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 1 TO VOLUME VIII

LAND MOBILE SERVICE
AMATEUR SERVICE
AMATEUR SATELLITE SERVICE

CCIR INTERNATIONAL RADIO CONSULTATIVE COMMITTEE

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ANNEX 1 TO VOLUME VIII

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

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 VIII of the XVIth Plenary Assembly, Dubrovnik 1986, is indicated.)

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ANNEX 1 TO VOLUME VIII

LAND MOBILE SERVICE - AMATEUR SERVICE - AMATEUR-SATELLITE SERVICE

(Study Group 8)

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SECTION 8A: LAND MOBILE SERVICE AND RELATED SUBJECTS

REPORT 358-5

PROTECTION RATIOS AND MINIMUM FIELD STRENGTHS REQUIRED IN THE MOBILE SERVICES

(Question 1/8)

(1966–1970–1974–1978–1982–1986)

1. VHF and UHF land and maritime mobile services

1.1 *Protection ratios based on internal noise and distortion in the receiver*

The World Administrative Radio Conference, Geneva, 1979, defined the protection ratio as the minimum value of the wanted-to-unwanted signal ratio, usually expressed in decibels, at the receiver input determined under specified conditions such that a specified reception quality of the wanted signal is achieved at the receiver output (*RR No. 164*). For further information on the definition see Report 525. This ratio may have different values, according to the type of service desired.

However, in the absence of information submitted to Study Group 8 on subjective measurements made in the VHF and UHF land and maritime mobile services, several admininistrations submitted the results of laboratory measurements, using appropriate test signals, of the degradation of the signal-to-noise ratio of the wanted test signal, when a co-channel interfering signal is superimposed on the latter. A degradation of the initial signal-to-noise ratio of 20 dB to a signal-to-noise + interference ratio of 14 dB is taken as the criterion. For some systems this grade of service is acceptable.

In the tests described by the various administrations, the frequency deviations are 70% or 60% of the maximum specified frequency deviations, and for amplitude modulation the modulation percentages are 70% or 60%, for both wanted and unwanted signals. From a study of the documents submitted, it may be deduced that the slight differences in measurement conditions and in the characteristics of the receivers used in the different tests, may result in differences in the measured receiver protection ratios, of up to about ± 3 dB.

One administration performed tests to determine the protection ratio for the case where the wanted narrowband G3E signal is interfered by a direct-printing F2B signal (see Recommendation 476) [CCIR, 1978-82]. The e.m.f. of the wanted signal at the receiver input was 2 μV. In these tests the level of the interfering co-channel F2B signal was so adjusted that the subjective effect on the wanted signal was the same as that of an interfering co-channel narrowband G3E signal attenuated by the protection ratio of 8 dB laid down in Table I for this case. The peak frequency deviations used for the F2B signal were ± 1, ± 3 and ± 5 kHz respectively. The sub-carrier was 1500 Hz and the frequency shift 170 Hz. 12 dB was found to be a suitable representative value for the protection ratio and is therefore included in Table I.

Although the ability of the receiver to receive the wanted signal is dependent on the passband characteristics of the receiver, the frequency difference between the co-channel wanted and unwanted signals, the frequency deviation, etc., the receiver protection ratios in Table I may be used as the basis for the calculation of system protection ratios for mobile systems for a minimum grade of service. Additional protection should be provided to allow for the effects of multipath propagation, man-made noise, terrain irregularities, and in the case of very closely spaced assignments, adjacent-channel interference (see Report 319).

When using frequency modulation, "capture effect" is enhanced as the frequency deviation of the wanted signal is increased; therefore, a wideband F3E, G3E system requires less protection than a narrowband F3E, G3E system for the same type of interfering source.

If a higher grade of service is required, a higher protection ratio should be adopted, particularly in the case of amplitude-modulated wanted emissions.

1.2 *Man-made noise*

Man-made noise degrades the performance of a mobile system. To maintain a desired grade of service in the presence of man-made noise, it is necessary to increase the level of the field strength of the wanted signal. Motor vehicles have been shown, by measurements [US Advisory Committee, 1967], to be the primary source of man-made noise for frequencies above 30 MHz. Other noise sources are fewer in number and usually radiate from fixed locations.

