

REPORT 302-1

INTERFERENCE TO SOUND BROADCASTING IN THE SHARED BANDS IN THE TROPICAL ZONE

(Question 45/10 and Study Programme 45E/10)

(1956–1959–1963–1978)

1. Introduction

This Report is a summary of the information available on the question of interference in the bands shared with sound broadcasting in the Tropical Zone for the determination of the radio-frequency protection required for a broadcast signal in the presence of interference. The radio-frequency (RF) protection ratio is the value of the radio-frequency wanted to-interfering signal ratio that enables, under specified conditions, the necessary audio-frequency protection ratio to be obtained at the output of a receiver (Recommendation 638). These specified conditions include such diverse parameters as spacing Δf of the wanted and interfering carrier, emission characteristics (type of modulation, modulation depth, frequency deviation, etc.), receiver input and output levels as well as the receiver characteristics (selectivity and susceptibility to cross-modulation, etc.). The audio-frequency (AF) protection ratio is the agreed minimum value of the audio-frequency signal-to-interference ratio considered necessary to achieve a subjectively defined reception quality. This ratio may have different values according to the type of service desired (Recommendation 638). The wanted signal is from a broadcasting station operating in the shared bands in the Tropical Zone and the interfering signal may be either:

- from A1A/A1B and A2A/A2B telegraphy,
- A3E telephony and broadcasting or combinations of more than one type of emission.

Agreed values of protection ratios are necessary for the solution of frequency assignment problems in amplitude modulation sound-broadcasting systems and may also serve as basic reference data for the evaluation of the relative effectiveness to be expected of various amplitude modulation transmission systems.

The minimum wanted field to which this protection ratio is to be maintained is also to be determined taking into account the noise levels prevalent in different parts of the Tropical Zone.

In this Report, Part I deals with the considerations for the determination of protection ratios and Part II is concerned with the determination of the minimum value of the wanted field to which the recommended protection ratio is to be maintained.

PART I (PROTECTION RATIO)

2. Studies and measurements

Various administrations have carried out studies to determine, by subjective tests, the protection ratios for different percentages of listener satisfaction. In general, the measurements have been carried out at the output of the receiver, fitted with simple filters having an audio-frequency cut-off of 5 kHz. Some measurements have been made for cut-off frequencies of 6, 7, 8 and 9 kHz also. These measurements have been carried out for various carrier frequency separations up to 10 kHz. The permissible frequency tolerances of both wanted and unwanted signals, as specified in Appendix 7 of the Radio Regulations, have been taken into account while determining the protection ratios.

3. Results

3.1 [CCIR, 1956a], gives the results of an extensive series of subjective tests carried out by generally simulating domestic broadcast listening conditions in the absence of fading. A broadcast receiver, with a substantially flat response up to about 4 kHz, but with a filter giving an attenuation of about 8 dB at 5 kHz and a sharp cut-off above this frequency, was used.

For unwanted signals of classes of emission A2A/A2B and A3E and for various frequency separations between the carriers of the wanted and unwanted signals, listeners were presented with various ratios of wanted-to-unwanted signal in random order and asked to state whether they considered the reception satisfactory or unsatisfactory. Table I gives information for the wanted-to-unwanted signal ratios required to provide 90%, 70% and 50% listener satisfaction for unwanted signals of classes of emission A2A/A2B telegraphy, A3E telephony and broadcasting and for:

- frequency separation of 0 kHz and 5 kHz exactly; and
- nominal frequency separations of 0 kHz and 5 kHz under the most unfavourable conditions that could arise within the maximum permissible frequency tolerances of both wanted and unwanted signals, as were specified in the Radio Regulations, Atlantic City, 1947.

Utilizing the information given in the above document, curves giving relative protection ratios for frequency separation between 0 and 5 kHz have been derived and are shown in Fig. 1. The actual values for any frequency separation up to 5 kHz can, however, be obtained from these curves and from the value of co-channel protection ratio given in Table I for different percentages of listener satisfaction.

3.2 [CCIR, 1956b], gives details of the results of subjective tests made to determine the ratio of wanted-to-unwanted signal as a function of the frequency separation of the carriers of the two signals. Two typical broadcast receivers were used, having a fairly uniform response up to about 4 kHz falling to about –8 dB to –10 dB at 5 kHz. The unwanted signal was modulated by speech with a frequency range limited to 3 kHz. The ratio necessary to satisfy nearly all listeners varied from about 54 dB at 1 kHz separation, to a maximum of 56 dB between 2 and 3 kHz separation, falling to 52 dB at 5 kHz separation. The corresponding ratios when nearly all the listeners found the conditions unsatisfactory, were about 15 dB lower. Subsequent tests to determine the ratio at which interference was “perceptible” gave intermediate values.

