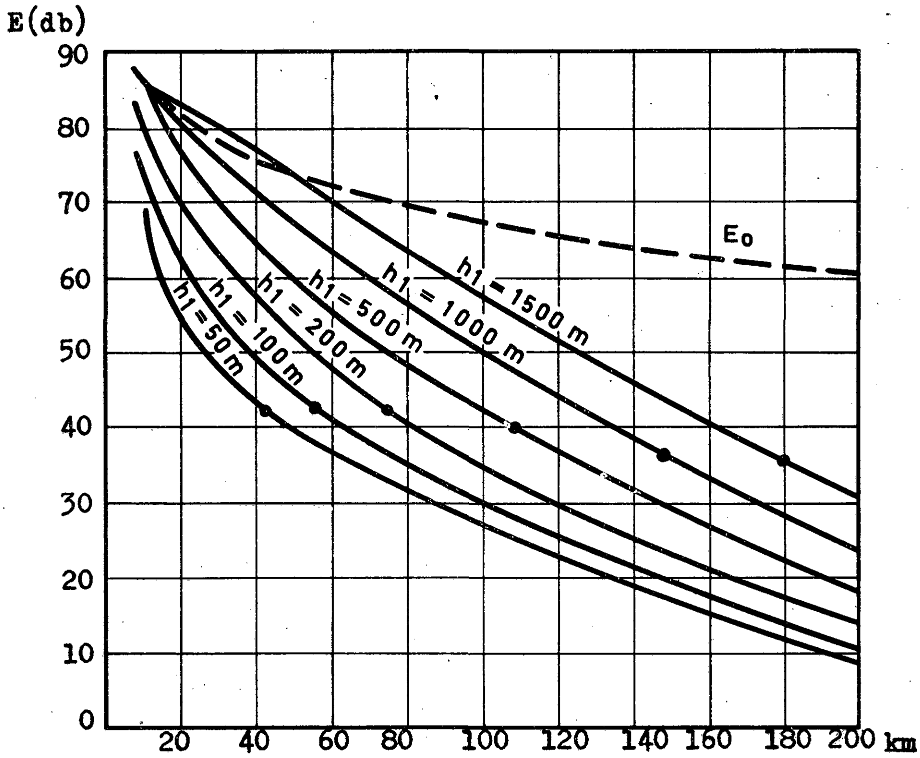
Corrections to be applied to overseas curves when path is partly overland



Half-wave dipole - h_2 = 10 m

f = 60 Mc/s - 50% of time - 50% of locations

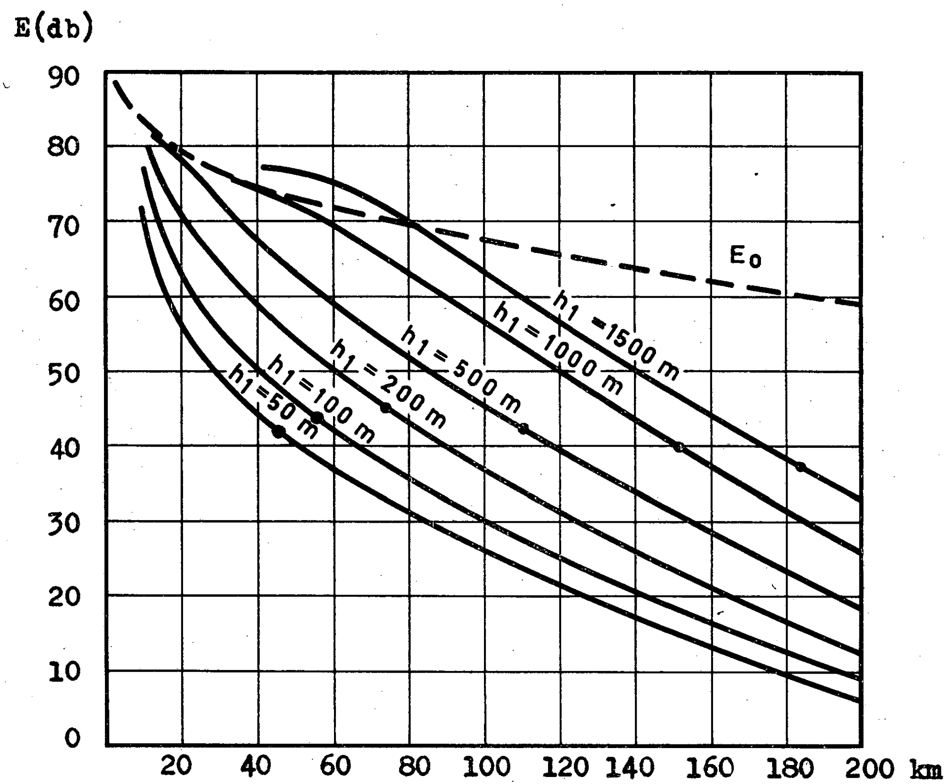
FIGURE 12



Half-wave dipole - h_2 = 10 m

f = 100 Mc/s - 50% of time - 50% of locations

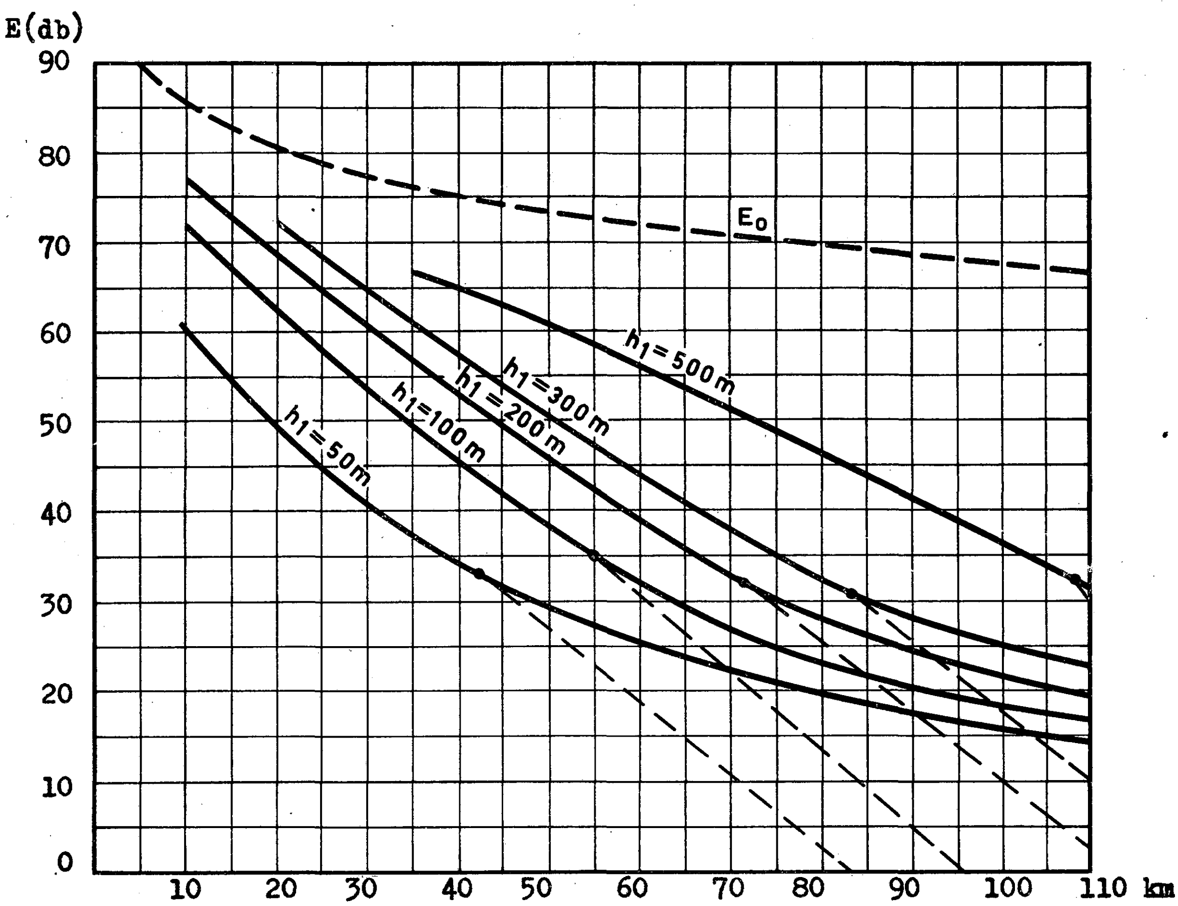
<u>FIGURE 13</u>



Half-wave dipole - h_2 = 10 m

f = 200 Mc/s - 50% of time - 50% of locations

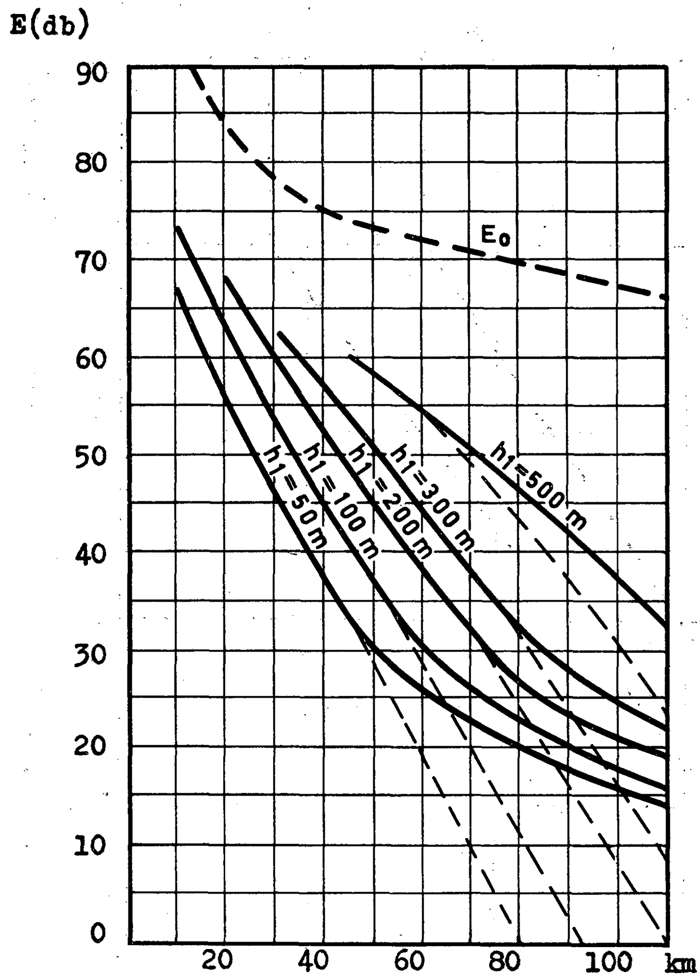
FIGURE 14



Half-wave dipole - hilly ground

f = 500 Mc/s - h_2 = 10 m - 50% of time - 50% of locations

FIGURE 15



Half-wave dipole - hilly ground

f = 800 Mc/s - h_2 = 10 m - 50% of time - 50% of locations

FIGURE 16

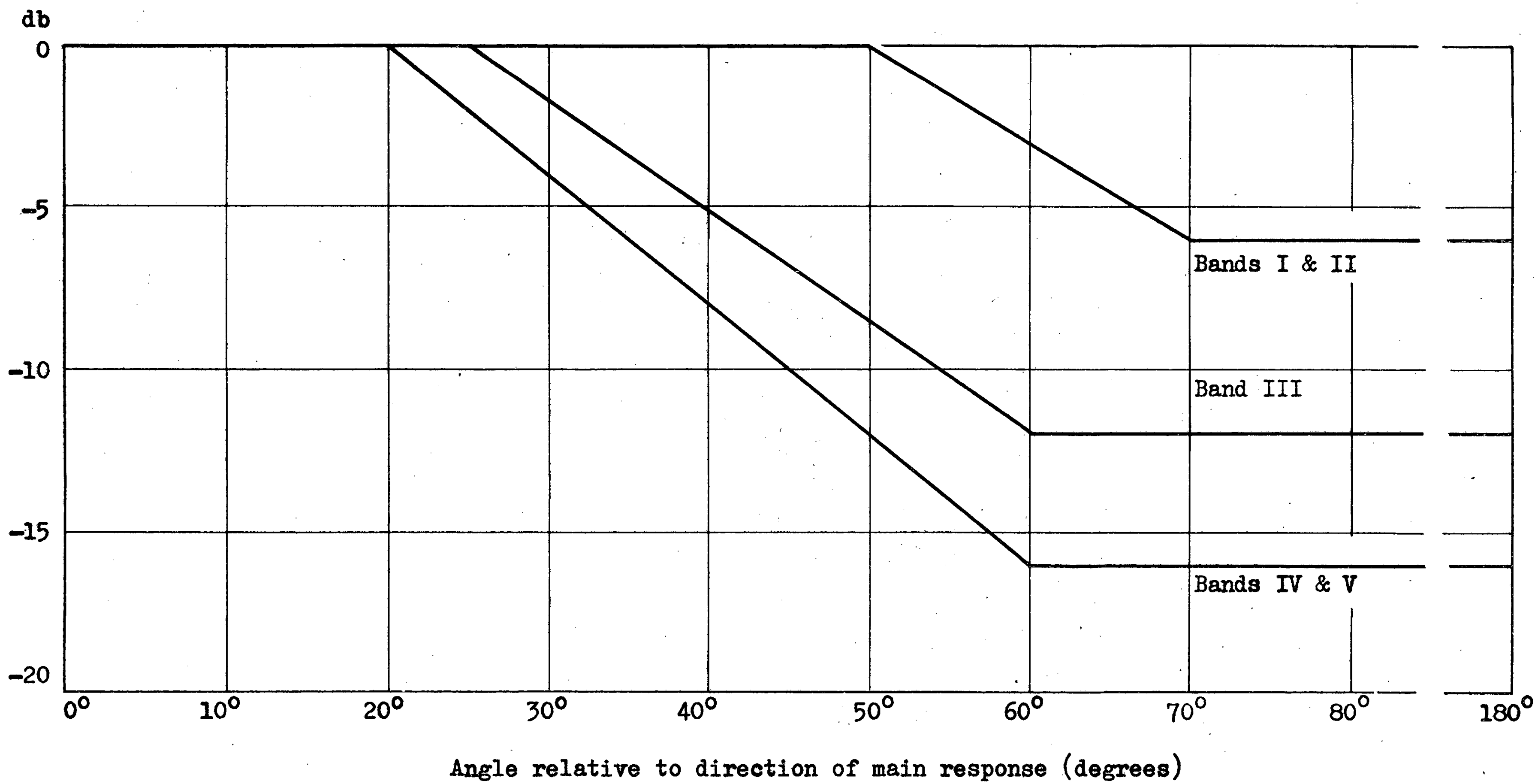


FIGURE 17

Discrimination obtained by the use of directional receiving antennae in broadcasting

PART 2

TELEVISION STANDARDS

2.1 The television standards as used in Bands I, II and III (see C.C.I.R. Report No. 124) are designated as follows in the Frequency Plan*.