TABLE I – *Typical receiver protection ratios, for use in calculating system protection ratios*

Wanted emission (Note 1)	Unwanted emission (Note 1)	Receiver protection ratio (dB)
Wideband F3E, G3E	Wideband F3E, G3E	See Report 319
Narrowband F3E, G3E	Narrowband F3E, G3E	See Report 319
Wideband F3E, G3E	A3E	8
Narrowband F3E, G3E	A3E	10
Narrowband F3E, G3E	Direct printing F2B	12
A3E	Wideband F3E, G3E	8-17 (Note 2)
A3E	Narrowband F3E, G3E	8-17 (Note 2)
A3E	A3E	17

Note 1. – Wideband F3E, G3E systems normally employ frequency deviations with a maximum value in the range ± 12 to ± 15 kHz.

The narrowband F3E, G3E systems considered here normally employ frequency deviations with maximum values of either ± 4 or ± 5 kHz.

The value of the F2B case is with a peak frequency deviation of ± 5 kHz. Frequency deviations of ± 3 and ± 1 kHz do not significantly decrease this value.

Note 2. – The receiver protection ratio may vary within the range shown dependent upon the difference in frequency between the carriers of the wanted and unwanted emissions and the frequency deviation of the unwanted emission. In general, it will tend towards the higher figure as the frequency deviation of the unwanted emission decreases.

For convenience in evaluating the degradation of performance of a base receiver, the following classifications of noise sources are provided:

– high noise locations – traffic density of 100 vehicles/km^2 at any given instant of time;
– moderate noise locations – traffic density of 10 vehicles/km^2 at any given instant of time;
– low noise locations – traffic density of 1 vehicle/km^2 at any given instant of time;
– concentrated noise sources (hot spots): noise radiated from individual sources or closely spaced multiple sources which are usually located within 500 m of the receiving antenna, such as a high concentration of vehicles, manufacturing plants and defective power transmission lines.

Noise data for base stations at high, moderate and low noise locations are presented by a noise amplitude distribution (NAD) (the number of pulses per second equal to or greater than the value shown as ordinate) and are illustrated in Fig. 1. The amplitude (A) (in dB(μV/MHz)) of noise pulses at a rate of 10 pps (pulse-per-second) is expressed as follows:

$$A = C + 10 \log V - 28 \log f$$

where,

C: constant (tentative value: 106 dB(μV/MHz)

V: traffic density vehicles/km^2

f: channel frequency, MHz.

Noise data for hot spots can also be presented in the form of a noise amplitude distribution. However, due to a wide variety of noise sources, it is not yet practical to provide a classified list.

The constant C is a function of the electrical noise suppression applied to vehicles and may also vary according to the relative proportion of goods and passenger vehicles if the level of suppression is not the same for both categories. A tentative value of 106 dB(μV/MHz) is shown and this may be revised as more information becomes available.

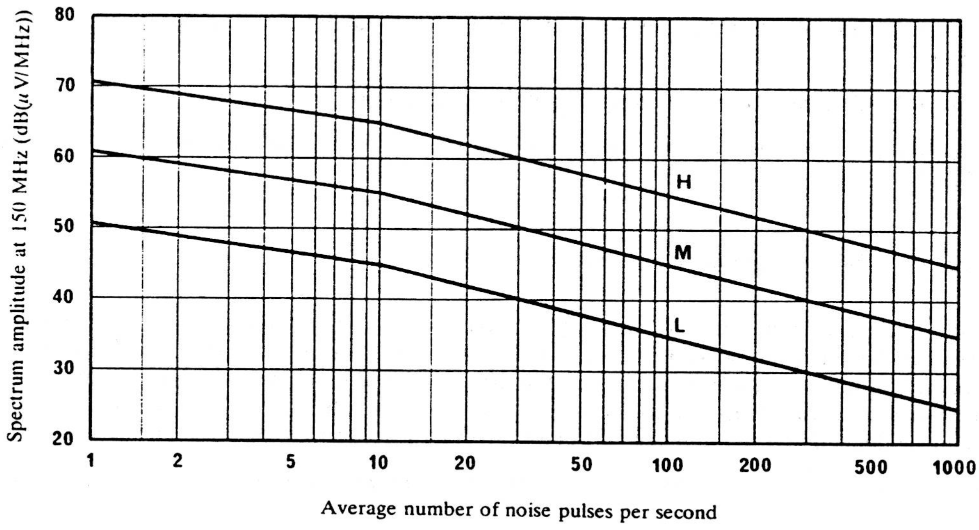

FIGURE 1 – *Noise amplitude distribution at base station (150 MHz)*

For frequencies other than 150 MHz, raise or lower curves H, M and L in accordance with the formula below.

