



XVIIth PLENARY ASSEMBLY
DÜSSELDORF, 1990



INTERNATIONAL TELECOMMUNICATION UNION

REPORTS OF THE CCIR, 1990

(ALSO DECISIONS)

ANNEX TO VOLUME X – PART 1

BROADCASTING SERVICE (SOUND)

CCIR INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

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INDEX OF TEXTS WHICH HAVE BEEN DELETED
AT THE END OF THE STUDY PERIOD 1986-1990

(In order to facilitate the retrieval of a given text, the page number of Volume X-1 of the XVith Plenary Assembly, Dubrovnik 1986, is indicated.)

ANNEX TO VOLUME X-1

Text	Title	Page No. Vol. X-1 Dubrovnik, 1986
Report 616-3	Practical aspects of MF broadcasting coverage	34
Report 619	Sky-wave reception in LF, MF and HF broadcasting	62
Report 461	Reduction of sky-wave in MF broadcasting	75
Report 32-5	Transmitting antennas in HF broadcasting	115
Report 1062	A set of simplified HF antenna patterns for planning purposes	119
Report 617-2	Sound-broadcasting receivers and receiving antennas	138
Report 465-3	Determination of the subjective loudness of a broadcasting programme	283
Report 797-2	Determination of the acoustical properties of control rooms and high-quality listening rooms in broadcasting	300
Decision 52	Reference sound-broadcasting receivers for planning purposes	366
Decision 73	CCIR studies to be carried out in the inter-sessional period for submission to the Second Session of the WARC ORB-88	371

ANNEX TO VOLUME X-1

BROADCASTING SERVICE (SOUND)

(Study Group 10)

TABLE OF CONTENTS

	Page
Plan of Volumes I to XV, XVIIth Plenary Assembly of the CCIR (see Volume X-1 - Recommendations)	
Distribution of texts of the XVIIth Plenary Assembly of the CCIR in Volumes I to XV (see Volume X-1 - Recommendations)	
Table of contents	I
Numerical index of texts	V
Index of texts deleted	VII
 <u>Section 10A-1 - Amplitude-modulation sound broadcasting in bands 5 (LF), 6 (MF) and 7 (HF)</u>	
Report 1058 Minimum AF and RF signal-to-noise ratio required for broadcasting in band 7 (HF)	1
Report 1201 Number of HF sound broadcasting transmitters using a single channel	6
Report 516-4 Field strength resulting from several electromagnetic fields	8
Report 401-6 Transmitting antennas in LF and MF broadcasting	13
Report 1063 Prediction and control of re-radiation in MF broadcasting	18
Report 458-5 Characteristics of systems in LF, MF and HF broadcasting	24
Report 1059-1 Characteristics of single-sideband systems in HF broadcasting	34
Report 1061-1 Transmission of supplementary information in amplitude modulation sound broadcasting	51
Report 1060-1 Energy saving methods in amplitude modulation broadcasting and their influence on reception quality	60

Report 943-1	Protection of sound-broadcasting stations against atmospheric electricity	64
--------------	---	----

Section 10A-2 - Sound broadcasting in the Tropical Zone

Report 303-3	Determination of the effects of atmospheric noise on the grade of reception in the Tropical Zone	69
Report 302-1	Interference to sound broadcasting in the shared bands in the Tropical Zone	70
Report 304-3	Fading characteristics for sound broadcasting in the Tropical Zone	81
Report 472-2	Single-sideband reception for re-broadcasting applications within the Tropical Zone	99

Section 10B - Frequency-modulation sound broadcasting in bands 8 (VHF) and 9 (UHF)