A - 405 lines system

B - 625 lines system

C - Belgian 625 lines system

D - I.B.T.O. 625 lines system

E - 819 lines system

F - Belgian 819 lines system

2.2 2.2.1 The parameters proposed by various European countries for preparation of the 625-line television frequency plan with a channel spacing of 8 Mc/s in Bands IV and V can be grouped into 5 categories, designated here Standards G to L.

Standard	Video band-width (Mc/s) (a)	Picture sound separation (Mc/s) (b)	Vestigial sideband (Mc/s) (c)	Picture modulation (d)	Sound modulation (e)	Frequency of chrominance sub-carrier (Mc/s) (f)	Picture sound power ratio (g)
G	5	5.5	0.75	Neg	FM	4.43	5 : 1
H	5	5.5	1.25	Neg	FM	4.43	5 : 1
I	5.5	6	1.25	Neg	FM	4.43	5 : 1
K	6	6.5	0.75**	Neg	FM	4.43	5 : 1
L	6	6.5	1.25	Pos	AM	4.43	8 : 1

The following list shows the Standards proposed by the various countries for planning purposes:

Standard G: Austria, Belgium (see notes), Denmark, Spain, Finland, Greece (see notes), Iceland, Libya, Norway, Netherlands, Portugal, Federal Republic of Germany, Eastern Germany, Sweden, Switzerland.

Standard H: Belgium (see notes), Cyprus, Greece (see notes), Israel, Italy, Luxembourg, Turkey (see notes), Yugoslavia (F.P.R.), United Kingdom Overseas Territories.

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* Ireland is providing for the possibility of using a Standard similar to Standard I in Bands I and III.

** The Administrations proposing this standard are studying the possibility of extending the vestigial sideband to 1.25 Mc/s.

Standard I: Ireland, United Kingdom.

Standard K: P.R. of Bulgaria, Hungarian P.R., P.R. of Poland, Roumanian P.R., Czechoslovak S.R., U.S.S.R.

Standard L: France, Monaco.

Notes: The notes relating to the columns of the table summarizing the Standards are given below for each column.

Country	Column in the table	Remarks
AUSTRIA		Reserves the right to use additional FM-modulated sound carriers in the space between 5.75 and 6.75 Mc/s in relation to the picture carrier.
BELGIUM		A final decision on the standards to be adopted in Belgium will, to a very great extent, depend on the arrangements made by adjacent countries.
	(b)	Belgium could accept a picture/sound separation of 5.5 Mc/s for planning purposes.
	(c)	Belgium also wants 0.75 and 1.25 Mc/s to be considered as widths of the vestigial sidebands.
DENMARK	(c)	Has taken no final decision, but could accept a vestigial sideband of 0.75 Mc/s for planning purposes.
FINLAND	(c)	See under Denmark, in column (c).
FRANCE		The French Administration has decided to use a 625-line system for television in Bands IV and V. The essential characteristics thereof will be those described in the Table under "Standard L".
	(f)	A probable figure, on the assumption that a common colour television standard will be adopted in Europe.
GREECE	(c)	See under Denmark, column (c).
IRELAND		No decision has been taken on the standards, including the number of lines, to be adopted for Bands IV and V in Ireland. But for planning purposes without prejudice to such decision, the parameters preferred are those shown in the Table under "Standard I".
ICELAND		Does not at present intend to use Bands IV and V, but accepts the parameters shown for "Standard G" as the television standards in those bands.

Country	Column in the table	Remarks
ISRAEL	(c)	No final decision has yet been taken about the vestigial sideband. But for planning purposes the figure shown in the Table (1.25 Mc/s) under "Standard H" should be adopted.
ITALY	(c)	For planning purposes can accept the figure shown in the Table under "Standard H".
MONACO		A final decision on the characteristics of the 625-line system adopted by the Administration of Monaco will to a great extent depend on the final assignments made by the French Administration.
NORWAY	(c)	See under Denmark, column (c).
NETHERLANDS	(c)	Reserves the right to increase the vestigial sideband to 1.25 Mc/s. But for planning purposes 0.75 Mc/s as shown in the Table, could be used.
EASTERN GERMANY	(c)	Is considering the possibility of extending the vestigial sideband to 1.25 Mc/s.
UNITED KINGDOM		The parameters preferred for use in the planning of a 625-line system; the standards, including the number of lines, to be adopted in the United Kingdom for Bands IV and V, have not yet been decided.
SWEDEN	(c)	See under Denmark, column (c).
SWITZERLAND		Intends to introduce additional FM-modulated sound carriers in the frequency space between 5.5 and 6.5 Mc/s in relation to the picture carrier, at levels equal to or less than the ordinary level of the sound carrier, for additional sound-tracks or sound broadcast programme.
	(c)	Is also considering the possibility of extending the vestigial sideband to 1.25 Mc/s.
TURKEY	(c)	Could accept for planning purposes, subject to a final decision being taken later, the figure for the vestigial sideband shown in the Table under "Standard H".

2.2.2 Carrier frequencies in Bands IV and V

In each 8 Mc/s channel, all the vision carriers must have the same nominal frequency, no matter what system be used. The relative position of the sound carrier and chrominance sub-carrier are shown in Fig. 18.

The nominal vision carrier frequency of each television station in Bands IV and V should be situated at 1.25 Mc/s above the lower edge of the channel. (Thus, for example, in the channel 470-478 Mc/s, the vision carrier frequency should be 471.25 Mc/s).

The relatively close separation of the vision carrier frequency from the lower edge of the channel may give rise to interference by television stations to stations of other services operating in frequency bands immediately below those used by the television service and due account must be taken of this in the establishment of frequency assignment plans for television stations.

2.2.3 Numbering of Channels in Bands IV and V

All channels in the frequency range 470-960 Mc/s are numbered consecutively. The lowest channel (470-478 Mc/s) is designated Channel No. 21, the next higher channel (478-486 Mc/s) is designated No. 22, and so on.

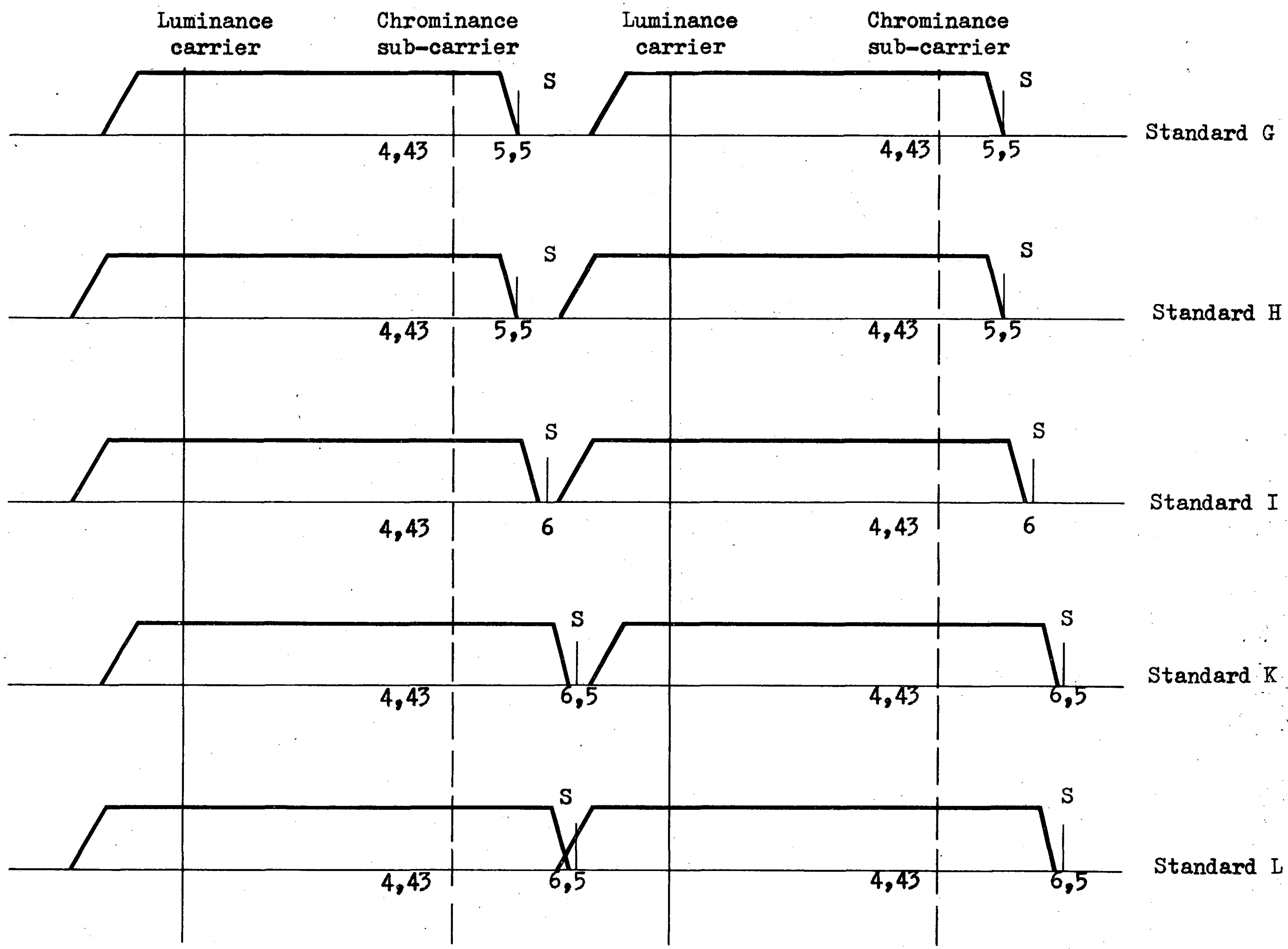

FIGURE 18

Proposed position of carriers in Bands IV and V
(S : Sound carrier)

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PART 3

PROTECTION RATIOS

3.1 Sound Broadcasting in the VHF Band

3.1.1 Protection against other sound broadcasting transmissions

(a) Monophonic broadcasting

The protection ratios required to give satisfactory reception are given by the curves of Fig. 19 in terms of the spacing between the carrier frequencies, for a maximum frequency deviation not exceeding ± 75 kc/s.

The solid curve applies for all carrier frequency spacings when the interference results from tropospheric propagation, and the protection is for 99% of the time. It also applies for carrier frequency spacings exceeding 60 kc/s under conditions of steady interference.

The dotted curve applies for carrier frequency spacings from 0 to 60 kc/s under conditions of steady interference.

For FM sound broadcasting services on carrier frequencies below 87.5 Mc/s using a maximum frequency deviation not exceeding ± 50 kc/s, the protection ratios are given in Fig. 20, (Fig. 20 is a reproduction of Fig. 4 of the Final Acts of the Special Regional Conference, Geneva, 1960).

(b) Stereophonic broadcasting

No agreement has yet been reached on a definitive stereophonic system, and it is therefore recommended that any extension of the present plans for VHF sound broadcasting be based on monophonic standards.

However, the stereophonic system finally adopted may require a few decibels more protection than a monophonic system in order to give satisfactory monophonic reception and account may be taken of this to any possible extent.

3.1.2 Protection against other radiocommunications services

In the absence of further information, the curves given in Figs. 19 and 20 should be used to determine the necessary protection ratios for VHF-FM sound broadcasting services against interference caused by other services (e.g. fixed or mobile) account being taken only of the frequency difference and the carrier powers involved.

If the interfering signal was given by a 625-line television transmitter modulated by a test pattern, the following protection ratios may be used for guidance in planning:

Frequency (Mc/s)	0	0.25	0.5	0.75	1	1.5	2	3	4	5
Protection ratio (db)	32	-3	-10	-12	-14	-17.5	-22	-25	-29	-33

In the experiment no sound accompanied the TV signal. The desired FM signal level was 1 mV in 240 Ω. The modulation of this signal was taken from Beethoven's 5th Symphony (the same theme as that used in the stereophonic reception experiments of the E.B.U.). The results were measured with full modulation of the TV transmitter. For vestigial sideband modulation the result at the side of the carrier should be corrected in accordance with the width of this vestigial sideband.

3.1.3 Protection against multiple interference

See para. 3.4.

3.1.4 Protection resulting from the use of receiving-aerial directivity

No allowance should be made for directivity of the receiving-aerial in frequency planning.

3.1.5 Optimum carrier spacing

Attention is drawn to work carried out in the Federal Republic of Germany on this problem, the general conclusions of which are summarized in Annex II.