$A = C + 10 \log V - 28 \log f$
where A = dB (μV/MHz) at 10 pps

Curve H: high noise location ($V = 100$)
Curve M: Moderate noise location ($V = 10$)
Curve L: low noise location ($V = 1$)

1.3 *Noise Amplitude Distribution (NAD) determination of degradation*

1.3.1 *Definitions*

1.3.1.1 *Noise amplitude distribution*

A presentation of impulsive noise data in terms of its basic parameters of spectrum amplitude and impulse rate.

1.3.1.2 *Spectrum amplitude*

The vector sum of the voltages produced by an impulse in a given bandwidth, divided by the bandwidth.

1.3.1.3 *Impulse rate*

The number of impulses that exceed a given spectrum amplitude in a given period of time.

1.3.1.4 *Impulsive-noise tolerance*

The spectrum amplitude of impulses at a given pulse-repetition frequency at which the receiver, with an input signal applied at specific levels, produces standard signal-to-noise ratios at the output terminals.

1.3.2 *Determination of degradation*

Degradation of receivers can be determined as follows:

1.3.2.1 measure the impulsive noise tolerance of the receiving equipment in accordance with applicable IEC standards;

1.3.2.2 measure NAD in accordance with applicable IEC standards;

1.3.2.3 Superimpose the graphs for the receiver impulse noise tolerance and the NAD. An example is shown in Fig. 7.

1.4 *Minimum values of field strength to be protected*

The minimum values of field strength to be protected in the land mobile service at frequencies above 30 MHz are determined by internal noise generated in the receiver, man-made noise usually in the form of radiation from ignition systems of motor vehicles and the effects of multipath propagation to and from moving vehicles. Some information on the effects of traffic density is now available. In the maritime mobile service, the level of man-made noise depends on the number and nature of high level sources of noise on the ship.

A convenient measure of the threshold of performance for narrowband receivers is a specified value of

$$\frac{S + N + D}{N + D}$$

ratio; the conventionally accepted value being 12 dB (see Recommendation 331).

This defines the minimum usable field strength for any particular installation, in the absence of man-made noise.

The sensitivity of typical receivers is such that an input signal of 0.7 μV e.m.f. (assuming a receiver input impedance of 50 Ω) would result in a 12 dB

$$\frac{S + N + D}{N + D}$$

ratio at the output. A mobile service is characterized by large variations of field strength as a function of location and time. These variations may be represented by a log-normal distribution for which standard deviations of 8 dB at VHF and 10 dB at UHF are appropriate for terrain irregularities of 50 m (see Recommendation 370). To determine the minimum value of median field strength to be protected, it is necessary to specify the percentage of time for which the minimum usable field strength should be exceeded for different grades of service. For land mobile radiotelephony, a high grade of service would require that the value be exceeded for 99% of the time, but, for a lower (or normal) grade of service, for 90% of the time.

The minimum values of field strength to be protected can be determined subjectively, taking into account man-made noise and multipath propagation. Ignition systems of motor vehicles are usually the most prevalent source of man-made noise. Field strength cancellations due to multipath propagation produce an annoyance somewhat similar to that created by ignition systems. When a mobile unit is in motion, both of these annoyances occur at the same time. Only the effects of receiver noise and man-made noise remain when the mobile unit is stationary. The separation of motor vehicles is generally less with slow-moving or stationary traffic, and under these circumstances, particularly at the lower frequencies, the degradation experienced in a stationary mobile unit is greater than when it is in motion.

Figures 3 and 4 can be used to determine the combined degradation effects of man-made noise and multipath propagation for the case of vehicles in motion. These figures are based on subjective testing under traffic conditions commonly experienced by most mobile vehicles [FCC, 1973]. Specifically, these traffic conditions are the following: in motion while in a low noise area, in motion in traffic surrounded by other vehicles, and stationary surrounded by other stationary or moving vehicles.

The tendency for the curves of Figs. 3 and 4 to merge at the higher frequencies is due to the almost constant multipath degradation effect with frequency and the fact that the degradation effect of man-made noise decreases with frequency.

