XVII A.P.
DÜSSELDORF
21.5-1.6 1990
CCIR

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

Geneva, 1990

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

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BROADCASTING SERVICE (SOUND)

(Study Group 10)

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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 bandwith 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).

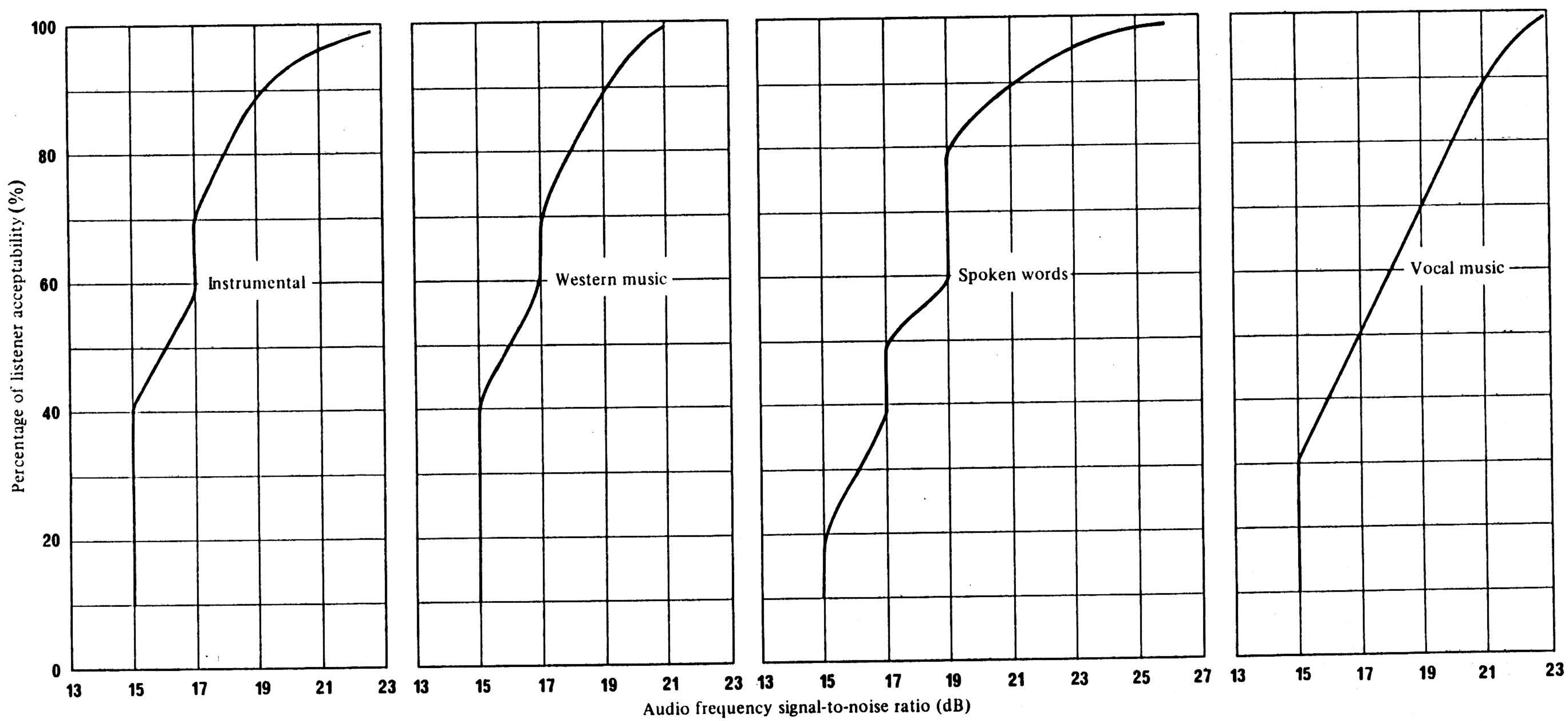

FIGURE 1 – *Signal-to-noise ratios acceptable for different types of programme*

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 intrinisic receiver noise to be disregarded.