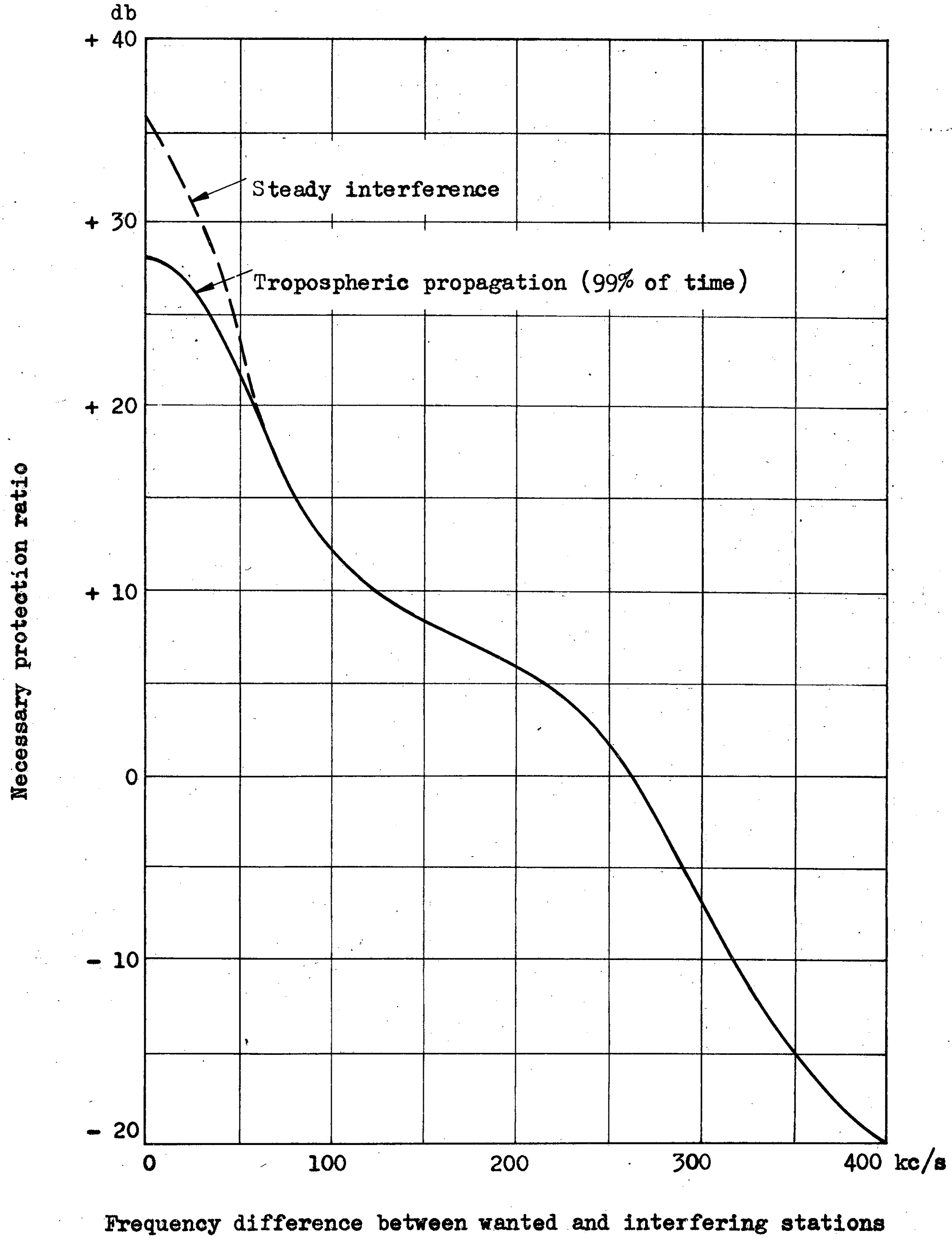
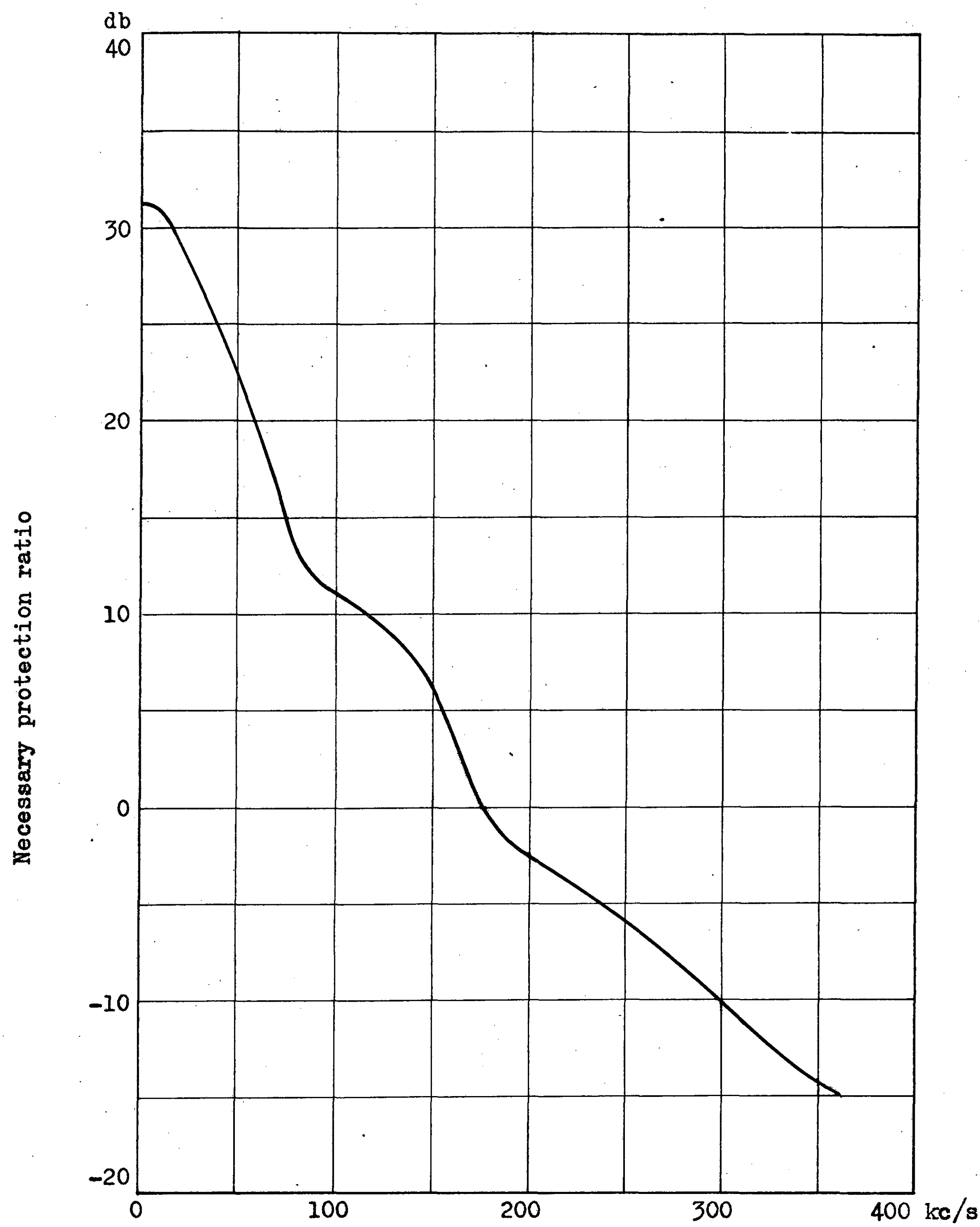

db
+ 40
+ 30
+ 20
+ 10
0
- 10
- 20
Necessary protection ratio
Steady interference
Tropospheric propagation (99% of time)
0
100
200
300
400 kc/s
Frequency difference between wanted and interfering stations

FIGURE 19



Frequency difference between wanted and interfering stations

FIGURE 20

Protection ratio required by VHF-FM sound broadcasting services on frequencies below 87.5 Mc/s using a maximum deviation of ± 50 kc/s

3.2 Monochrome Television

This Section has been prepared on the basis of the results of subjective tests made at a distance of four to six times the picture height to determine the tolerable ratio of wanted signal to unwanted signal in monochrome television. The protection ratios quoted are considered to be acceptable for a small percentage of the time, not precisely defined, but assumed to be between 1% and 10%. Protection ratios for just perceptible interference would be some 10 to 20 db higher.

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

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

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

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

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

3.2.1 Interference within the same channel - Protection ratio when the wanted and unwanted signals have the same line frequency

(a) Carriers separated by less than 1000 c/s but not synchronized:

Just tolerable interference : 45 db.

(b) Carriers separated by less than 50 c/s but not synchronized:

Just tolerable interference reduced by 5 - 10 db, relative to the preceding case.

(c) Nominal carrier frequencies separated by 1/3, 2/3, 4/3, or 5/3 of the line frequency

Just tolerable interference :

- for 625 - and 819-line systems : 30 db;

- for 405 line system : 35 db.

These values may be reduced to 20 db and 28 db respectively if a carrier separation equal to a multiple of the field frequency can be maintained with a total deviation less than 5 c/s; the line frequency should be kept constant to within 5×10^{-6} and each transmitter should have a frequency tolerance of not more than $\pm$ 2.5 c/s.

The 20 db value is at present valid for the 625-line system when there is one unwanted transmitter. More tests are needed before this value can be applied to other television systems or to the case of more than one unwanted transmitter. Under these conditions the ratio between the wanted and unwanted sound signals will also be 20 db, and this is only permissible if the offset is at least 5/3 of the line frequency in the case of frequency modulated sound (see para. 3.2.6(a)) or above the audio frequency range in the case of amplitude-modulation sound (see para. 3.2.6(b)).

(d) <u>Nominal carrier frequencies separated by 1/2 or 3/2 of the line frequency</u>

Just tolerable interference :

- for 625 - and 819-line systems : 27 db;

- for 405-line system : 31 db.

3.2.2 <u>Interference within the same channel; Protection ratio for the picture signal when the wanted and unwanted signals have different line frequencies</u>

(a) <u>Carrier separated by less than 1000 c/s but not synchronized</u>:

Just tolerable interference : 45 db

(b) <u>Carriers separated by less than 50 c/s but not synchronized</u>:

Just tolerable interference reduced by 5 - 10 db relative to the preceding case.

(c) <u>Nominal carrier frequencies separated by 6.3 kc/s</u>

Just tolerable interference between a 625-line system and an 819-line system : 30 db.

3.2.3 <u>Adjacent-channel interference</u>

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

(a) <u>Lower* adjacent-channel interference - Bands I and III</u>

The worst interference on the picture signal from another signal using the same standard results from the sound signal in the lower* adjacent channel. The figures below relate to the

---

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

cases where the separation between the wanted vision carrier frequency and the unwanted sound carrier frequency is 1.5 Mc/s and the ratio between the unwanted vision and unwanted sound powers is 7 db. The ratios are expressed in terms of the wanted and unwanted vision signals.

Just tolerable interference :

- for frequency-modulated sound carrier : -6 db;
- for amplitude-modulated sound carrier : -2 db.

(b) Lower adjacent-channel interference - Bands IV and V

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

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

(1) Administrations using the 625 (I.B.T.O.) system in Bands I and III are studying the possibility of broadening the vestigial side-band to 1.25 Mc/s for use in Bands IV and V without changing the other parameters of the systems. In this case, the protection ratios required for the modified 625 (I.B.T.O.) system would be the same as those quoted for the 625 (F) system.

(2) The values for the 625-line (U.K.) and 625-line (F) systems are different in this case because receivers for the 625 (U.K.) system will contain a sound trap giving additional rejection at the frequency of the interference.

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

(c) Upper* adjacent-channel interference - Bands I, III, IV and V

Just tolerable interference :

- for the I.B.T.O. 625-line system : +4 db;
- for all other 625-line systems and for the 405-line and 819-line systems : -12 db.

3.2.4 Overlapping-channel interference

Figs. 21 to 28 give protection ratios for each of the systems 405, 625 and 819 lines when a CW signal or the carrier of an interfering sound or vision signal lies within the channel of the wanted transmission.

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

In all cases where it affects the result, the ratio of vision power to sound power is assumed to be 9 db for the 625-line (France) system and 7 db in all other cases.

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* Lower, in the case of the 405-line standard in Bands I and III.

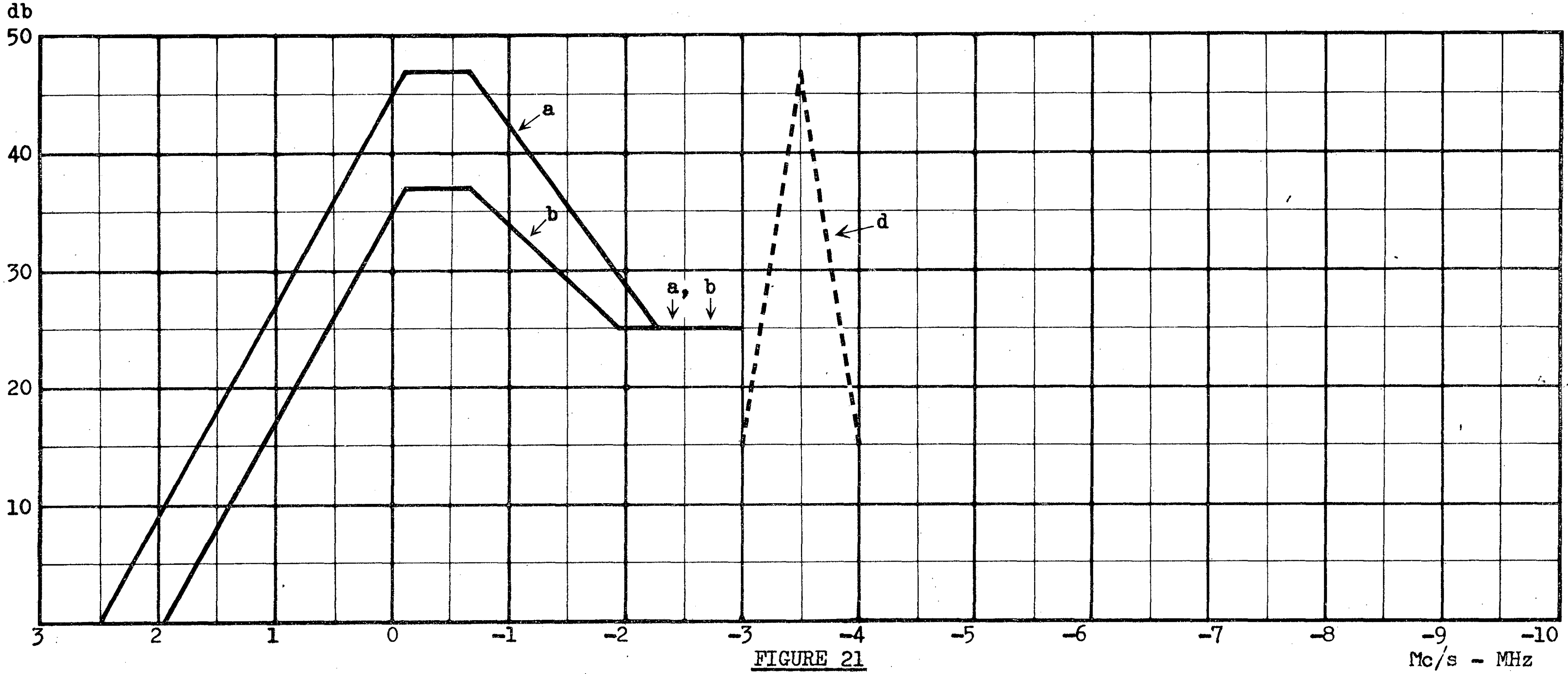

FIGURE 21

405-line system. Protection from vision signal interference

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

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

Curve b - Interference to vision from a 405-, 625-, or 819-line vision signal when the nominal frequency difference between the wanted and unwanted signal carriers is a multiple of the line frequency (10.125 kc/s) plus or minus 3 to 5 kc/s. If the nominal frequency difference is 1/2 or 3/2 of the line frequency, a protection ratio of 31 db may be accepted (see para. 3.2.1(d)).