Degradation is defined as the increase of level necessary in the desired input signal to maintain the receiving signal at the degree of quality obtainable when affected by receiver noise only.

Definitions of signal quality are as follows:

Grade	*Interfering effect:*	
5	Almost nil	Speech understandable,
4	Noticeable	but with increasing
3	Annoying	effort as the grade
2	Very annoying	decreases
1	So bad that the presence of speech is barely discernible	

Some information on field strengths can be derived from Recommendation 370. Additional information can be found in the document of the CCIR, [1966-69], and in the article of Okumura *et al.* [1968].

Information on protection ratios and minimum field strengths may also be found in the "Special Agreement between the Administrations of Belgium, the Netherlands, and the Federal Republic of Germany relating to the use of metric and decimetric waves for fixed and mobile services in border areas, Brussels, 1963", and in the Final Acts of the Special Regional Conference, Geneva, 1960. Similar information may be found in the Agreement between the Telecommunications Administrations of Austria, the Federal Republic of Germany, Italy and Switzerland, Vienna, 1969.

The document of the CCIR [1963-66], deals with the above questions for signal-to-noise ratios of 30 dB and 40 dB at the receiver output.

Until values based on man-made noise and multipath effects are available, the calculated values of minimum and median values of field strength shown in Fig. 2 may be used for hand-portable stations.

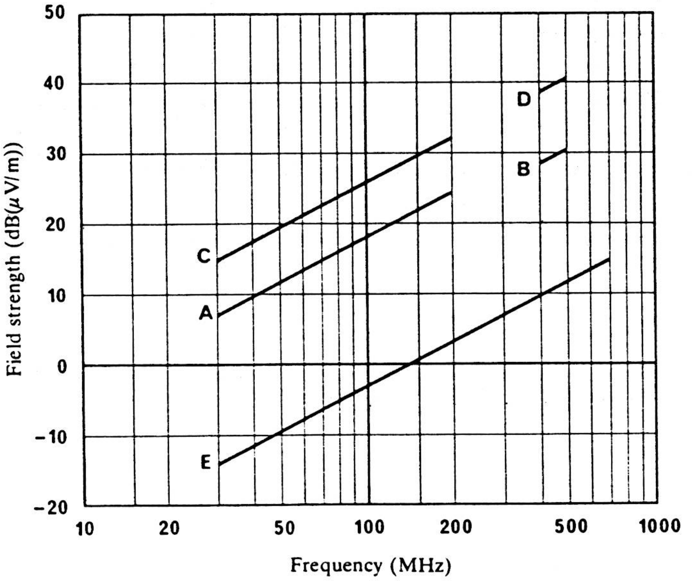

FIGURE 2 – *Minimum usable and median field strengths for typical hand-portable stations (based on minimum usable input of 0.7 μV e.m.f., in the absence of man-made noise)*

Characteristics assumed: antenna gain { A and C: – 9 dB; B and D: – 6 dB }

A, B: median, normal grade
C, D: median, high grade
E: minimum usable field strength (dipole antenna)