Report 1066-1	Control of modulation level in FM sound broadcasting ...	103
Report 947	Radio-frequency protection ratio required by FM sound broadcasting in the band between 87.5 MHz and 108 MHz against interference from D/SECAM television transmissions	105
Report 1064-1	Particular interference cases in FM broadcasting	108
Report 1202	Protection ratio for FM sound broadcasting in the case of the same programme and synchronized signals	117
Report 1065	The RF spectrum of frequency-modulation sound-broadcasting transmitters	121
Report 464-5	Polarization of emissions in frequency-modulation broadcasting in band 8 (VHF)	127
Report 944	Theoretical network planning	133
Report 945-2	Methods for the assessment of multiple interference	147
Report 946-1	Frequency-planning constraints on FM sound broadcasting in band 8 (VHF)	169
Report 300-7	Stereophonic or multi-dimensional sound in frequency-modulation sound broadcasting	173
Report 463-5	Transmission of several sound programmes or other signals with a single transmitter in frequency-modulation sound broadcasting	177
Report 1067	Improvement of the reception quality in automobiles for frequency modulation sound broadcasting in band 8 (VHF)	184

Report 1203	Digital sound broadcasting to mobile, portable and fixed receivers using terrestrial transmitters	191
Report 1198	Compatibility between the broadcasting service in the band 87.5 - 108 MHz and the aeronautical services in the band 108 - 136 MHz (Published separately)	204
Report 795-3	Transmission of two or more sound programmes or information channels in television	205

Section 10C - Audio-frequency characteristics of sound-broadcasting signals

Report 292-6	Measurement of programme level in sound broadcasting ...	223
Report 1072-1	Suitable sound systems to accompany high-definition and enhanced television systems	227
Report 798-2	Simulated programme signals	236
Report 1068	Digital audio coding standards	238
Report 1199	Low bit-rate digital audio coding systems	241
Report 1069	Digital audio interface for the interconnection of digital broadcasting studios with digital transmission networks	248
Report 1070	Quality measurement methods for digital sound	249
Report 799-2	Subjective assessment of quality of sound in broadcasting using digital techniques	250
Report 1200	The effect of delay in sound-programme operations	252
Report 1204	Automatic synchronization of video and audio after transmission	256
Report 1071	Sampling frequency conversion and synchronization of digital sound signals	261
Report 953-2	Digital coding for the emission of high-quality sound signals in satellite broadcasting (15 kHz nominal bandwidth) (see Annex to Part 2 of Volumes X and XI).....	262
Report 1237	Satellite news gathering (see Annex to Volume XII).....	262

Section 10D - Recording of sound programmes (see Annex to Part 3 of Vols. X and XI)

Section 10E - Broadcasting service (sound) using satellites (see Annex to Part 2 of Vols. X and XI)

Decisions

Decision 18-6	Digital systems for the transmission of sound-programme and television signals	267
Decision 71-1	Continuation of studies on compatibility between the aeronautical radionavigation service in the band 108-117.975 MHz, the aeronautical mobile (R) service in the band 117.975-137 MHz and the FM sound broadcasting stations in the band about 87-108 MHz (Published separately)	272
Decision 72-1	Data broadcasting services	273
Decision 76-1	Satellite News Gathering (SNG)	275
Decision 78	Acoustical quality parameters for listening conditions ..	278
Decision 79-1	Calculation of the radiation patterns of LF, MF and HF antennas	280
Decision 87	Determination of the coordination area (see Annex to Part 2 of Vols IV and IX)	283
Decision 94	Multi-channel sound systems (<u>Especially suited to accompany high-definition and enhanced television systems</u>)	284
Decision 95	Subjective assessment of sound and television picture quality	287
Decision 96	CCIR studies to be carried out for submission to the World Administrative Conference (WARC-93) dealing with matters connected with the HF broadcasting service	291
Decision 97	Sharing criteria between broadcasting and fixed and mobile services in the band 2-30 MHz	295
Decision 98	Low bit-rate digital audio coding systems	298
Decision 99	System design for HF broadcasting	301

NUMERICAL INDEX OF TEXTS

ANNEX TO VOLUME X-1

Page

SECTION 10A-1:	Amplitude-modulation sound broadcasting in bands 5 (LF), 6 (MF) and 7 (HF)	1
SECTION 10A-2:	Sound broadcasting in the Tropical Zone	69
SECTION 10B:	Frequency-modulation sound broadcasting in bands 8 (VHF) and 9 (UHF)	103
SECTION 10C:	Audio-frequency characteristics of sound- broadcasting signals	223
SECTION 10D:	Recording of sound programmes (see Annex to Part 3 of Vols. X and XI)	
SECTION 10E:	Broadcasting service (sound) using satellites (see Annex to Part 2 of Vols. X and XI)	