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

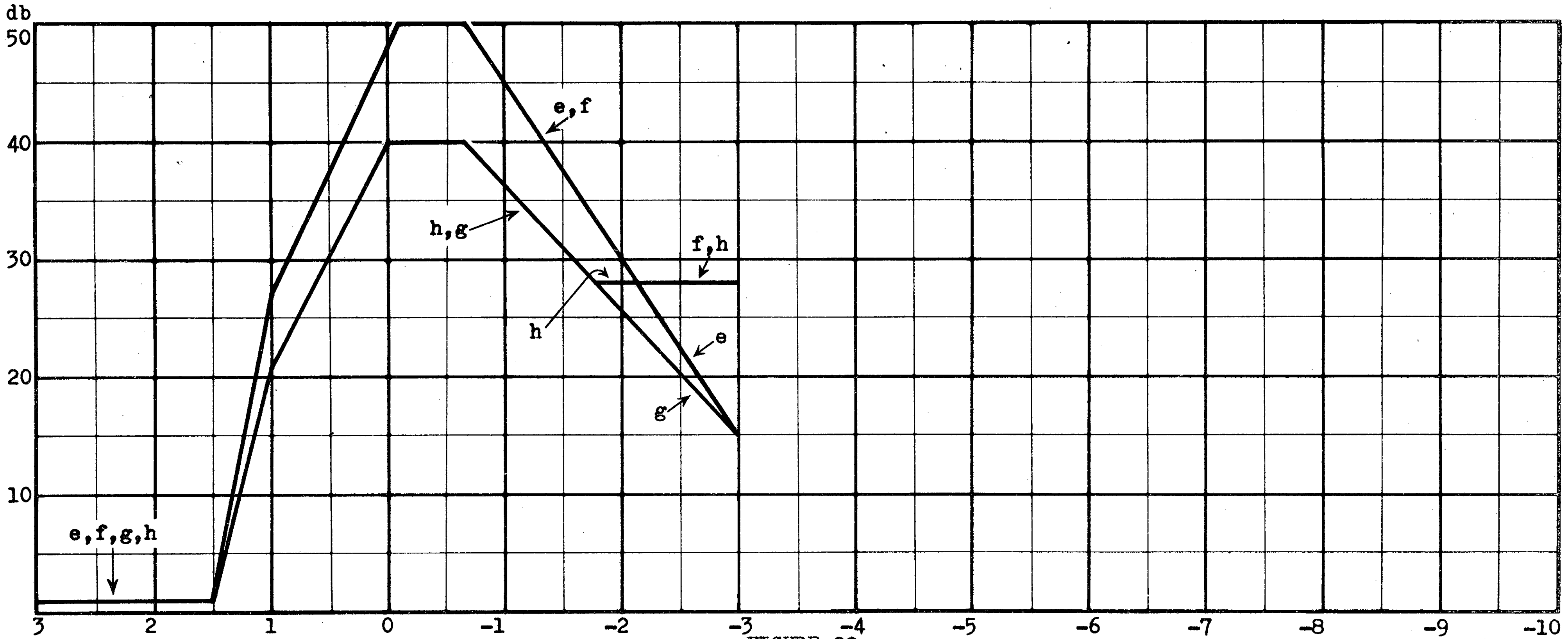

FIGURE 22

405-line system. Protection from CW or sound-level interference

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

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

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

Curve g - Interference to vision from a frequency-modulated sound signal when the nominal frequency difference between the wanted signal carrier and the interfering sound carrier during quiescent periods is an odd multiple of half the line-frequency (5.0625 kc/s).

Curve h - Interference to vision from an amplitude-modulated sound signal when the nominal frequency difference between the wanted and unwanted signal carriers is an odd multiple of half the line-frequency (5.0625 kc/s).

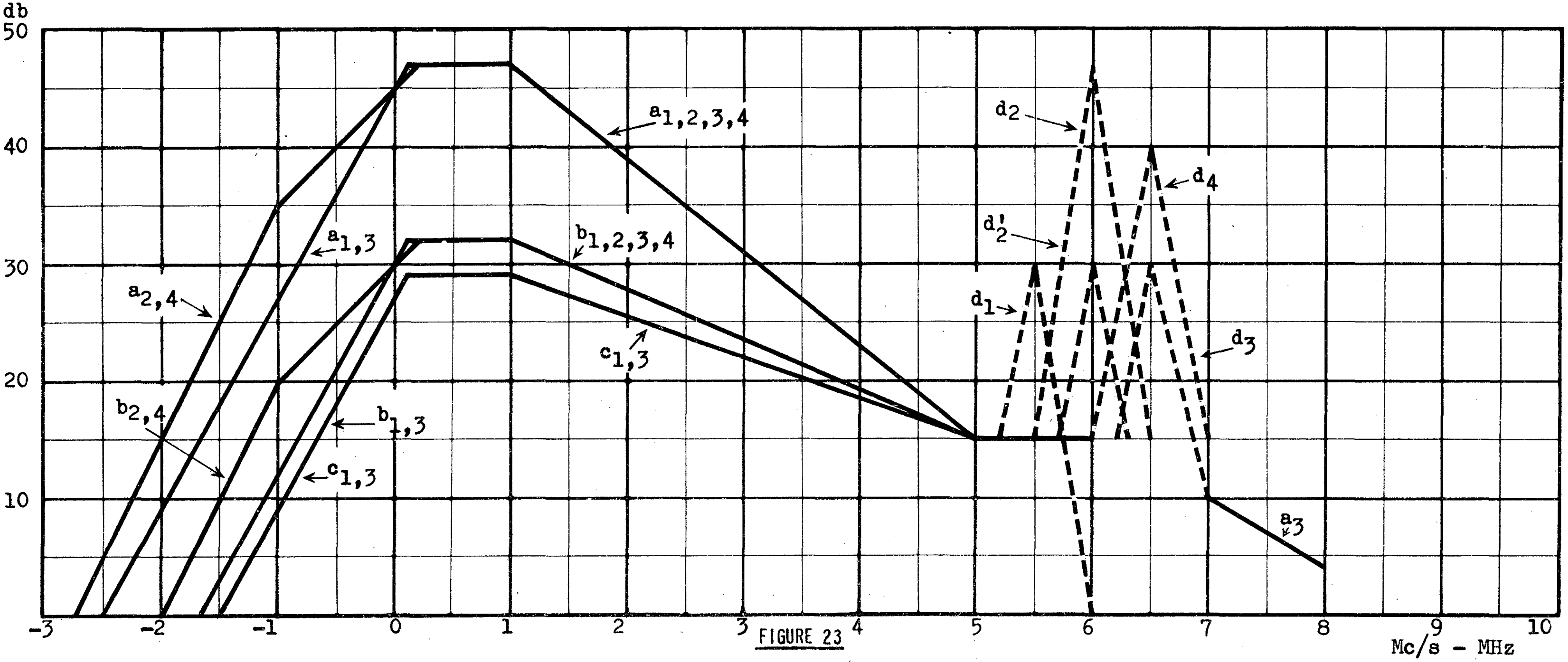

FIGURE 23

625-line system. Protection from vision-signal interference

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

The subscript numbers used on the curves indicate the various applications of the 625-line system:

1 - 625 lines; 2 - 625 lines (United Kingdom); 3 - 625 lines (I.B.T.O.) * ; 4 - 625 lines (France).

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

Curve b - Interference to vision from a 625-line vision signal when the nominal frequency difference between the wanted and unwanted signal carriers is a multiple of the line frequency (15.625 kc/s, plus or minus one third of the line-frequency (5.208 kc/s).

Curve c - Interference to vision from a 625-line vision signal when the nominal frequency difference between the wanted and unwanted signal carriers is an odd multiple of half the line-frequency (7.8125 kc/s).

Curve d - Interference to sound from a 625-line vision signal. Two alternative curves - d_2 and d'_2 are given, for the 625-line (United Kingdom) system, depending on whether amplitude-modulation (d_2) or frequency-modulation (d'_2) is to be used for the wanted sound signal.

---

* If a vestigial sideband of 1.25 Mc/s is used in a modified (I.B.T.O.) 625-line system, curves a_4 and b_4 should be used instead of curves a_3 and b_3 and curve c_3 should be ignored.

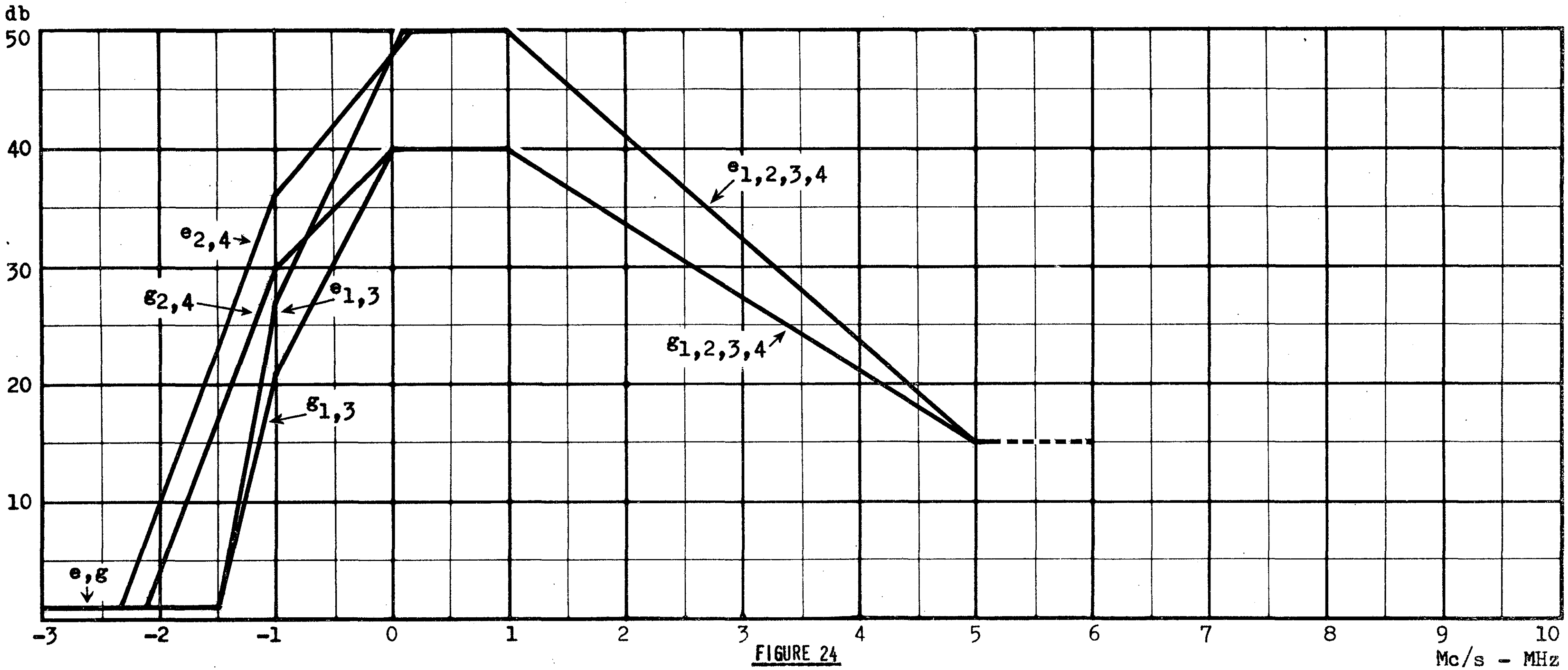

FIGURE 24

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

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

The subscript numbers are used on the curves to indicate the variations applicable to the various 625-line systems as follows:
1 - 625-lines; 2 - 625-lines (United Kingdom); 3 - 625-lines (I.B.T.O.) * ; 4 - 625-lines (France).

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

Curve g - Interference to vision from a frequency-modulated sound signal when the nominal frequency difference between the wanted signal carrier and the sound carrier during quiescent periods is an odd multiple of half the line frequency (7.8125 kc/s).

* If a vestigial sideband of 1.25 Mc/s is used in a modified 625 (I.B.T.O.) system, curves e_4 and g_4 should be used instead of curves e_3 and g_3.

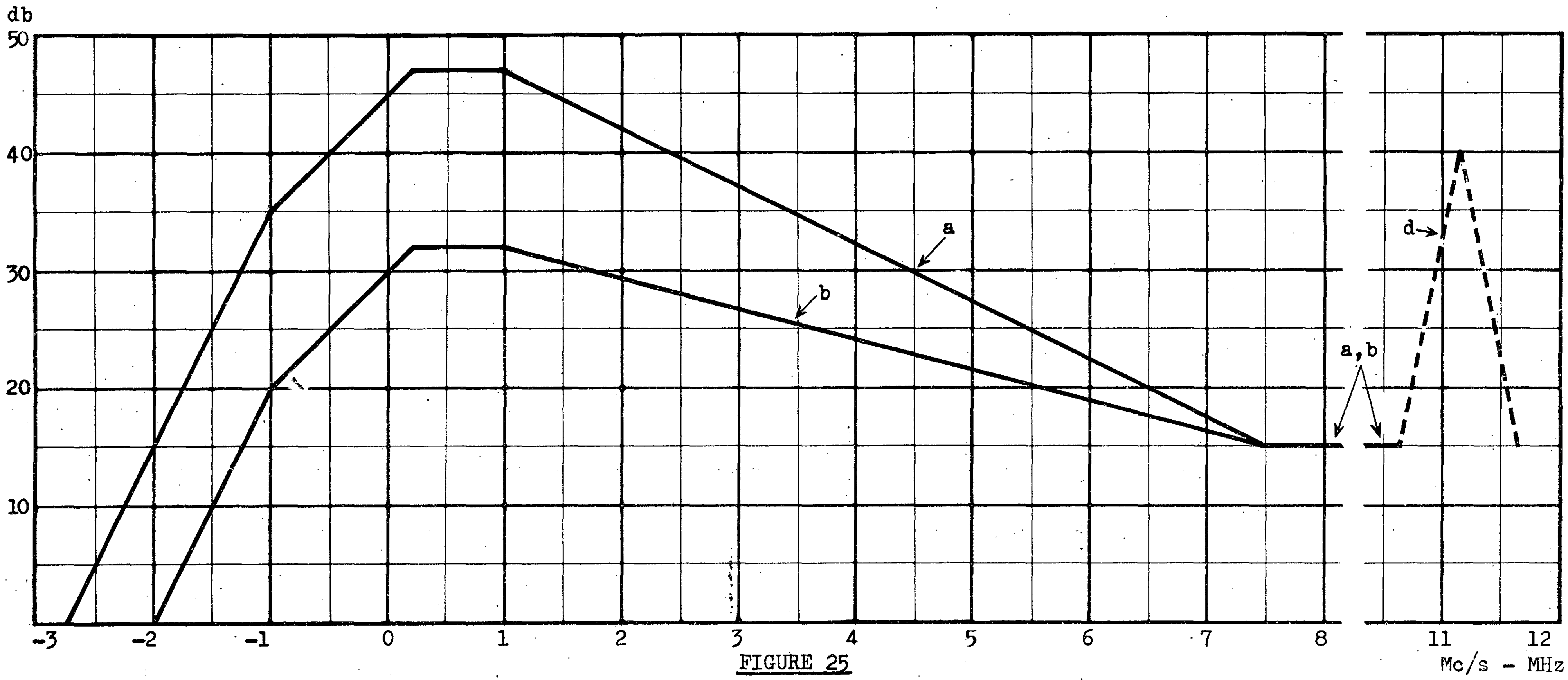

FIGURE 25

819-line system. Protection from vision-signal interference

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

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

Curve b - Interference to vision from an 819-line vision signal when the nominal frequency difference between the wanted and unwanted signal carriers is a multiple of the line frequency (20.475 kc/s) plus or minus one third of the line frequency (6.825 kc/s).

