REPORT 945-2*

METHODS FOR THE ASSESSMENT OF MULTIPLE INTERFERENCE

(Question 46/10, Study Programme 46L/10)

(1982-1986-1990)

1. Introduction

The usable field strength, E_u, is defined in Recommendation 638 and may be used as a criterion for the interference situation in a given channel and in a given area. It takes account, in principle, of natural and man-made noise as well as of the combined effect of the entirety of interfering transmitters. If the usable field strength is large, the influence of the interfering transmitters is also large, whereas this influence is small if the usable field strength is small.

The usable field strength is independent of the characteristics of the wanted transmitter and does not normally exhibit large variations with location. It can be determined for any location of interest. For international planning purposes, it may be convenient to calculate the usable field strength at the site of the wanted transmitter. As a first approximation, this value may be considered to be representative of the situation in the whole coverage area.

For the calculation of these interferences basically two categories of methods are in use:

- statistical methods;
- non-statistical methods.

Normally use is made either of the 'simplified multiplication method' as an example of a statistical method or of the non-statistical 'power-sum method'. Experience has also been gained in the successful use of the statistical 'log-normal method' [Kubrakov et al., 1985].

These three methods are described and indications are given for their efficient use.

The simplified multiplication method and the log-normal method incorporate the effects of location variability on the assumption that they follow a Gaussian law and are intended for use at VHF and higher frequencies. The power-sum method applies for point-to-point reception and must be applied successively with different receiver locations in coverage studies.

Details for the use of the simplified multiplication method and its physical bases are to be found in Annex I and in [O'Leary and Rutkowski, 1982], while similar information on the log-normal method is contained in Annex II and in [Bobkova and Pavliouk, 1987].

2. Power-sum method

Use has been made of the power-sum method for the assessment of multiple interference at the LF/MF Broadcasting Conference for Regions 1 and 3, Geneva, 1975, and at the Administrative Radio Conferences for the Broadcasting-Satellite Service, Geneva, 1977 and 1983. A similar method called the "RSS method" has been used at the Regional Administrative MF Broadcasting Conference (Region 2), Rio de Janiero, 1981.

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* This Report should be brought to the attention of Study Groups 1 and 11.

3. Statistical methods

Four statistical computation procedures which can be used to calculate the effects of multiple interference have been developed to date [*Ad hoc* Committee 1949, 1950]. These are:

- the integration method,
- the log-normal method,
- the multiplication method,
- the simplified multiplication method.

These procedures attempt to make use of the statistical (in locations) nature of propagation curves such as those given in Recommendation 370. Although, essentially based on a single theoretical approach, these procedures differ from one another as a result of different physical assumptions. These are made in each procedure in order to simplify the mathematical calculations. The use of any of these procedures results in distribution functions which describe the location probability of reception used in conjunction with Reports 228 and 485 to calculate coverage.

The simplified multiplication method and the log-normal method are the least complex. The former was used for the assessment of multiple interference at the VHF/UHF European and African Broadcasting Conferences in 1961 and 1963, and at the Regional Administrative Conference for FM Sound Broadcasting in the VHF band (Geneva, 1984).

3.1 The simplified multiplication method

This method is based on the following assumptions:

- no correlation exists between the fields of interest;
- the time dispersion of the field strength of the desired transmitter can be neglected, compared to that of the unwanted transmitter;
- one interfering field dominates at the reception location;
- the influence of noise can be neglected, to compensate for the errors introduced by the other approximations.

The usable field strength E_u, is determined for a specified coverage probability (with respect to time and location) and depends on the values of the nuisance fields:

$$E_{si} = P_i + E_{ni(50,\,T)} + A_i + B_i \qquad (3)$$

where:

- E_{si}: nuisance field corresponding to the *i*-th unwanted transmitter.
- P_i: the e.r.p., in dB(kW), of the *i*-th unwanted transmitter.
- $E_{ni(50,\,T)}$: the field strength, in dB(μV/m), normalized to an e.r.p. of 1 kW, of the *i*-th unwanted transmitter. This field strength is exceeded at 50% of the locations during at least *T*% of the time.
- A_i: the radio-frequency protection ratio associated with the *i*-th unwanted transmitter, expressed in dB.
- B_i: the receiving antenna discrimination, expressed in dB.