REPORTS	Section	Page	REPORTS	Section	Page
292-6	10C	223	1059-1	10A-1	34
300-7	10B	173	1060-1	10A-1	60
302-1	10A-2	70	1061-1	10A-1	51
303-3	10A-2	69	1063	10A-1	18
304-3	10A-2	81	1064-1	10B	108
401-6	10A-1	13	1065	10B	121
458-5	10A-1	24	1066-1	10B	103
463-5	10B	177	1067	10B	184
464-5	10B	127	1068	10C	238
472-2	10A-2	99	1069	10C	248
516-4	10A-1	8	1070	10C	249
795-3	10B	205	1071	10C	261
798-2	10C	236	1072-1	10C	227
799-2	10C	250	1198	10B	204
943-1	10A-1	64	1199	10C	241
944	10B	133	1200	10C	252
945-2	10B	147	1201	10A-1	6
946-1	10B	169	1202	10B	117
947	10B	105	1203	10B	191
953-2	10C	262	1204	10C	256
1058	10A-1	1	1237	10C	262

Note - Decisions which already appear in numerical order in the table of contents, are not reproduced in this index.

SECTION 10A-1 : AMPLITUDE-MODULATION SOUND BROADCASTING IN BANDS 5 (LF), 6 (MF)
AND 7 (HF)

REPORT 1058

**MINIMUM AF AND RF SIGNAL-TO-NOISE RATIO REQUIRED FOR
BROADCASTING IN BAND 7 (HF)***

(Question 44/10, Study Programme 44B/10)

(1986)

1. Introduction

The RF signal-to-noise ratio at the receiver input depends, apart from other factors, on audio frequency S/N ratio for a defined grade of performance. Since the majority of the physiological and psychological factors ultimately influence only the AF signal-to-noise ratio, a series of subjective listening tests were carried out in India and the USSR to assess the minimum acceptable value of this ratio, from which the equivalent RF signal-to-noise ratio at the input of the receiver may also be derived.

* The First Session of the World Administrative Radio Conference for the Planning of HF Bands Allocated to the Broadcasting Service (WARC HFBC(1)) has already considered the content of the documents mentioned in the reference and adopted a value of 24 dB for AF signal/noise ratio for planning purposes.

2. Tests carried out in India [CCIR, 1982-86a]

2.1 Experimental procedure

2.1.1 A variety of pre-recorded programme samples (spoken word, instrumental music, vocal classical music and western music) played back from a tape deck were mixed with white noise obtained from a random noise generator. The bandwidth setting of the noise generator was kept at 20 kHz. These programme samples mixed with noise were recorded on a magnetic tape through a filter with a cut-off frequency of 3 kHz (3 dB attenuation) and an attenuation slope of 24 dB per octave. These filter characteristics represent the characteristics of an average HF receiver in India. Each sample was recorded for different combinations of signal-to-noise ratio ranging from 15 dB to 30 dB in steps of 2 dB. The average level of each programme sample was pre-determined by means of a level recorder. This level was maintained in the play-back system by using a standard vu-meter calibrated by a steady level tone. The r.m.s. AF noise was measured by a sound level meter conforming to the specification laid down in IEC 179-A publications. The signal-to-noise ratio measured with this set-up could be considered as representing the ratio of the audio frequency signal as measured on a standard vu-meter, to the r.m.s. noise, for a bandwidth of 3 kHz.

2.1.2 Each recorded sample was reproduced before an audience through a good quality reproducing system. The listeners were asked to assess whether a particular sample was acceptable to them, keeping in mind the inherent quality characteristics of HF broadcasting services.