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

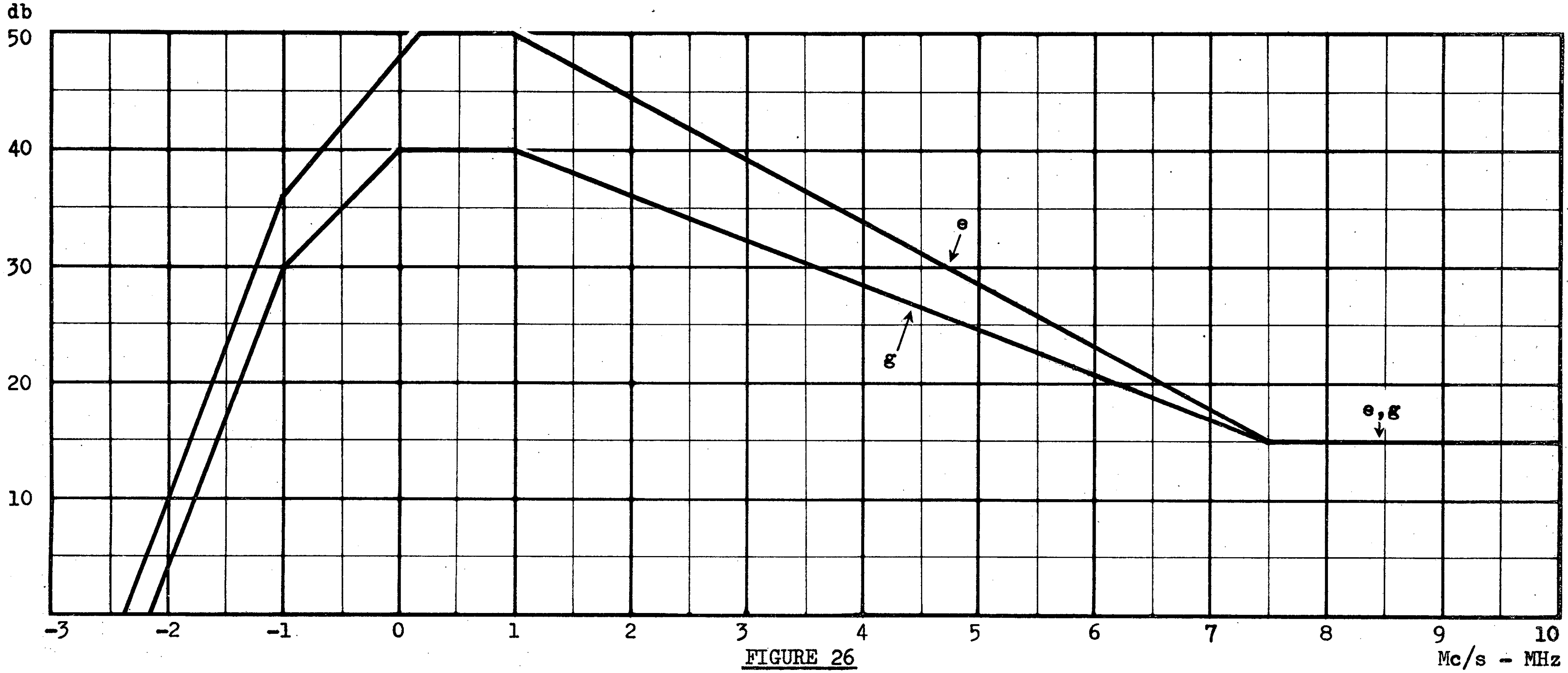

FIGURE 26

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

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

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

Curve g - Interference to vision from a frequency-modulated sound signal when the nominal frequency difference between the wanted signal carrier and the sound carrier during quiescent periods in an odd multiple of half the line frequency (10.2375 kc/s).

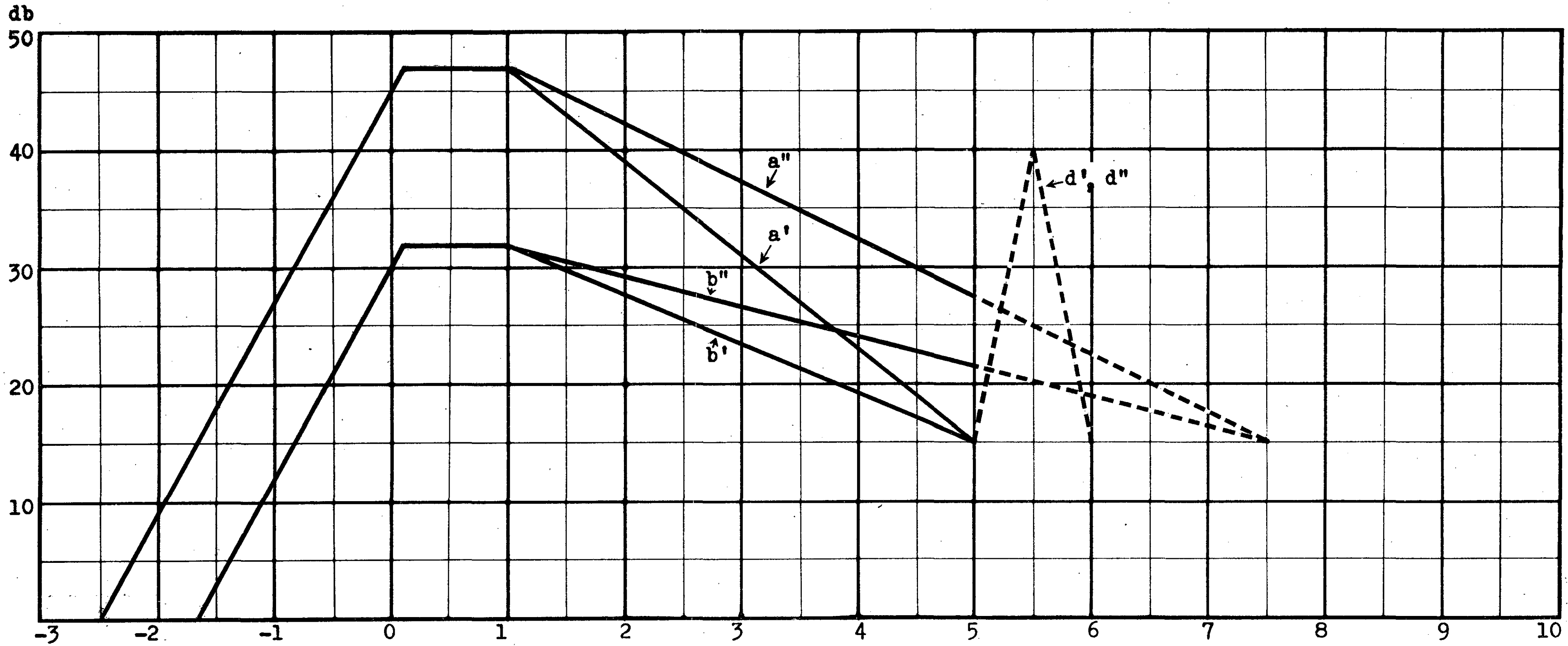

FIGURE 27

Belgian 625-line and 819-line systems. Protection from vision-signal interference

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

Letters with a single prime are used for curves applying to the 625-line system. Letters with double primes are used for curves applying to the 819-line system.

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

Curve b - Interference to vision from a vision signal having the same number of lines when the nominal frequency difference between the wanted and unwanted signal carriers is a multiple of the line frequency (15.625 or 20.475 kc/s) plus or minus one third of the line frequency (5.208 or 6.825 kc/s).

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

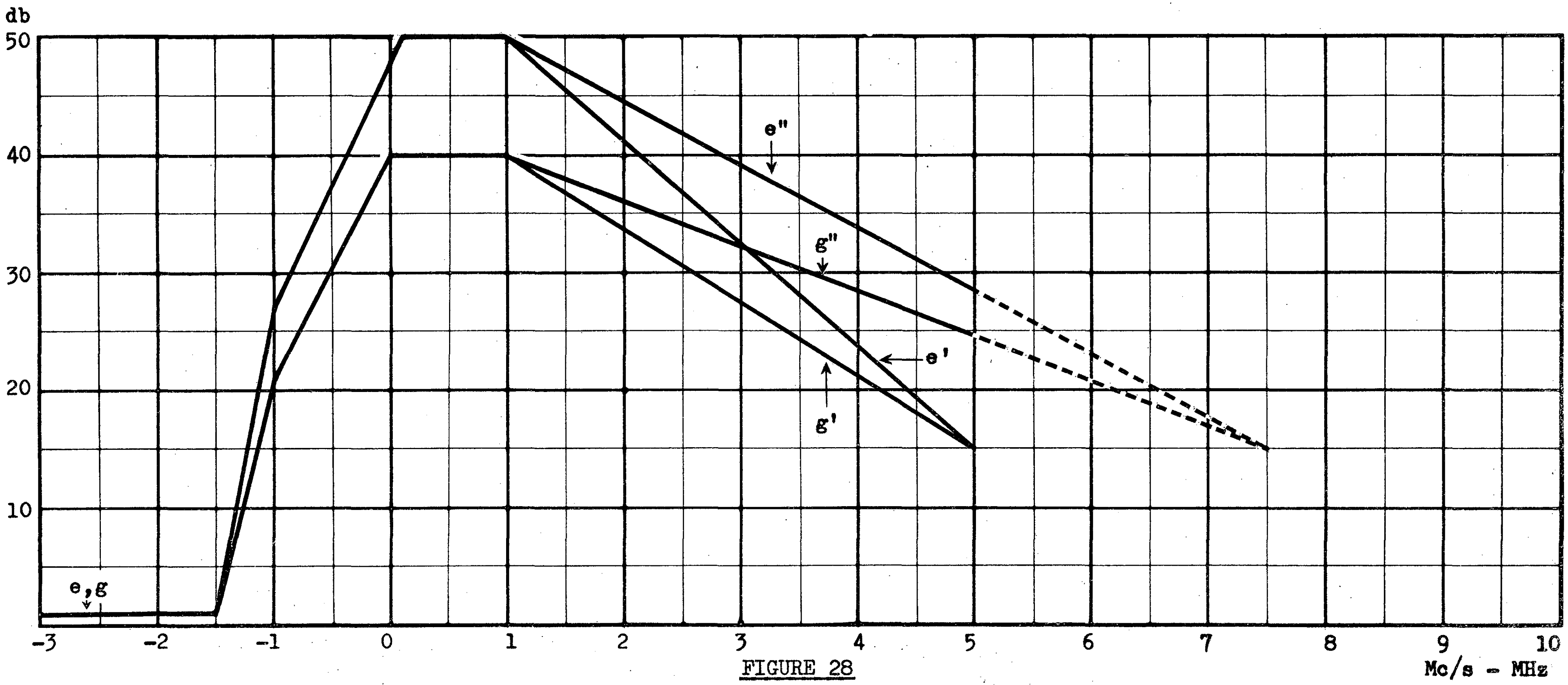

FIGURE 28

Belgian 625-line and 819-line systems. Protection from CW and sound-signal interference

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

Letters with a single prime are used for curves applying to the 625-line system. Letters with double primes are used for curves applying to the 819-line system.

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

Curve g - Interference to vision signal from a CW or frequency-modulated sound signal when the nominal frequency difference between the wanted signal carriers and the sound carrier during quiescent periods is an odd multiple of half the line frequency (7.8125 or 10.2375 kc/s).

3.2.5 Second channel (image channel) interference

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

3.2.6 Protection ratios between sound signals

(a) Wanted and unwanted sound signals frequency-modulated

Just tolerable interference :

- for carriers separated by less than 1000 c/s : 28 db;
- for carriers separated by 5/3 of the line frequency : 20 db.

(b) Wanted and unwanted signals amplitude modulated

Just tolerable interference :

- for carriers separated by frequency below audio range : 30 db;
- for carriers separated by frequency within audio range : 40 db;
- for carriers separated by frequency above audio range : 15 db.

(c) Wanted signal amplitude-modulated, unwanted signal frequency-modulated

Just tolerable interference :

- for carriers separated by frequency below 1000 c/s : 40 db;
- for carriers separated by 25 kc/s : 30 db;
- for carriers separated by 50 kc/s : 12 db.

(d) Wanted signal frequency-modulated, unwanted signal amplitude-modulated

Just tolerable interference : 30 db.

(e) Wanted signal frequency-modulated, unwanted signal vision amplitude-modulated

See the appropriate part d of the protection ratio curves of Figs. 18, 20 and 22.

3.3 Colour television

The protection ratios required by four variants of the 625-line system proposed for use in 8 Mc/s channels in Bands IV and V, when adapted for colour transmission with a colour sub-carrier of 4.43 Mc/s, have been considered. All the ratios given in this section should be regarded as tentative pending decisions upon the type of colour system and the precise parameters to be used. For the purposes of planning it may be assumed that the power in the chrominance channel at peaks of the colour modulation envelope cannot exceed a value 14 db lower than the power in the main carrier at peaks of the modulation envelope.