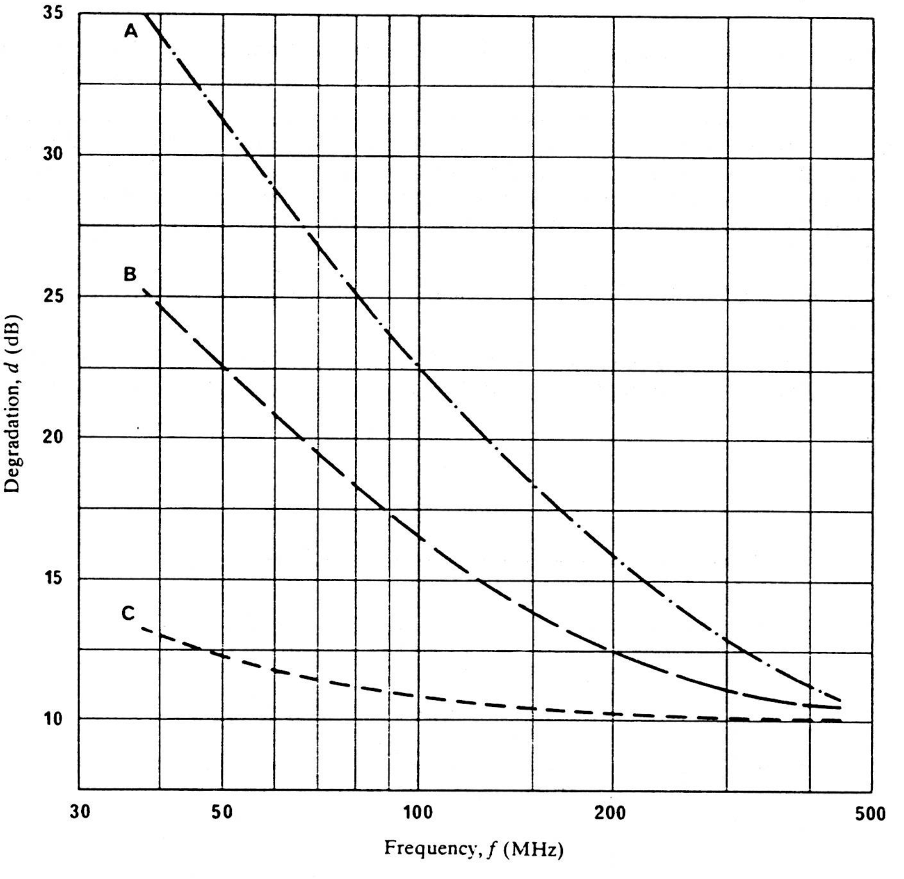

FIGURE 3 – *Variation of degradation of mobile reception and minimum values of field strength to be protected for* signal quality grade 4 *and receiver sensitivity of 0.7 μV e.m.f.*

Field strength = $-41 + d + 20 \log f$ dB(μV/m)

A : mobile vehicle stationary within a high noise area
B : mobile vehicle in motion within a high noise area
C : mobile vehicle in motion within a low noise area

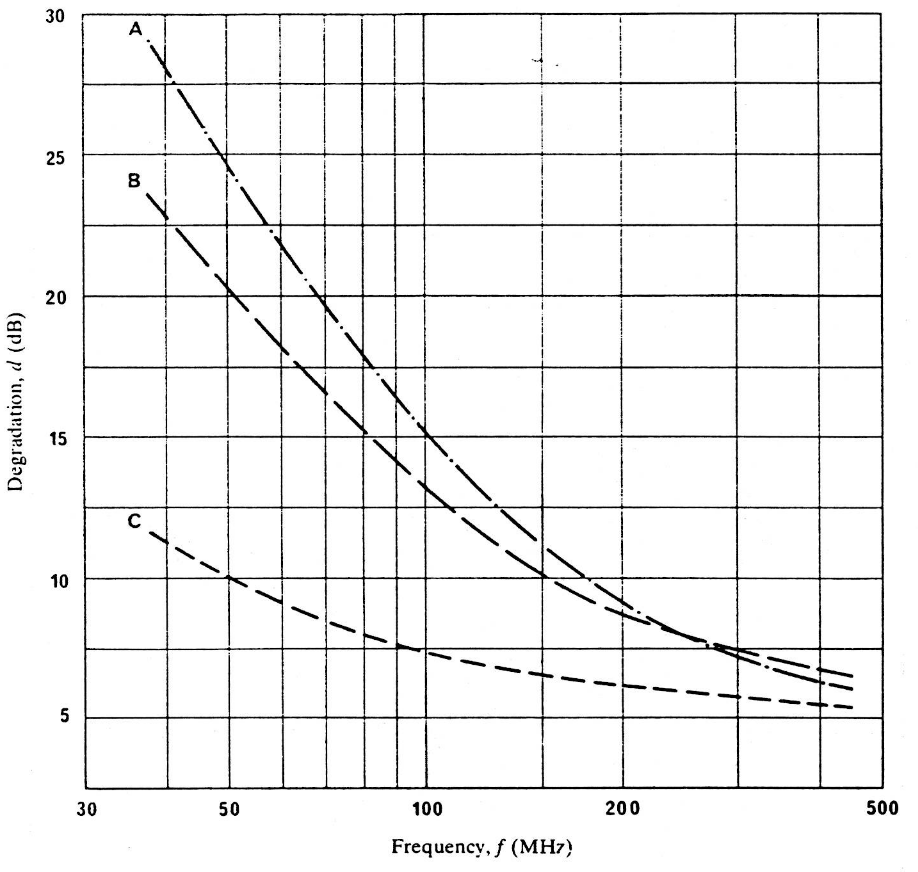

FIGURE 4 – *Variation of degradation of mobile reception and minimum values of field strength to be protected for* signal quality grade 3 *and receiver sensitivity of 0.7 μV e.m.f.*