2.2 Analysis and discussion

2.2.1 Minimum acceptable signal-to-noise ratios are shown in Table I and Fig. 1 for different types of programme. Audio frequency signal-to-noise ratio values of 16 dB, 17 dB and 19 dB were accepted by 50, 70 and 90% of the listeners respectively, for instrumental and western music programmes. For the spoken word and vocal classical music programmes, values of 17 dB, 19 dB and 21 dB were found acceptable by 50, 70 and 90% of the listeners, respectively. These values of AF signal-to-noise ratio apply to 3 kHz audio bandwidth under stable conditions.

TABLE I — Minimum audio frequency signal-to-noise ratio (dB)
accepted by various percentages of listeners

	50%	70%	90%
Instrumental (music Sarod)	16	17	19
Western music (pop song)	16	17	19
Spoken word	17	19	21
Vocal music (classical)	17	19	21

2.2.2 Thus an AF signal-to-noise ratio of 21 dB was determined as the minimum requirement under the worst conditions.

2.2.3 Further tests were carried out to determine the equivalent S/N ratio at the input of a receiver whose characteristics were representative of the average characteristics of HF receivers available in India [CCIR, 1978-82]. A steady RF signal modulated to 30% with 1 kHz tone was fed to the receiver. For an S/N ratio of 15 dB to 22 dB at the output, a corresponding S/N ratio of 24 dB to 31 dB was observed at the input. The differences between the output and the input S/N ratio was thus found to be 9 dB. It was therefore concluded that a value of 30 dB RF S/N ratio may be regarded as an acceptable value for broadcasting in band 7 (HF).