3.3.1 Co-channel interference - Protection ratios for mutual interferences between any of the four systems

(a) Carriers separated by less than 1000 c/s but not synchronized

Just tolerable interference : 45 db.

(b) Nominal carrier frequencies separated by 1/3, 2/3, 4/3 or 5/3 of the line frequency

Just tolerable interference : 30 db.

(c) Carriers separated by 1/2 or 3/2 of the line frequency

Just tolerable interference : 27 db *.

3.3.2 Adjacent-channel interference

(a) Lower adjacent-channel interference :

The protection ratios are the same as those quoted for monochrome television in the table given in paragraph 3.2.3(b).

(b) Upper adjacent-channel interference :

The protection ratios are the same as those quoted for monochrome television in paragraph 3.2.3(c).

3.3.3 Protection ratio curves

The curves k of Fig. 29 give the estimated protection ratios required by the four variants of the 625-line colour television signal for interference from a CW or frequency-modulated sound signal.

---

* If the wanted signal is 625-lines (I.B.T.O.) or 625-lines (France) and the interfering signal is 625-lines (with vision-to-sound carrier spacing of 5.5 Mc/s) the protection ratio must be increased to 29 db (French system) or to 35 db (I.B.T.O. system) to avoid interference from the unwanted sound signal.

The following designators are used to differentiate between the variants :

1 - 625-line system

2 - 625-line system (United Kingdom)

3 - 625-line system (I.B.T.O.) *

4 - 625-line system (France).

For frequency differences up to 2.85 Mc/s, the curves are the same as those for the corresponding monochrome 625-line systems (see Figure 24, curves e_1, e_2, e_3, e_4). For higher frequency differences, the estimates are based upon the requirements for an adapted N.T.S.C. system.

For interfering signals other than CW or frequency-modulated sound, no curves are given as insufficient information is available.

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* If a vestigial sideband of 1.25 Mc/s is used in a modified 625-line (I.B.T.O.) system, curve k_4 should be used instead of curve k_3 for frequencies located on the same side as the vestigial sideband.

For frequencies located on the opposite side to the vestigial sideband, curve k_4 refers to a system in which the colour information is transmitted by a process of quadrature modulation in which double instead of single-sideband modulation of the chrominance sub-carrier is used (± 1.26 Mc/s relative to the sub-carrier).

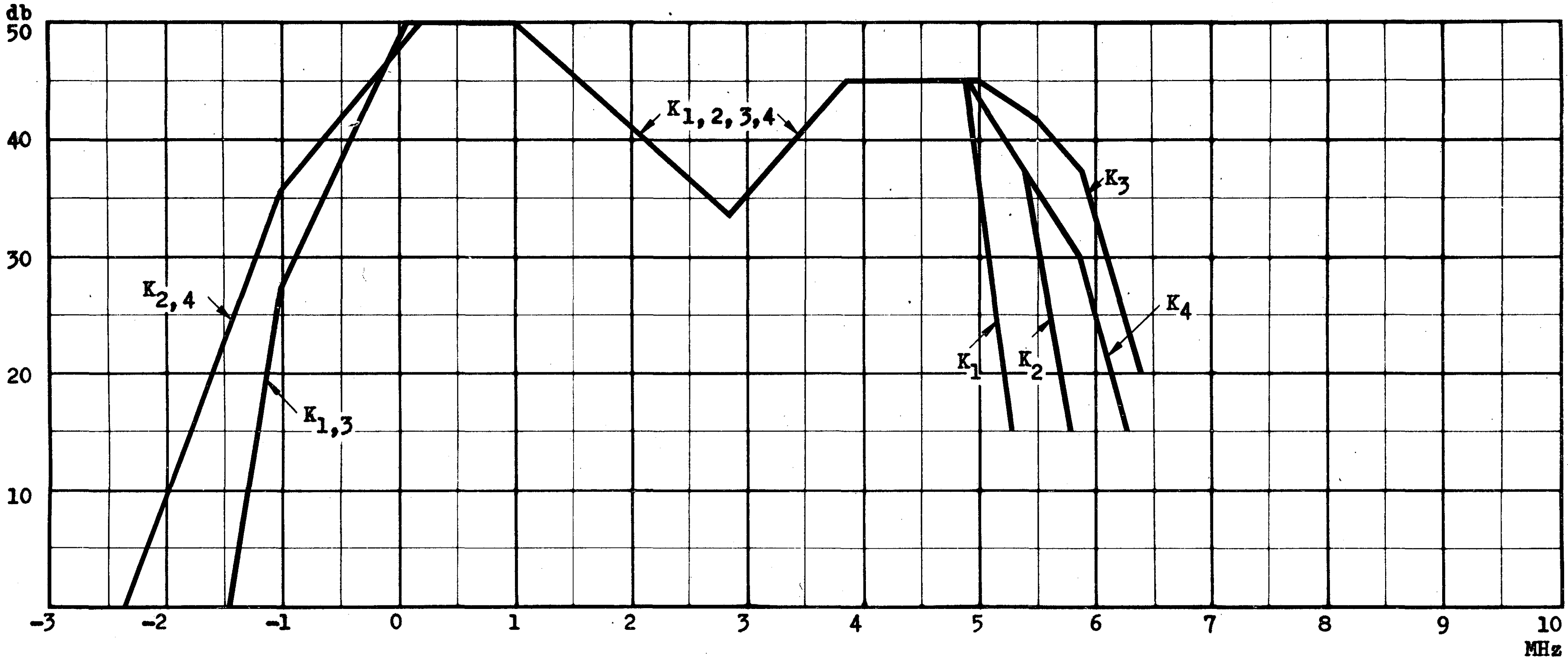

FIGURE 29

Estimated protection ratios for colour television systems

3.4 Multiple interference

3.4.1 To assess the effects of interference from a number of sources, it is recommended that the method known as "simple multiplication method" in which location probabilities of protection are multiplied, should be adopted. This method is fully described in several publications, but a brief explanation, in which no attempt is made to explain the theoretical bases of the method is given below.

The overall location probability of protection is obtained by multiplying together the location probabilities that a given field strength is protected against each separate source of interference.

The field strength protected against each source of interference is first calculated in the usual way, i.e. as the sum of the interfering field strength and the appropriate protection ratio, less any receiving aerial discrimination against the interfering signal.

Next, the protection margin, of deviation, is found in each case by subtracting the protected field strength so obtained from the field strength it is desired to protect. This margin, of deviation, is then converted into a protection probability by finding the probability corresponding to this deviation for a log-normal distribution having a standard deviation of $\sqrt{2}$ times that of the variation with location for the frequency band and the type of terrain concerned. This may be done graphically or from suitable statistical tables.

The product of these separate probabilities of protection then gives the overall probability that protection will occur, from all sources of interference, to the field strength it is desired to protect. Should this product be greater than the required degree of protection, i.e. 50% or 45% or whatever value has been chosen as acceptable, the wanted field strength is adequately protected.

If the product is less than the required figure, this means that a higher field strength than was originally stipulated is protected. The value of this higher field strength is then found as follows : the calculation is repeated for a higher wanted field strength such that a product of the probabilities greater than the required figure may be found. Linear interpolation, either graphically or using an interpolation formula, then enables the wanted field strength which just gives the required percentage probability of protection to be obtained.

Once familiarity with the procedure has been acquired, the amount of the increase in wanted field strength required to make the product of the probabilities just exceed the required figure can be judged with sufficient accuracy to reduce the number of trial calculations necessary. These calculations may be simplified by preparing tables or curves giving the quantity $-10^5 \log_{10}$ of the probability as a function of the margin, or deviation; this quantity may be called the "logarithmic index". In order to multiply the separate probabilities, it is then only necessary to add these logarithmic indices and their sum is then the logarithmic index of the product.

3.4.2 Attention is drawn to the statistical nature of the result and the somewhat pessimistic prediction of coverage given by this method. Engineering judgment must always be used in interpreting the results obtained by either manual or automatic computation, in deciding whether a station has acceptable coverage.

3.4.3 An average allowance of 4 db can be made in the initial preparation of a draft plan for the effect of multiple interference. It must be emphasized that this is an average value; the actual value will be greater or less, according to the degree to which the station concerned is surrounded by other stations producing interference.

3.4.4 Attention is also drawn to the following points :

- The effects of topography on propagation can only be taken into account to a limited extent in electronic calculation by any method.

- Manual computation by the simple multiplication method will be assisted considerably if the "logarithmic index" system described in paragraph 3.4.1 is adopted. Suitable tables or graphs for this purpose can be readily prepared from standard statistical tables. This system will also facilitate the essential final step of interpolation.

- Overseas propagation could involve difficulties for entirely electronic computation. Further study is required on this point, but a combination of manual and electronic calculations would overcome possible difficulties which might arise.

3.5 Protection ratios in the shared bands

A number of data have been communicated to the Conference concerning mutual protection ratios in the following bands : 216-223 Mc/s, 223-230 Mc/s, 582-606 Mc/s and 790-960 Mc/s.

These data are given in Annex III.

PART 4

MINIMUM FIELD STRENGTHS TO BE PROTECTED

4.1 FM sound broadcasting in the VHF band

In confirmation of C.C.I.R. Recommendation No. 263, paragraphs 1 to 4:

- for a maximum frequency deviation of ± 75 kc/s or ± 50 kc/s
- for a pre-emphasis characteristic defined by a curve rising with frequency in conformity with the admittance of a parallel combination of a capacitance and a resistance having a time constant of 50 μs, then:

(a) in the absence of interference from industrial and domestic equipment a minimum field strength* of 50 μV/m can be considered to give an acceptable service;

(b) in the presence of such interference a satisfactory service requires a minimum median field strength* of

0.25 mV/m in rural areas,

1 mV/m in urban areas,

3 mV/m in large cities.

4.2 Television

The minimum field strength at a receiving aerial that will give a satisfactory grade of picture is considered to be as follows:

Band	I	III	IV**	V**
Field strength (db rel. 1 μV/m)	+ 47	+ 53	+ 62	+ 67

These figures make allowance for cosmic noise, receiver noise, aerial gain and feeder loss. The percentage of locations at which protection should be sought and the percentage of time for which protection should be aimed at are planning matters which must be decided upon before making use of the figures.

---

* The field strength is measured 10 metres above ground level.

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

In any case, the median field strength to be protected for 90% to 99% of the time should never be lower than:

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

The exact values to be used in the boundary zone between any two countries should be agreed between the Administrations concerned.

In a practical plan, the field strengths that can be protected will generally be higher than the values quoted above.

---

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

PART 5

PLANNING OF TELEVISION IN BANDS IV AND V

5.1 Data to be taken into consideration in establishing a theoretical pattern of channel distribution

For planning purposes the following data have to be taken into consideration :

(a) total number of channels available;

(b) channel separations for co-sited transmitters;

(c) separation between channels likely to cause interference.

The types of separation between channels likely to cause interference are :

- co-channel without offset,
- co-channel with offset,
- channels giving rise to interference by radiation from local oscillators,
- adjacent channels,
- second (image) channels,
- channels giving rise to an intermediate frequency beat.

Differing views were expressed concerning the relative importance of these types of interference, but it was agreed that the separation distances for local oscillator, adjacent channel and image channel conditions should be of the same order of magnitude.

The table below indicates the channel separations which may give rise to interference in different cases.

Conditions necessary for the establishment of a theoretical lattice

System	Difference in channel numbers									
	2	3	4	5	6	7	8	9	10	11
K		i	o,i	i		od,s	s	s	od	
L	i	w	o	i	w		i	s		
H (Italy)			i	o,i	o,i			s		s
I		w		o	w			s	w	
G, H (others)		w	i	o,i	w			s		

o - oscillator

w - wanted separation for co-sited transmitters

s - second-channel

i - IF beat

d - double frequency-change

Note : The I.B.T.O. stress that the data in the table, line K, are for example only and would need to be confirmed.

5.2 Theoretical lattices used for planning in Bands IV and V

5.2.1 The attached Fig. 30 is the theoretical apportionment pattern for channels in Bands IV and V which was used as a basis for the preparation of a regional plan for channel use by the following countries: the Bielorussian Soviet Socialist Republic, the People's Republic of Bulgaria, the Hungarian People's Republic, the People's Republic of Poland, Eastern Germany, the Roumanian People's Republic, the Czechoslovak Socialist Republic, the Ukrainian Soviet Socialist Republic, and the Union of Soviet Socialist Republics.

5.2.2 After a comparison of the I.B.T.O. theoretical lattice and that of Fig. 31 (E.B.U. proposal), the experts of countries not belonging to the I.B.T.O. and those of Finland considered that the lattice in Fig. 31 might be a very suitable basis for planning.

The French experts consider that the lattice in Fig. 31 is also acceptable to France, since the lattice proposed by France could be deduced from it by changing a few details.

The Delegate of the United Kingdom also expressed the view that it would not be too difficult to meet the requirements of his country if the lattice in Fig. 31 were used as the basis for the preparation of a plan applicable to the whole of the continent.

5.2.3 The practical planning stage will have to be awaited for the matching of the I.B.T.O. and E.B.U. lattices, since no theoretical solution has been found. Sacrifices are necessary on both sides of the dividing line.

5.3 Practical application of theoretical patterns of channel distribution

The theoretical patterns for planning in Bands IV and V were used in the following way. The European Broadcasting Area is divided into quadrilaterals which meet certain conditions; one of these is that the number of transmitters (not transmitter sites) in each quadrilateral must not exceed the number of channels available in that region. By arranging for the number of transmitters to be 10% to 20% less, depending on the severity of conditions to be met (such as may be imposed by population density, topography or other factors) the flexibility required can be achieved. For instance, for regions in which a large number of satellites and low-powered transmitters are projected, the actual amount of this margin between the number of transmitters and the number of frequencies available would be greater than in other regions.

5.4 Definition of service area

The boundaries of a service area are given by the distances from the transmitter at which the field strength of the wanted signal at 50% of locations and 50% of the time has a value equal to that of the so-called "protected field strength", as determined by the method of Section 3.4.

The value of the protected field strength depends upon the grade of service chosen.

Three different grades of service : A, B and C were considered :

Grade	Percentage	
	Locations	Time
A	70%	99% *
B	50%	99% *
C	45%	90%

* If oversea propagation occurs, the value of 95% of the time may be taken instead of 99% of the time.