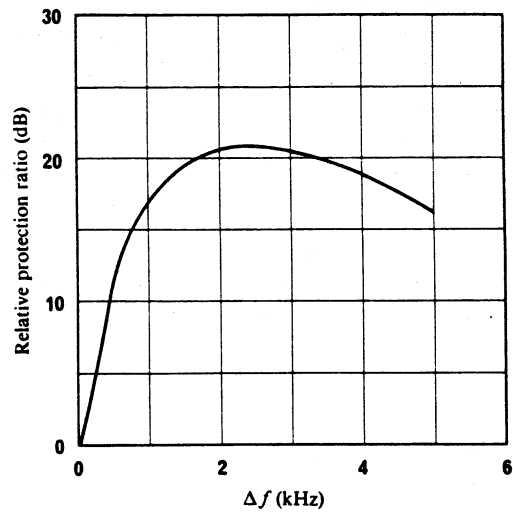
3.3 [CCIR, 1956c], gives the results of similar tests made with two types of receiver, one a narrow-band receiver with considerable attenuation above 3 kHz, and the other a wider-band receiver with an attenuation of about 8 dB at 5 kHz. For the wide-band receiver, as commonly used for broadcast listening, the wanted-to-unwanted signal ratio for various frequency separations follows the same general curve as before and, at a frequency separation of 5 kHz, is 43 dB for 90% listener satisfaction.

3.4 Comparison of the results arrived at in the three documents shows that there is a considerable degree of agreement. The values are within ± 5 dB and those in the United Kingdom and Federal German Republic documents are almost of the same order as those given by India. There is, therefore, sufficient justification to assume that the values of the wanted-to-unwanted signal ratio which provide the various degrees of listener satisfaction given in Table I are reliable.

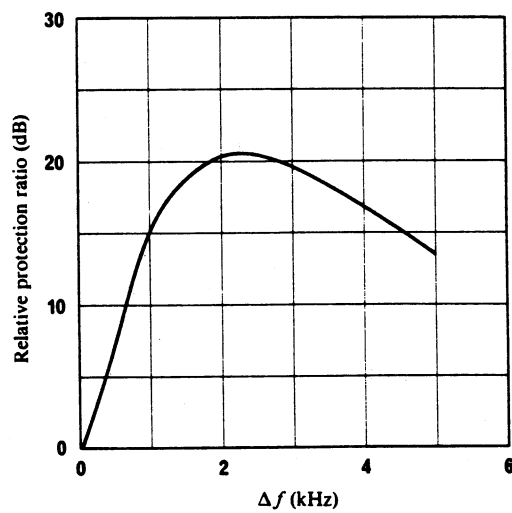
From an examination of Table I, it will be seen that, when the unwanted signal is a mobile A3E emission, there is a considerable increase in the required wanted-to-unwanted signal ratio when allowance is made for maximum frequency tolerances. The possibility of interference to broadcasting services from mobile services would be appreciably reduced, particularly where the two services have the same nominal frequency, if the mobile services operated within closer frequency tolerances, if possible with the same tolerance as the fixed and broadcasting services.

TABLE I

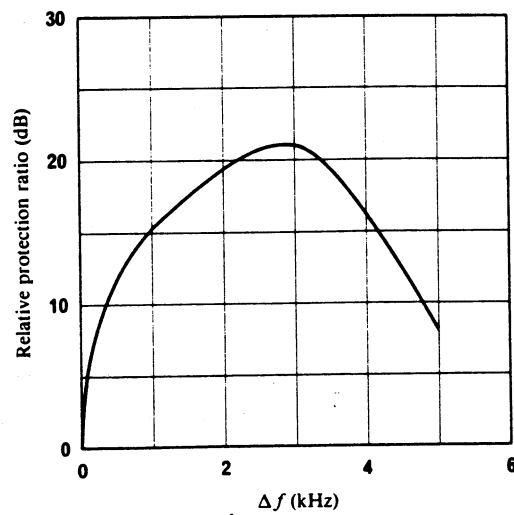
Interfering emission	Maximum frequency tolerance (App. 7 to Radio Regulations) (Hz)	Frequency separation (kHz)	Signal-to-interference ratios for 90%, 70% and 50% listener satisfaction (dB)					
			Ignoring frequency tolerances			Allowing for maximum frequency tolerances		
			90%	70%	50%	90%	70%	50%
A2B – fixed (525 Hz tone)	150	0	35	31	28	42	38	34
A2B – mobile (525 Hz tone)	1000	0	35	31	28	49	45	42
A3E – fixed (3 kHz maximum modulation)	150	0	33	30	28	40	36	33
A3E – mobile (3 kHz maximum modulation)	1000	0	33	30	28	50	47	44
A3E – broadcasting	150	0	33	30	28	44	40	36
A2B – fixed (525 Hz tone)	150	5	39	37	36	43	40	38
A2B – mobile (525 Hz tone)	1000	5	39	37	36	49	46	43
A3E – fixed (3 kHz maximum modulation)	150	5	48	44	40	50	46	42
A3E – mobile (3 kHz maximum modulation)	1000	5	48	44	40	52	48	45
A3E – broadcasting	150	5	48	46	44	49	46	44



a) Wanted: broadcasting
Unwanted: broadcasting



b) Wanted: broadcasting
Unwanted: telephony (A3E)



c) Wanted: broadcasting
Unwanted: telegraphy
(A3B with 525 Hz tone modulation)

FIGURE 1 – Relative protection ratio as a function of frequency separation, Δf