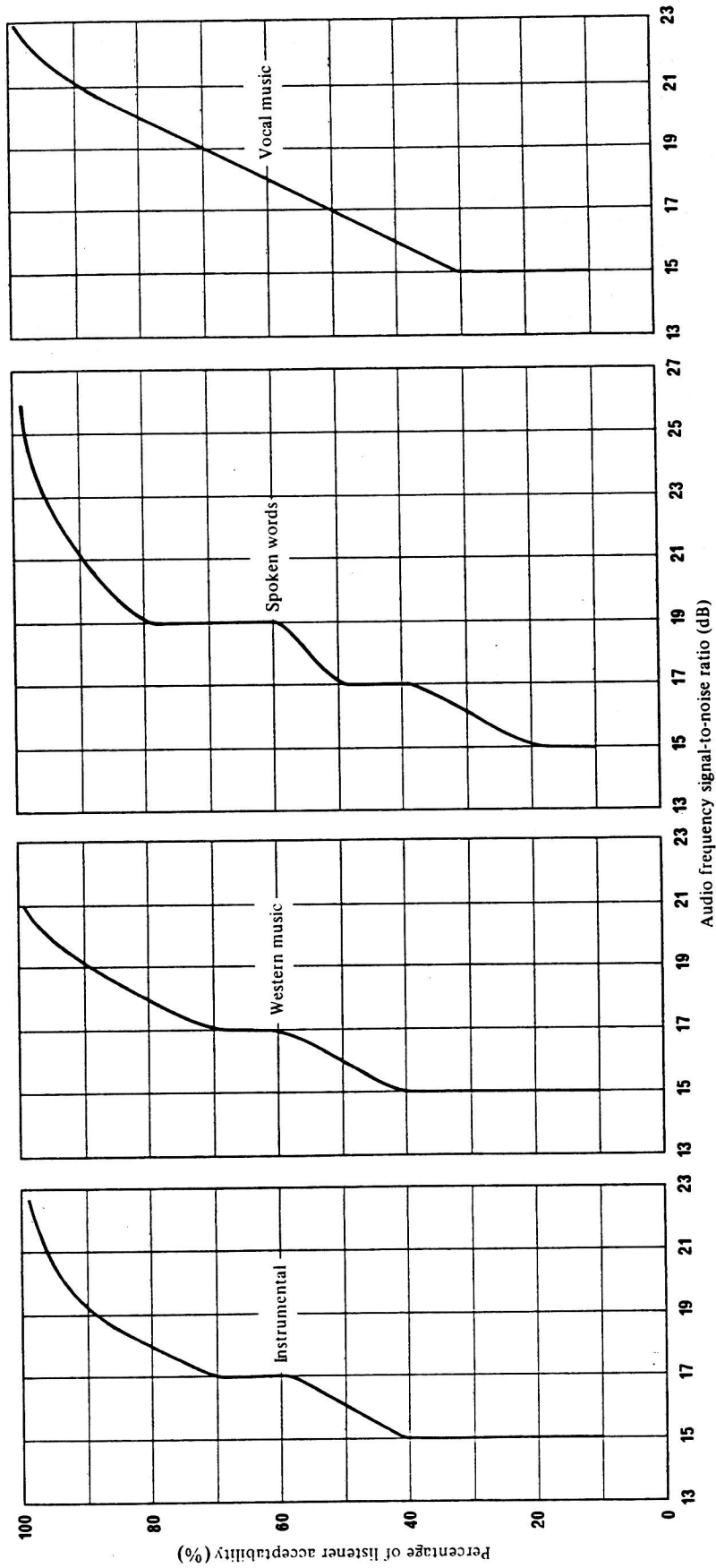


FIGURE 1 - Signal-to-noise ratios acceptable for different types of programme

3. Tests carried out in the USSR [CCIR, 1982-86b]

Several series of controlled listening tests in accordance with the method described in Recommendation 562 for programmes of various types and for various AF signal-to-noise ratios have been carried out in the USSR, the results of which are presented below.

3.1 Description of the experiments

Figure 2 contains a block diagram of the experimental arrangement used for the listening tests. A variety of programme samples (speech, music) were pre-recorded on magnetic tape and played back from a tape deck. The resulting signal was fed into the modulator of an HF generator. The same modulator also received white noise from the output of a noise generator. Before input into the modulator, the wanted audio modulating signal and the noise were mixed in a passive adding circuit. The HF signal at the HF generator output was fed via an artificial antenna to a standard broadcasting receiver with an RF bandwidth of 6 kHz and an AF bandwidth of 3 kHz. The HF signal at the receiver input was maintained at a sufficiently high level to enable the intrinsic receiver noise to be disregarded.

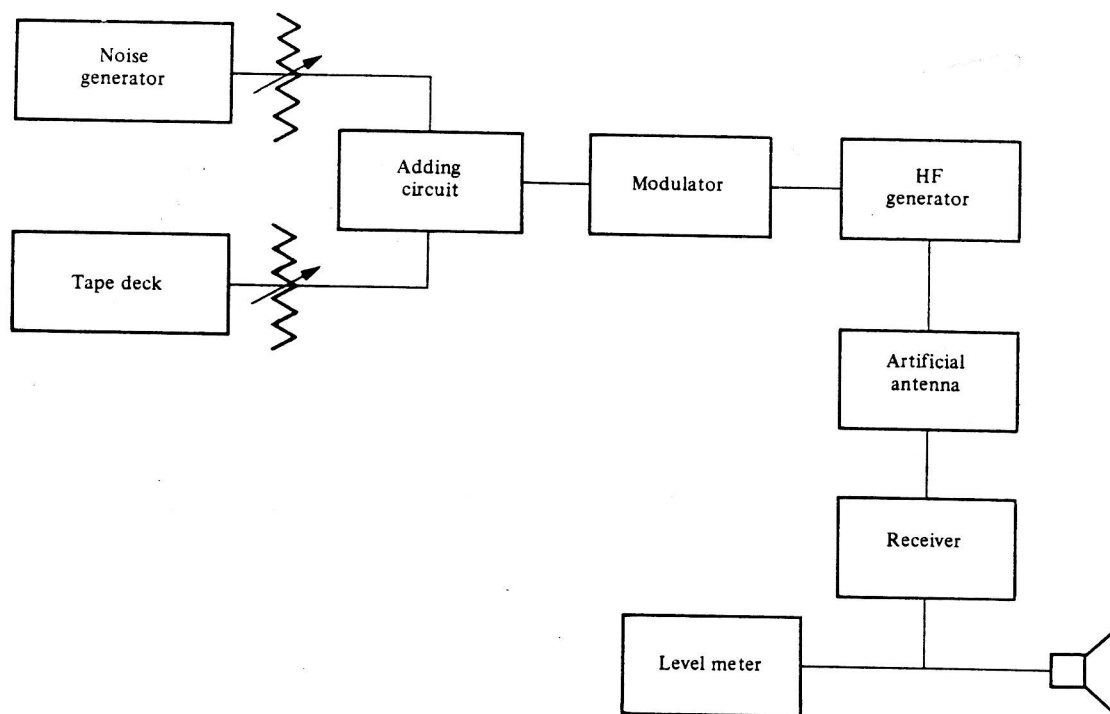


FIGURE 2 – Block diagram of the experimental arrangement used for the listening tests