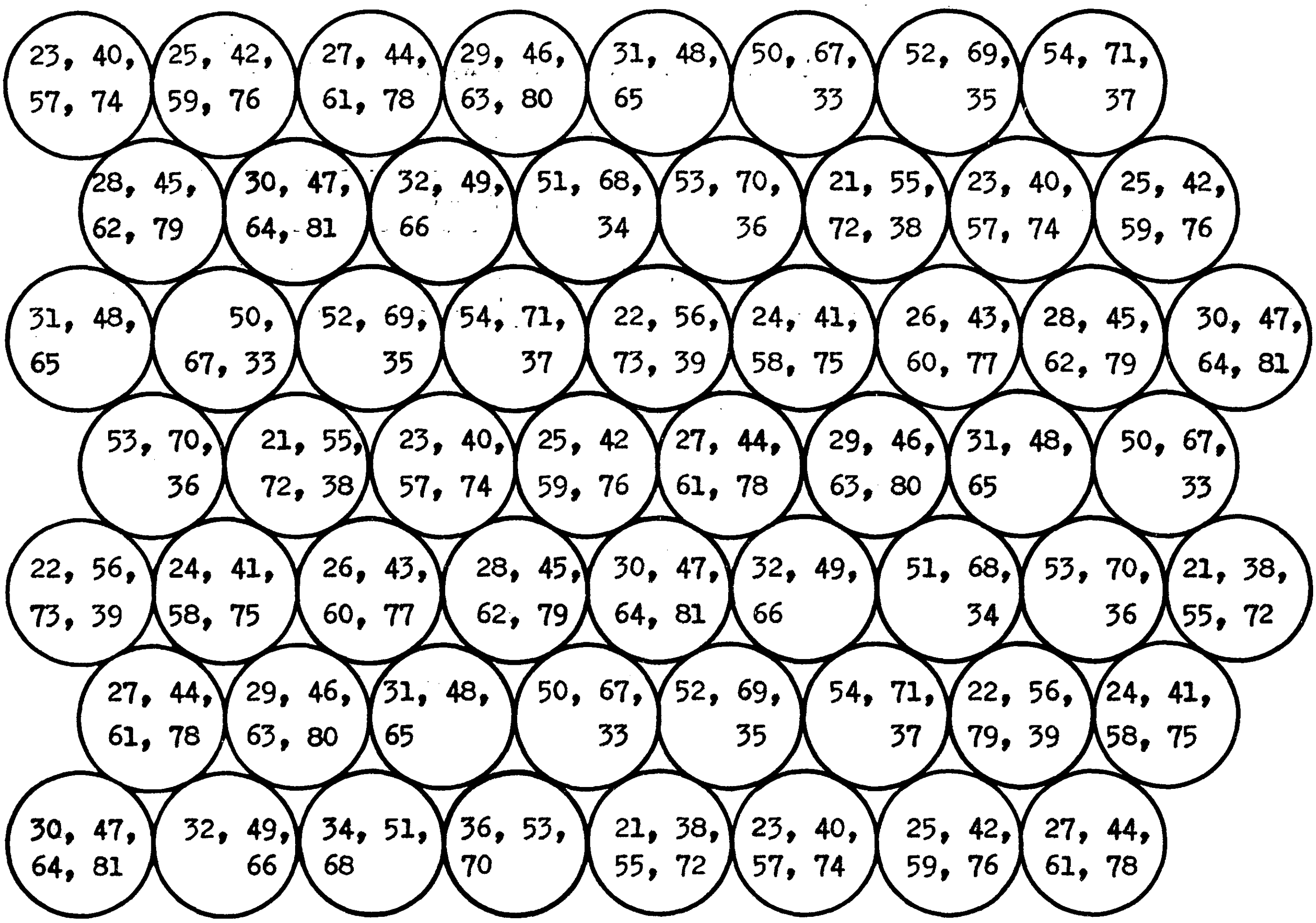

FIGURE 30

Theoretical apportionment of channels in Bands IV and V, in countries using the I.B.T.O. standard

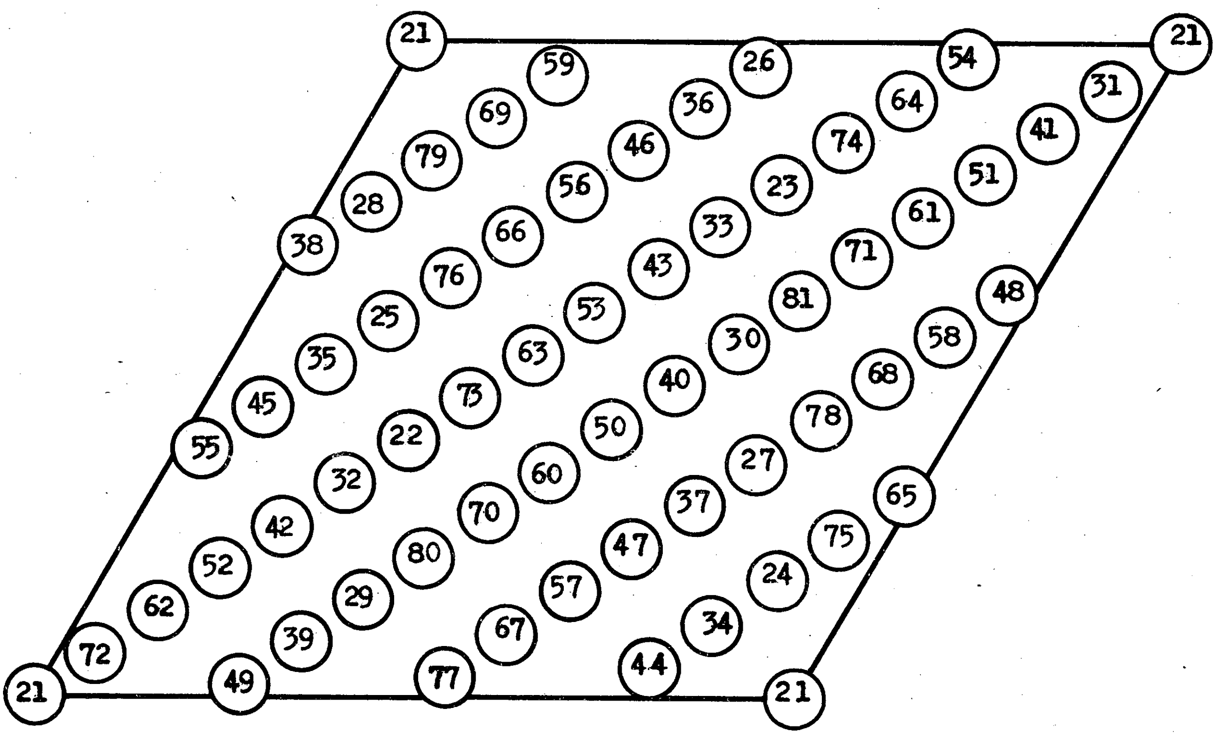

FIGURE 31

Theoretical apportionment of channels in Bands IV and V, proposed by the E.B.U.

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ANNEX I

REPORT No. 122 *

ADVANTAGES TO BE OBTAINED BY USING ORTHOGONAL WAVE POLARIZATIONS IN THE PLANNING OF BROADCASTING SERVICES IN THE VHF (METRIC) AND UHF (DECIMETRIC) BANDS

Television and sound

(Question No. 101)
(Study Group No. XI)

(Warsaw, 1956 - Los Angeles, 1959)

Investigations have been conducted in several countries to ascertain the advantages which can be obtained in sound and television broadcasting by using polarization discrimination in reception. The results of extensive studies made in Europe by the Federal German Republic, France, Italy and the United Kingdom and also in the United States of America, have been made available in documents at Warsaw (1956) and Geneva (1958); and a reasonably definite answer may now be given to the question.

1. VHF (metric) band

In this band of frequencies between 30 and 300 Mc/s, the median value of discrimination that can be achieved at domestic receiving sites by the use of orthogonal polarization may be as much as 18 db, and under these conditions, the values exceeded at 90% and 10% of the receiving sites are about 10 db and 25 db respectively.

The values of discrimination are likely to be better in open country and worse in built-up areas or places where the receiving antenna is surrounded by obstacles. For domestic installations in densely populated districts the median values of 18 db will usually only be realized at roof level; and this value may be reduced to 13 db or less at street level.

No significant changes in the polarization of metric waves due to transmission through the troposphere have been observed over distances exceeding 200 km. Furthermore, there have been no reports of systematic changes in polarization effects with frequency in the metric band, nor with distance nor type of terrain.

It must be emphasized, however, that in order to realise the discrimination ratios mentioned above, certain precautions are necessary at both the transmitting and receiving installations; cases have been reported in which for a transmitter of horizontally polarized waves, some 7% of the radiated power was

* This Report, which replaces Report No. 85, was adopted unanimously.

vertically polarized. It is clear that if the best discrimination is to be obtained for co-channel operation, the transmitters and antenna systems must be designed and installed so as to radiate as much as possible of the total power on the assigned polarization.

In the same way, in order to achieve the desired discrimination at the home receiving installation, the reception of the undesired orthogonally polarized waves on the antenna feeder and on the receiver itself must be reduced to the minimum practicable value.

2. UHF (decimetric) band

Experiments have been conducted in the United Kingdom using horizontally polarized radiation on a frequency of about 500 Mc/s. Systematic measurements were made to determine the polarization discrimination at typical urban and rural sites at distances up to about 55 km from the transmitter. The results showed that the discrimination obtained is similar to that already described above for frequencies in the VHF band, although the factor exceeded for 90% of the receiving sites was only 8 db (as compared with 10 db for VHF). It is to be noted, however, that the transmitting antenna in use had considerable directivity, and there was a marked decrease in the polarization discrimination for directions of reception some 40° away from the direction of maximum radiation.

As in the VHF band, care is necessary to ensure that the transmitter and receiver respectively do not emit or receive radiation of the undesired polarization. Apart from this, however, experience indicates that in the UHF band, the use of horizontal polarization offers advantages, because of the greater directivity obtainable at the receiving antennae; this reduces the effect of reflected waves, particularly in town areas. The European Broadcasting Union, therefore, considers that frequency assignments in these bands should be based on the general use of horizontal polarization, though exceptions may be made in cases where orthogonal polarization is necessary to achieve the desired protection.

3. Conclusion

From the studies described above, it is clear that the use of orthogonal polarization for broadcasting stations operating in the same frequency channel is of material assistance in discriminating against the reception of undesired signals. Worth-while advantages are obtainable over the whole band of frequencies from 40 to 500 Mc/s and within the normal broadcasting service ranges. From the uniformity of the discrimination obtained over these frequencies, it is considered to be almost certain that the advantages will extend to the top of the UHF broadcasting band at nearly 1000 Mc/s.

This Report is considered to provide a sufficient answer to Question No. 101 for practical use, and this Question should now be concluded.

Bibliography : Documents Nos. 267, 435 and 512 (Warsaw, 1956)
Documents Nos. V/1, V/6, V/12, V/23 and V/27 (Geneva, 1958).

ANNEX II

THE INFLUENCE ON PROTECTED FIELD STRENGTH AND COVERAGE OF REDUCING THE CARRIER FREQUENCY SPACING IN A VHF SOUND BROADCASTING NETWORK

The following is a summary of theoretical and practical work carried out in the Federal Republic of Germany:

The protected field strengths and coverage for a series of hypothetical VHF sound broadcasting networks of regular geometrical shape, with various separations of the channel carrier frequencies, have been calculated. A constant value for the power of the transmitters has been assumed, but this has no influence on the result if the extent of the service area is determined by interference from other transmitters rather than by receiver noise. Four different distances between transmitters (30, 35, 40 and 45 km) and four aerial heights (75, 150, 300 and 600 m) were used for these calculations.

Similar calculations were subsequently carried out for the 168 VHF transmitters in the Federal Republic of Germany, using the powers, distances between transmitters and aerial heights actually existing.

If a smaller separation between the carrier frequencies of adjacent channels is used, the number of channels available in a given frequency band is increased. Thus, if the frequency separation is decreased from 300 kc/s, at present used in the Federal Republic of Germany, to 100 kc/s, the number of channels available is multiplied by a factor of three, and this implies that, on average, the distance between co-channel transmitters may be increased by a factor $\sqrt{3}$, and interference between these transmitters will be decreased accordingly. On the other hand, interference from stations in channels separated by 100 or 200 kc/s from the wanted channel will arise.

The result of these calculations is to show a considerable decrease of the protected field strength, and therefore an important improvement of coverage when the carrier frequency separation is reduced from 300 kc/s to a smaller value. The optimum spacing was found to be of the order of 100 kc/s but the exact value is not critical.

In order to verify this theoretical work, a frequency plan, using separations of 100 kc/s was drafted, and 25 transmitters in the Federal Republic of Germany were assigned frequencies in the range of $\pm$ 500 kc/s relative to the frequency of one of them which was considered to be the wanted station. The frequencies of these transmitters were changed in accordance with the 100 kc/s plan during the night hours for a period of two weeks. To make allowance for interference from transmitters situated in neighbouring countries, the power of certain transmitters near the borders was increased.

All transmitters were modulated with normal programme material, except the wanted transmitter, which transmitted a special programme particularly susceptible to interference. This transmitter was situated approximately in the centre of the network used for the tests, and its service area is practically flat to the north and hilly or mountainous to the south.

Field strengths were measured and subjective assessments of the quality of the received programme were made throughout the whole service area of the wanted station. The calculated increase of the service area was confirmed by these measurements and observations, and no additional interference effects were observed.

ANNEX III

PROTECTION RATIOS IN THE SHARED BANDS

The technical data given below were submitted to the Committee concerned for information or guidance in its work. However, some delegates made reservations as to the prospect of fulfilling the technical criteria in the actual planning.

1. Television and radionavigation in the bands 216-223 and 223-230 Mc/s

The aeronautical radionavigation service, known as D.M.E. (distance measuring equipment), employs ground based beacons with a peak pulse power of 1 kW. The airborne receivers operate to a maximum range of about 300 km and at heights up to 20 000 metres.