Assuming a normal distribution of the field strength, expressed in dB(μV/m), appropriate account of the effect of multiple interference can be taken by the use of the simplified multiplication method. With this method the usable field strength, E_u, can be calculated by iteration from:

$$p_c = \prod_{i=1}^{n} L(x_i) \qquad (4)$$

with:

$$x_i = \frac{E_u - E_{si}}{\sigma_n \sqrt{2}}$$

where:

p_c: coverage probability (e.g. 50% of locations (100 − T)% of time), in the presence of n nuisance fields;

$L(x)$: coverage probability in the presence of a single nuisance field, which equals the probability integral for a normal distribution (see Annex I);

σ_n: standard deviation with location of the wanted and interfering field strengths (dB(μV/m)) (see Annex I).

For further details see Annex I and [O'Leary and Rutkowski, 1982].

3.2 The log-normal method

This method is based on the following assumptions:

- no correlation exists between the fields of interest;
- the location variability in the field strength of the wanted and all interfering transmitters is taken to be identical;
- the effect of certain interfering field strengths, each of which obeys a log-normal law, is replaced at the point of reception by the effect of one resultant interfering field strength subject to the log-normal law with the following parameters [Fenton, 1960; Bobkova and Pavliouk, 1987]:

$$E_r = 0.1152\,\sigma^2 + 10 \log\left(\sum_i M_{si}\right) - 5 \log U$$

$$\sigma_r = 6.58\sqrt{\log U}$$

$$U = \frac{(k-1)\sum_i M_{si}^2}{\left(\sum_i M_{si}\right)^2} + 1$$

$$k = \exp\left[(\sigma/4{,}34)^2\right]$$

$$M_{si} = 10^{E_{si}/10}$$

where: E_{si} - nuisance field corresponding to the ith unwanted transmitter, given by equation (3);

E_r - median value of resultant nuisance fields, expressed in decibels;

$\sigma;\sigma_r$ - standard deviations with location of interfering field strengths and resultant interfering field strength respectively, expressed in decibels;

- the usable field strength (for purposes of sound and TV broadcasting planning) is defined for L% of locations, at which the following conditions are simultaneously fulfilled:

  a) the wanted signal exceeds the noise level by the required amount, and

  b) the necessary protection ratio, i.e.:

  $E_u \geqslant E_{min}$ (50% of locations and 50% of time)

  $E_u \geqslant E_{si}$ (50% of locations and T% of time),

Condition b) is fulfilled when the usable field strength E_{u1} is equal to E_r. The probability of the fulfilment of both conditions a) and b) is equal to the product of their probabilities:

$$p_c = p_1 \cdot p_2 = L\left(\frac{E_{u1} - E_r}{\sqrt{\sigma^2 + \sigma_r^2}}\right) \cdot L\left(\frac{E_{u1} - E_{min}}{\sigma}\right)$$

where: p_1, p_2 - probabilities of fulfilment of conditions a) and b) respectively; their values are determined by a normalized distribution curve for the normal law.

and, L(x) is the probability integral, see equation (8) of Annex I.

If the value found for p_c satisfies the predetermined value of the coverage probability, p_{cp} (generally $p_{cp} = 0.5$, i.e., E_u is defined for 50% of the points of reception), then $E_u = E_{u1}$ and the calculation is completed. However, if $p_c \neq 0.5$, the further calculation of the usable field strength is performed by iteration using the formula:

$$E_u = E_{u1} + \frac{0.5 - p_c}{0.05}$$

The detailed calculation is shown in Annex II and in [Bobkova and Pavliouk, 1987].

The simplified log-normal method

If it is assumed, in the same way as for the power-sum method, that the effect of man-made interference and other noise may be covered by taking into account the minimum usable field-strength as a source of interference, the fluctuation in the corresponding field-strength also being subject to the log-normal law, this method may be simplified to give a non-iterative procedure for the determination of the usable field-strength for 50% of the receiving locations [Bobkova, 1988].

On this assumption, E_{min} may be introduced into the formula for determining the resultant field-strength as an additional source of interference:

$$E_{rs} = 0.1152\sigma^2 + 10 \lg(\sum_i M_i + M_{min}) - 5 \lg U_s,$$

$$\text{where} \quad U_s = \frac{(k-1)(\sum_i M_i^2 + M_{min}^2)}{(\sum_i M_i + M_{min})^2} + 1,$$

M_{min} - median value of minimum usable field-strength, expressed in relative power units.

The value obtained for E_{rs} directly determines the median usable field-strength (i.e., for 50% of receiving locations). The usable field-strength value for any other percentage of locations required may be obtained by the same iterative procedure as that used in the standard log-normal method, by means of the formula:

$$P_{cp} = L\left(\frac{E_u - E_{rs}}{\sqrt{\sigma^2 + \sigma_{rs}^2}}\right)$$

where P_{cp} - predetermined value of the coverage probability

σ_{rs} - r.m.s. deviation of the resultant interference field, determined by the above formula, substituting into it the value U_s.