The audio signal level at the receiver output was measured using a standard level meter with time integration of the order of 200 ms used to measure the average sound programme level. The r.m.s. noise level was also measured at this point. These two readings were then used to determine the signal-to-noise ratio.

The audio signals at the receiver output were reproduced before an audience through a good quality speaker.

The listeners judged the degree of noise impairment on the CCIR five-grade scale. Families of curves were then plotted for each specific value of the signal-to-noise ratio (in 3 dB increments) for the statistical evaluation of noise impairment according to the CCIR scale as a function of the number of listeners.

3.2 Findings and conclusions

Figure 3 portrays the relation between the grade of noise impairment judged on the CCIR scale and the AF signal-to-noise ratio. The graph is based on the selected opinions of 80% of listeners, for speech programmes. It is known that noise is more perceptible for speech programmes, and less obtrusive for music, particularly dance music.

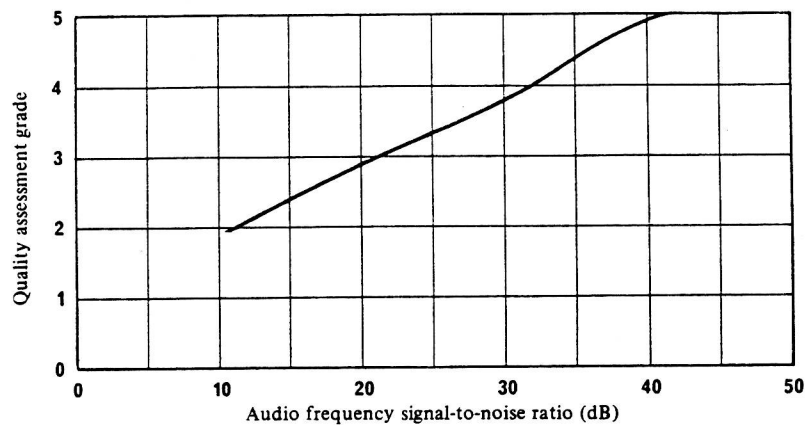


FIGURE 3 – Grade of noise impairment on the CCIR five-grade scale as a function of the AF signal-to-noise ratio

The graph in Fig. 3 shows that perceptible, but not annoying, noise, corresponding to grade 4 on the CCIR scale, occurs with an AF signal-to-noise ratio of approximately 31 dB. For a ratio of approximately 20-21 dB, 80% of the listeners evaluated the noise as slightly annoying, i.e. corresponding to grade 3 on the CCIR scale.

REFERENCES

CCIR Documents

[1978-82]: 10/204 (India).

[1982-86]: a. 10/67 (India); b. 10/227 (USSR).

REPORT 1201

NUMBER OF HF SOUND BROADCASTING TRANSMITTERS USING A SINGLE CHANNEL

(Study Programme 44F/10)

(1990)

Investigations were carried out in the USSR [CCIR 1986-90] with a view to determine the maximum number of transmitters using a single channel in HF sound broadcasting networks. These investigations were carried out using network models taking into account the specific design features of international and national sound broadcasting networks.

On the basis of the results obtained, it was possible to evaluate the capacity of the HF bands allocated to the sound broadcasting service as a function of the requirements governing the operation of the networks.

The maximum number of transmitters in a channel (K_f) depends on a multiplicity of geophysical factors and technical network parameters. Particular attention was paid to the influence of the following factors on K_f :

- type of network model;
- frequency band used;
- size of service area;
- protection ratios adopted;

Three types of model were used:

- a model corresponding to national and local broadcasting networks;
- a model representing the characteristic features of the organization of international and national broadcasting over large areas;
- a mixed model taking into account the characteristics of the first two models.