The protection ratios necessary for satisfactory operation of the equipment have been determined by experiment to be as follows:

Within the receiver pass-band of ± 1.4 Mc/s	+ 6 db
± 2 Mc/s from the centre of the pass-band	- 3 db
± 3 Mc/s from the centre of the pass-band	-20 db
± 4 Mc/s from the centre of the pass-band	-39 db

At the maximum operating range and height the D.M.E. airborne receiver will be within optical range of the D.M.E. beacon and the received field strength will be approximately equivalent to the free space field for a distance of 300 km (see C.C.I.R. Second Atlas of Groundwave Propagation Curves). To afford a protection ratio of at least 6 db an interfering television transmitter also at a distance of 300 km from the D.M.E. receiver would need to be limited to an E.R.P. of 250 watts. A geographical separation of 600 km would therefore, in general, be required between the D.M.E. beacon and an interfering transmitter of 250 watts E.R.P.

If the operational range of the D.M.E. system is less than the maximum range of 300 km the necessary separation distance is correspondingly reduced. The required separation distance is also reduced as the frequency separation of the centre of the D.M.E. receiver pass-band and the vision or sound carrier frequency of the interfering television transmission increases.

The required separation distance increases rapidly as the power of the interfering television station is increased but beyond the distance at which the path between the airborne D.M.E. receiver and the television station is no longer optical a large increase in the power of the television station will require a comparatively small increase in the separation distance.

On the basis of the data given above and making use of the C.C.I.R. Second Atlas the following table, giving the required geographical separation distances, has been prepared.

Separation between D.M.E. frequency and vision or sound carrier frequency of interfering television station (Mc/s)	E.R.P. of television transmitter (kW)	Necessary separation between D.M.E. beacon and interfering television station for D.M.E. range of 300 km (km)
± 1.4 Mc/s	0.1	520
	1	900
	10	970
	100	990
	1000	1000
2	0.1	350
	1	500
	10	950
	100	970
	1000	990
3	0.1	-
	1	320
	10	400
	100	600
	1000	950
4	0.1	-
	1	-
	10	-
	100	320
	1000	400

Using the same basic material similar tables can be prepared for values of the maximum D.M.E. range different from 300 km.

For low-power television stations there are other considerations to be taken into account. If, for example, a television station was sited very close to the D.M.E. beacon, from consideration of interference to the D.M.E. airborne receiver only, it could operate with an E.R.P. of the order of 250 watts since this would provide the necessary protection ratio of 6 db at the airborne D.M.E. receiver at all ranges. Correspondingly higher E.R.P. could be accepted when the vision or sound carrier frequencies of the television stations are separated by more than ± 1.4 Mc/s from the D.M.E. frequency

For a frequency separation of 3 Mc/s or more, a television station with an E.R.P. of 0.1 kW may be sited anywhere within or beyond the service area of the D.M.E. beacon and for a frequency separation of 4 Mc/s the permissible E.R.P. is increased to about 5 kW. However, where low-power television stations may be sited close to a D.M.E. beacon special consideration will have to be given to the question of possible interference to the ground receiver of the D.M.E. station.

2. Television and radionavigation in the band 582-606 Mc/s

2.1 Protection required by television

The United Kingdom has made subjective tests to determine the protection ratio required by television against interference from typical radionavigation equipment in the band 582-606 Mc/s. It has been found that when the radionavigation signal falls within the pass-band of the television receiver a signal/interference ratio of 10 db is required (the level of the television signal is expressed in terms of the power at peaks of the modulation envelope and that of the radionavigation signal as the peak pulse level). This ratio is sensibly constant over the greater part of the television receiver pass-band but decreases in accordance with the selectivity of the receiver as shown in Figure 32. It is considered that the protection ratios indicated by Figure 32 should, in general, be afforded for at least 99% of the time.

Two main types of radionavigation equipment are used in the band 582-606 Mc/s having effective radiated powers (peak pulse power) of approximately 80 MW and 800 MW. To afford a protection ratio of 10 db for at least 99% of the time to a television signal of 3 mV/metre, the following geographical separations between the television receiver and the interfering radionavigation station are necessary.

E.R.P. of radionavigation station	Separation distances	
800 MW	(High site	- 330 km
	(Low site	- 170 km
80 MW	(High site	- 250 km
	(Low site	- 100 km

In arriving at these figures no account has been taken of the rejection of the interfering signal that the television receiving aerial may afford.

2.2 Protection required by radionavigation

Studies made to determine the tolerable interference from television to typical radionavigation equipment in the band 582-606 Mc/s have shown that the performance of the radionavigation equipment will be degraded if the level of an interfering signal falling within the pass-band of the radionavigation equipment exceeds -10 db relative to 1 µV/metre. The tolerable level of the interfering television signal (expressed in terms of the vision signal level) varies with the relative positions of the vision carrier frequency and the centre frequency of the pass-band of the radionavigation receiver in accordance with Figure 33. This assumes a 625-line television transmission with a colour sub-carrier 4.43 Mc/s above the vision carrier frequency and a sound carrier of 6 Mc/s above the vision carrier frequency. It is considered that the maximum tolerable interfering field strengths shown by Figure 32 should not be exceeded for more than 1% of the time.

Television stations in the band 582-606 Mc/s may have effective radiated powers ranging from about 1 kW to 1000 kW. The geographical separations required between television stations and radionavigation stations in order to ensure that the proposed interfering signal levels are not exceeded are as follows:

E.R.P. of television station (kW)	Separation of distances (km)	
	(a) when the vision carrier of the interfering television stations falls in the radionavigation receiver pass-band	(b) when the vision carrier falls (for example) 3 Mc/s below the centre of the pass-band of the radionavigation receiver
1	330	110
10	430	170
100	540	240
1000	650	330

The delegation of France accepted these figures, which it regards as average values when no natural protection can be expected in the neighbourhood of the radionavigation station.

3. <u>Television and Fixed Services in the band 790-960 Mc/s</u>

3.1 <u>Portable equipment for fixed services</u>:

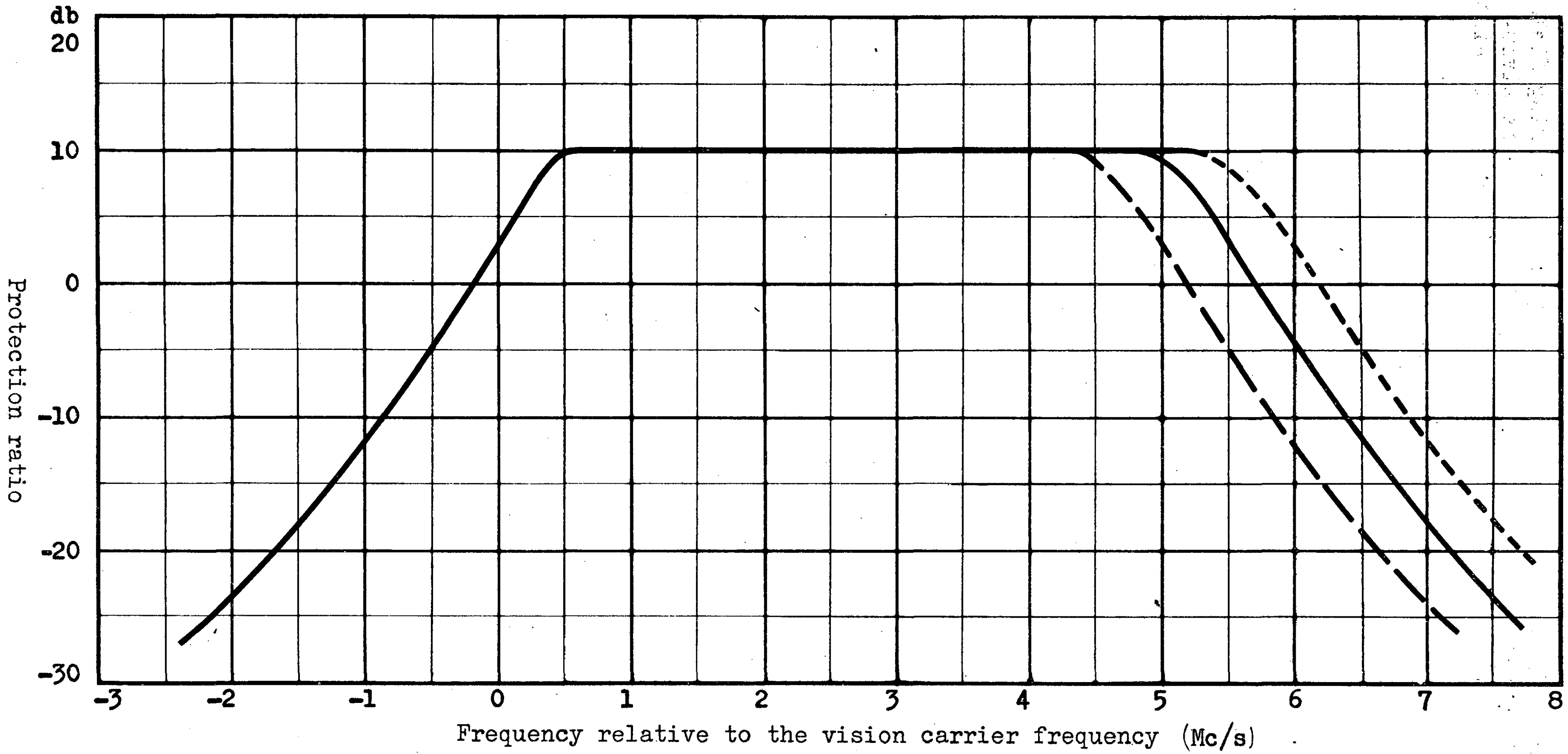
The minimum field strength of the fixed service to be protected for 90% of the time is 6 to 10 µV/m (14 to 20 db above 1 µV/m), and the necessary protection ratio is approximately 10 db in directions other than the main lobe.

3.2 <u>Non-portable equipment for fixed services</u>:

The maximum tolerable values of interfering field strength occurring for not more than 1% of the time for interfering signals arriving in directions outside the main lobe of the receiving aerial is 14 to 34 db relative to 1 µ/V/m, the exact value depending upon the characteristics of the system used, in particular the receiver bandwidth. The tolerable values are much lower for directions within the main lobe.

In general, the gain of the receiving aerial will be less for narrow-band systems than for wide-band systems, and figures of 20 db and

40 db respectively are typical. The maximum tolerable interfering field for 1% of the time for directions within the main lobe of the receiving aerial will therefore in the general case be of the order of -6 db relative to 1 μV/m.



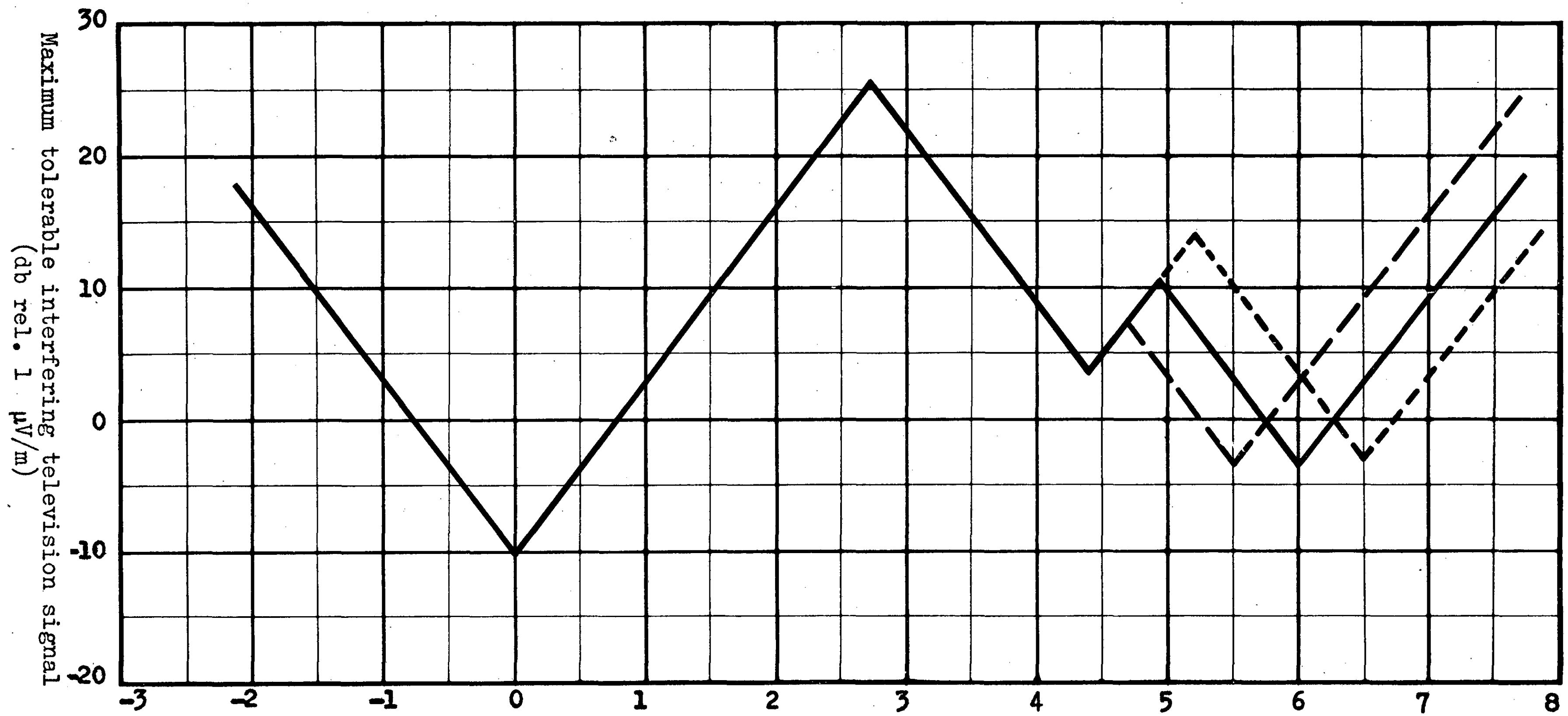
Television system with vision/sound spacing - 6 Mc/s

Estimated values for a television system with 5.5 Mc/s spacing

Estimated values for a television system with 6.5 Mc/s spacing

FIGURE 32

Protection ratio required by television against radionavigation in the band 582-606 Mc/s



Centre frequency of pass-band of radionavigation receiver relative to the vision carrier frequency of the interfering television signal (Mc/s)

——————— Television system with a vision/sound spacing - 6 Mc/s

— — — — Estimated values for television systems with 5.5 Mc/s spacing

--------- Estimated values for television systems with 6.5 Mc/s spacing

FIGURE 33

Maximum tolerable interfering signal-strength for the protection of radionavigation against television in the band 582 - 606 Mc/s

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