Field strength $= -41 + d + 20 \log f$ dB(μV/m)

A: mobile vehicle stationary within a high noise area
B: mobile vehicle in motion within a high noise area
C: mobile vehicle in motion within a low noise area

Figures 5 and 6 can be used for determining the degradation of base station reception due to ignition noise and multipath propagation.

Curves A and B of Figs. 5 and 6 show the combined degrading effects of multipath propagation and ignition noise for heavy and moderate traffic rates. The speed of the traffic was approximately 80 km per hour. Curves D and E show the degrading effect of ignition noise only. Curve C shows the degrading effects of multipath propagation only.

The data presented here were obtained at a distance of 23.5 m from a heavily travelled thoroughfare. Except for the ignition noise created by the thoroughfare, the base station test site itself was quiet. Curves A and B were obtained by radiating the desired signal from a mobile unit in motion. In this case, degradation is based on median values of voltage at the input terminals of the receiver. The effects of ignition noise, only when the mobile unit is standing still, are shown by curves D and E. In this case the desired signal was obtained from a signal generator. Curve C was obtained by inserting sufficient attenuation at the receiver input terminals in order to eliminate ignition noise pulses. The increased attenuation was compensated for by radiating a stronger signal from the mobile unit.

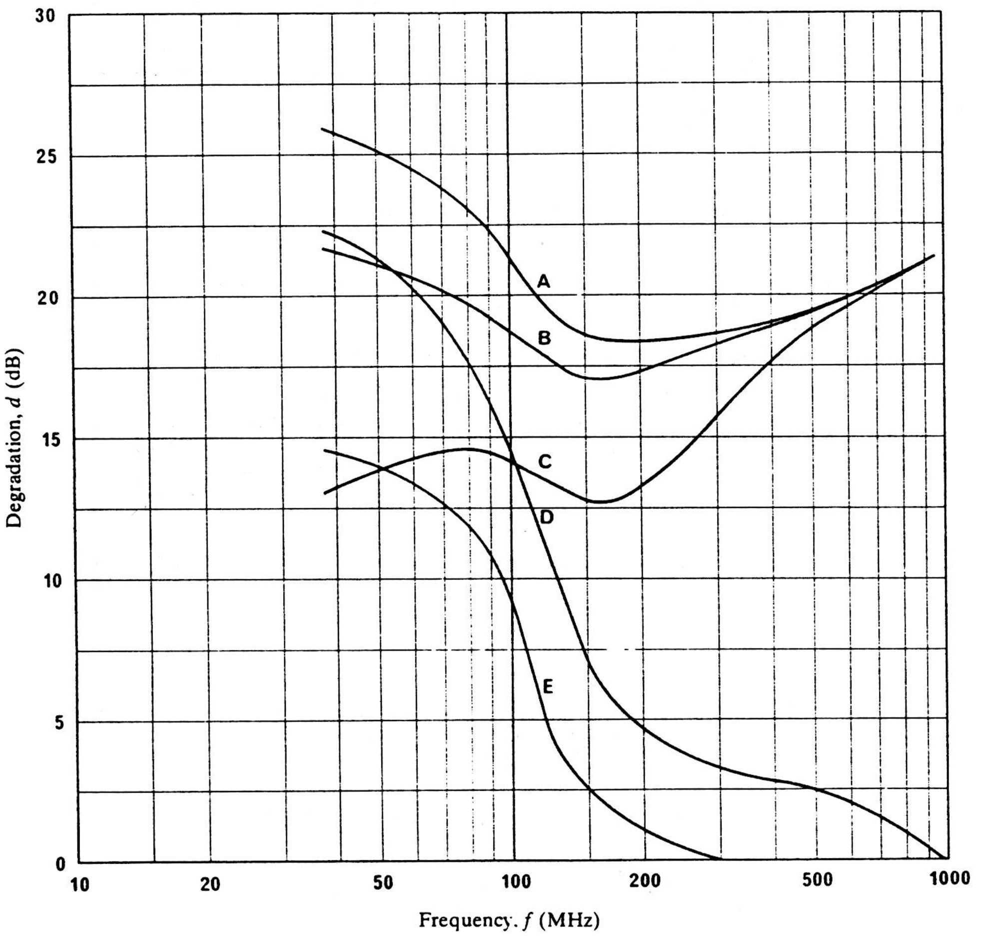

FIGURE 5 – *Variation of degradation of base station reception and minimum values of field strength to be protected* for signal quality grade 4 *and receiver sensitivity of 0.7 μV e.m.f.*