On the basis of a study of these models, the following conclusions were obtained:

- the maximum possible number of transmitters using a channel at the same time varies from 6-7 in the low frequency bands to 2-3 in the high frequency bands;

- the maximum number of transmitters is practically independent of the type of the model considered; a dependence on the type of the model is apparent in the low and high frequency bands;
- with large service areas (some CIRAF zones) which in practice are frequently notified by broadcasters, the maximum number of stations depends only slightly on the protection ratios; for smaller areas there is a more marked dependence.

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[1986-90]: 10/225 (USSR)

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Opredelenie chisla odnovenno rabotajushchikh na odnoi chastote VCh
veshchatelnykh peredatchikov (Determination by calculation of the number of
HF sound broadcasting transmitters operating on one frequency).
Elektrosviaz, 10, Moscow, USSR.

REPORT 516-4

FIELD STRENGTH RESULTING FROM SEVERAL ELECTROMAGNETIC FIELDS

(Question 44/10, Study Programme 44A/10)

(1970-1978-1982-1986-1990)

Studies have been carried out in Italy [CCIR, 1966-69] and in Hungary [CCIR, 1978-82] on the composition of several stable electromagnetic fields at the same point.

1. Field strength resulting from two stable electromagnetic fields

If two fields of different frequencies are considered at a point in space:

$$E_1 = A \cos \omega t \quad (1)$$

$$E_2 = B \cos [(\omega + \Delta\omega)t + \varphi] \quad (2)$$

where A , B , ω , $\Delta\omega$ and φ are constant in time, and if it is assumed that both fields are polarized in the same direction, the instantaneous amplitude of the vector representing the resultant field is:

$$E = \sqrt{A^2 + B^2 + 2AB \cos (\Delta\omega t + \varphi)} \quad (3)$$

The mean value of E in the period $T = 2\pi/\Delta\omega$ is:

$$E_R = \frac{1}{T} \int_{t_0}^{t_0 + T} E(t) dt = Af(A/B) \quad (4)$$

The $\Delta\omega$ frequency component of E for the same period is:

$$E_{\Delta\omega} = \left(\frac{2}{T}\right) \int_{t_0}^{t_0 + T} E(t) \cos (\Delta\omega t + \varphi) dt \quad (5)$$

If the values A , B , E_R and $E_{\Delta\omega}$ (dB(μ V/m)) are designated by E_1 , E_2 , $(E_1 + \Delta R)$ and $(E_2 + \Delta E)$ respectively and assuming that $E_1 \geq E_2$, a graph can be drawn of the values of ΔR , as indicated by a field measuring device, and of ΔE as a function of $(E_1 - E_2)$, and the curves shown in Fig. 1 (continuous line) and Fig. 2 are obtained.

The dotted line shown in Fig. 1 is obtained by calculating the r.m.s. of the amplitudes of the two fields:

$$E_R = \sqrt{A^2 + B^2} \quad (6)$$

The values of the first curve (continuous line) in Fig. 1 are always lower than those of the second curve, for each value of $(E_1 - E_2)$. The maximum difference is 0.9 dB for $E_1 = E_2$.