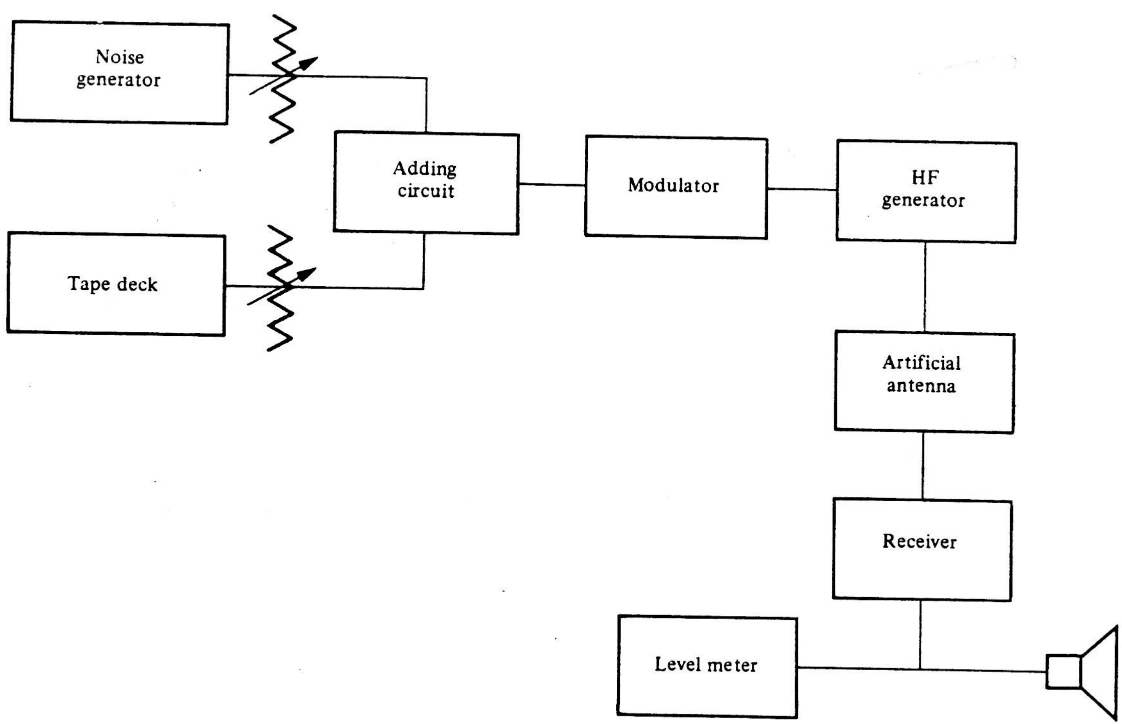

FIGURE 2 – *Block diagram of the experimental arrangement used for the listening tests*

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.

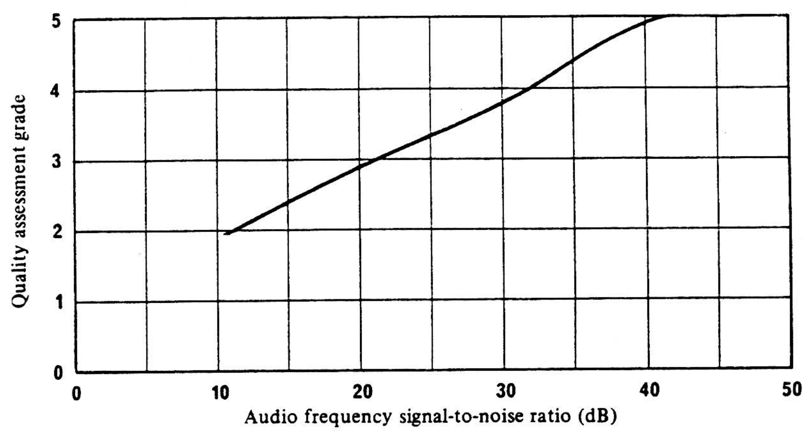

FIGURE 3 – *Grade of noise impairment on the CCIR five-grade scale as a function of the AF signal-to-noise ratio*

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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CCIR Documents

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

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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:

$$E_1 = A \cos \omega t \tag{1}$$

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

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:

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

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

$$E_R = \frac{1}{T} \int_{t_0}^{t_0 + T} E(t)\,\mathrm{d}t = Af\,(A/B) \tag{4}$$

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

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

If the values A, B, E_R and $E_{\Delta\omega}$ (dB(μV/m)) are designated by E_1, E_2, $(E_1 + \Delta R)$ and $(E_2 + \Delta E)$ respectively and assuming that $E_1 \geqslant E_2$, 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:

$$E_R = \sqrt{A^2 + B^2} \tag{6}$$

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 $E_1 = E_2$.