Field strength = $-41 + d + 20 \log f$ dB(μV/m)

A: mobile vehicle moving, traffic rate is 2 vehicles/s
B: mobile vehicle moving, traffic rate is 1 vehicle/s
C: mobile vehicle moving, no ignition or ambient noise
D: mobile vehicle standing still, traffic rate is 2 vehicles/s
E: mobile vehicle standing still, traffic rate is 1 vehicle/s

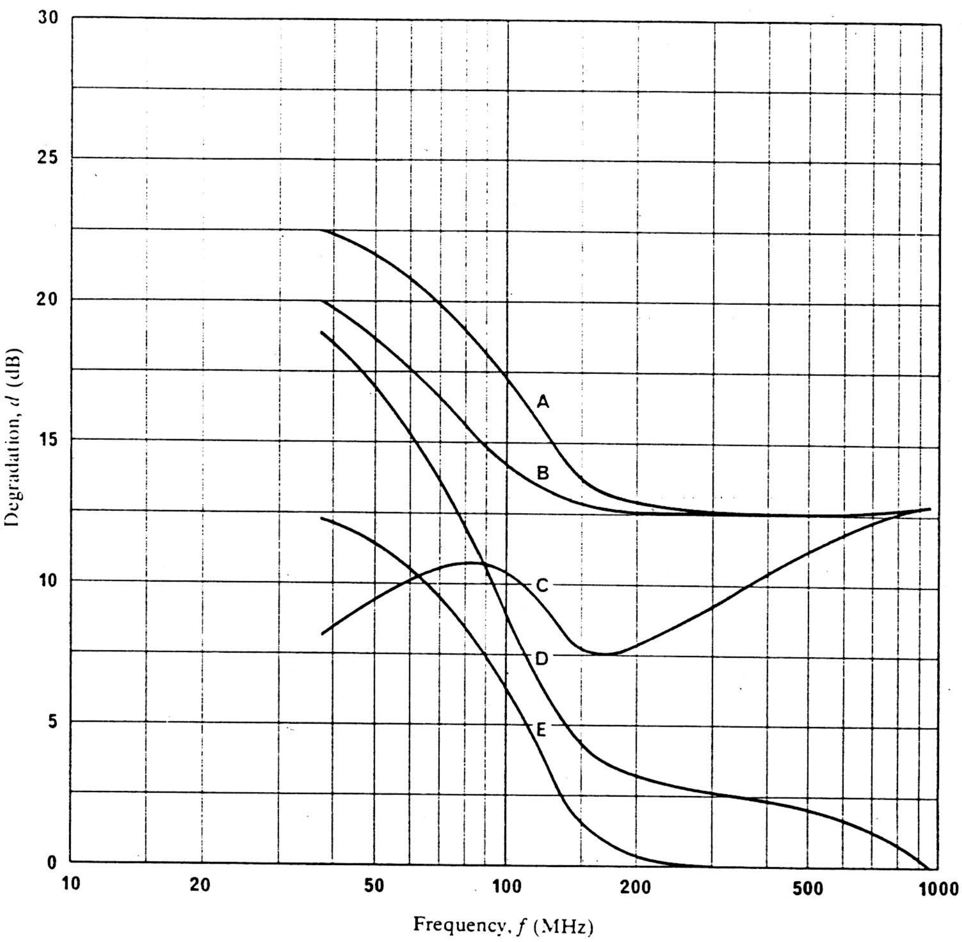

FIGURE 6 – *Variation of degradation of base station reception and minimum values of field strength to be protected for* signal quality grade 3 *and receiver sensitivity of 0.7 μV e.m.f.*

Field strength = $-41 + d + 20 \log f$ dB(μV/m)