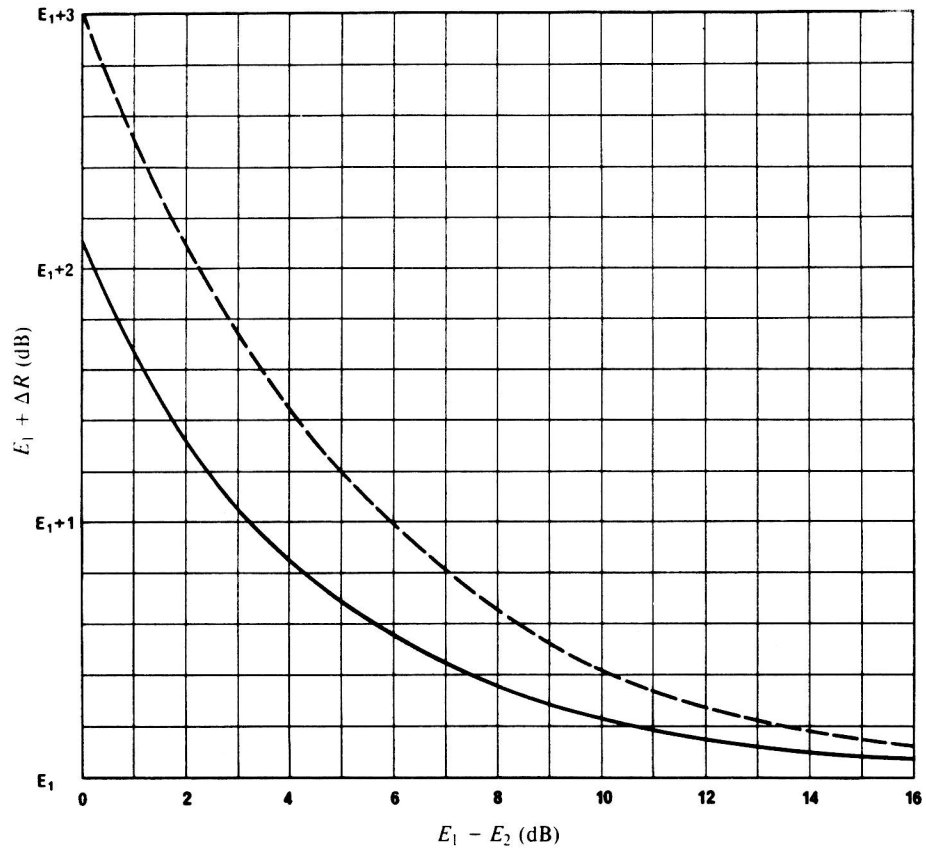


FIGURE 1 - Resultant ($E_1 + \Delta R$) of two stable electromagnetic fields ($E_1 > E_2$)

— : value indicated by a field measuring device
 - - : value calculated by adding the powers of the two signals

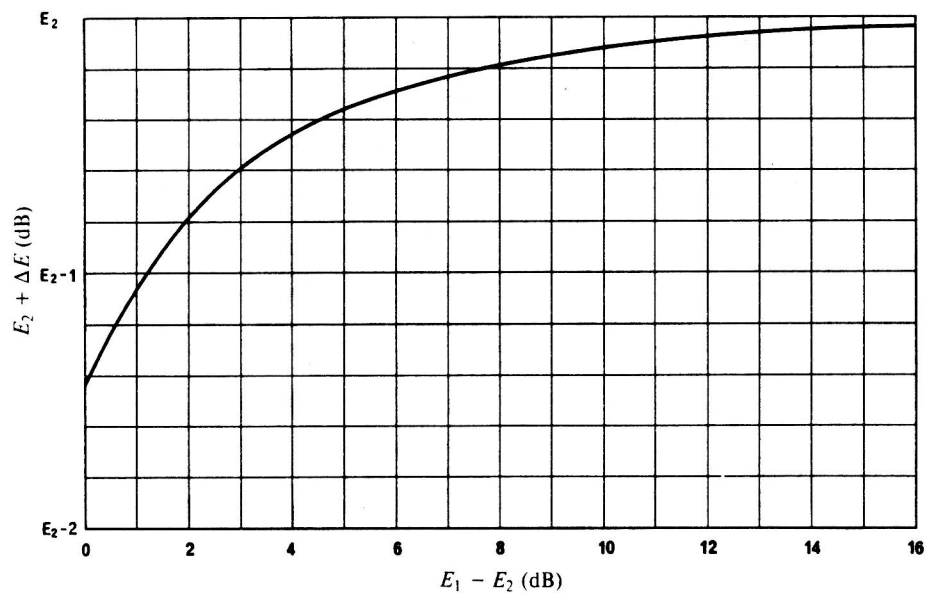


FIGURE 2 - ($E_2 + \Delta E$) component in the resultant of two stable electromagnetic fields ($E_1 > E_2$)