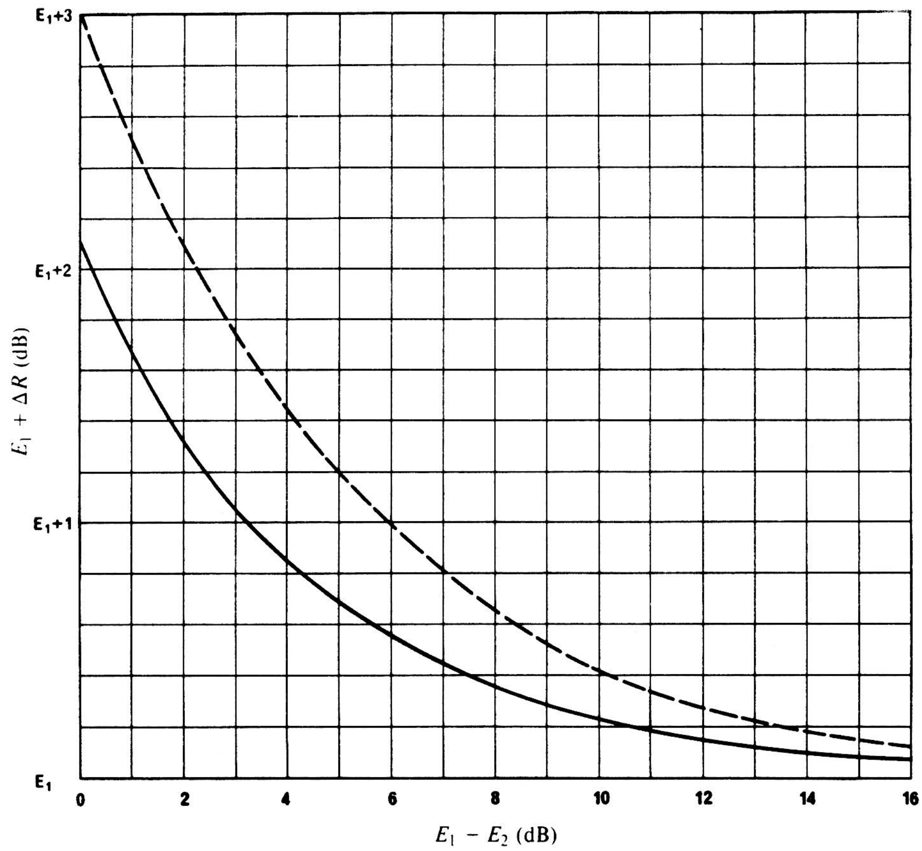

FIGURE 1 – *Resultant (E_1 + ΔR) of two stable electromagnetic fields ($E_1 > E_2$)*

——— : value indicated by a field measuring device

– – – : value calculated by adding the powers of the two signals

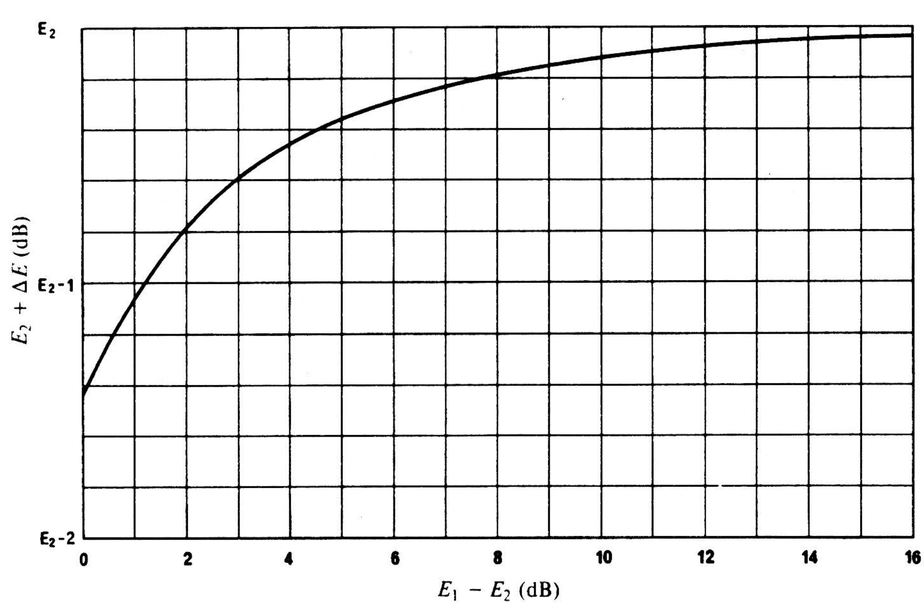

FIGURE 2 – *(E_2 + ΔE) component in the resultant of two stable electromagnetic fields ($E_1 > E_2$)*