A: mobile vehicle moving, traffic rate is 2 vehicles/s
B: mobile vehicle moving, traffic rate is 1 vehicle/s
C: mobile vehicle moving, no ignition or ambient noise present
D: mobile vehicle standing still, traffic rate is 2 vehicles/s
E: mobile vehicle standing still, traffic rate is 1 vehicle/s

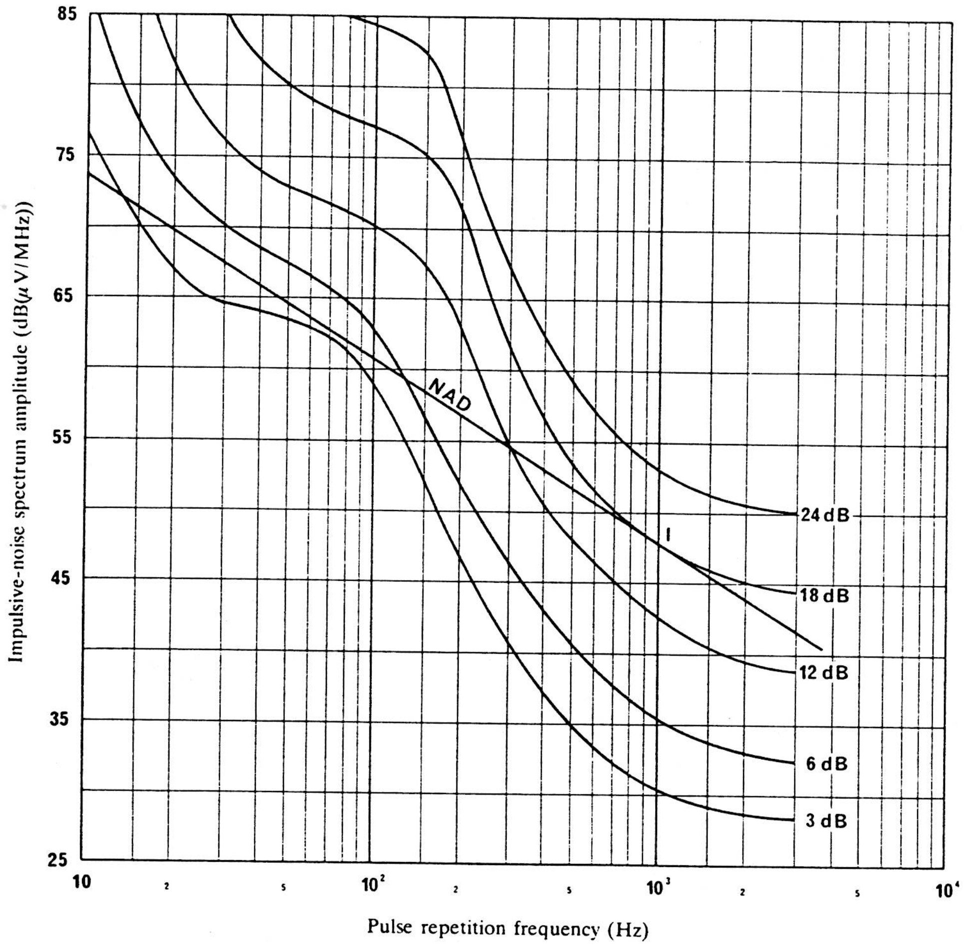

FIGURE 7 – *Example showing 18 dB degradation*
NAD tangent at I to 18 dB curve of the graph for receiver impulse noise tolerance

At approximately 450 MHz the degradation of base station reception due to multipath is greater than that for mobile reception. This is primarily due to the higher level of the ambient aural noise in the mobile unit as compared to that of the base station. The road and vehicle aural noise mask the multipath degradation effect, thereby reducing the value of receiver input signal needed to obtain a given grade.

2. HF maritime mobile service

The question of the protection ratio and the minimum field strength to be protected in the HF maritime mobile service for various classes of emission used by that service needs further study. In so far as HF radiotelephony is concerned the Study Group gave provisional advice to the IFRB in respect of these parameters (see Report 748).

3. Conclusions

Considerable additional work concerning §§ 1 and 2 is necessary to determine more fully the appropriate protection ratios and the values of the field strengths to be protected, and also to determine and record the measurement methods which should be adopted.