4. Comparison of the results obtained by the various methods

Sections 4.1 and 4.2 relate in particular to the simplified multiplication method and the power-sum method whilst section 4.3 includes considerations of the log-normal method.

4.1 *General considerations*

The comparison of calculations, using the two methods under equal conditions (no receiving antenna discrimination) is given below. This comparison is intended to enable the reader to estimate the difference to be expected, when applying one method or the other, rather than to advocate a specific method. It should be noted in this respect that either method can be expected to yield only approximate values of the usable field strength.

Differences between the results of both methods may be considerable, and the utmost care should be exercised when deriving further conclusions from these results, e.g. with respect to the number of channels required for satisfactory coverage by one programme.

It should, however, also be recognized that it would be possible to use, with comparable degree of precision, either method as a basis for comparison of different variants of a plan.

4.2 *Results*

Figures 1 and 2 exhibit the differences ΔE in usable field strengths when computed according to the simplified multiplication method (E_M) for a percentage of receiving locations of 45% and 50% respectively, or to the power sum method (E_P) for an undefined percentage of receiving locations. The differences ΔE depend on the relationship between the interference potentials of the various individual transmitters, i.e. their technical characteristics, their distance from the wanted transmitter and the frequency spacing. Normally there is one predominant source of interference producing nuisance field E_1, following by a second and less harmful source of interference creating nuisance field E_2 and the remaining interfering transmitters causing gradually decreasing nuisance fields $E_3 \ldots E_n$.

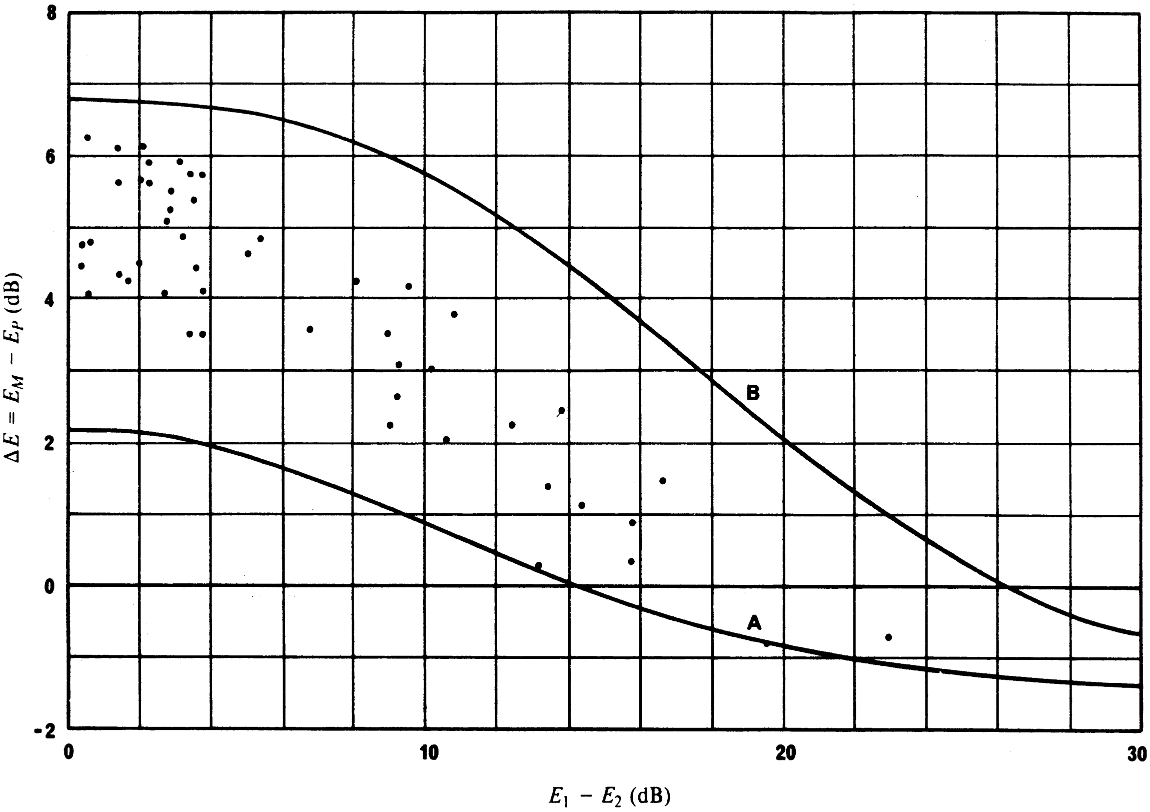

FIGURE 1 – *Difference in usable field strength, ΔE, as a function of the difference between nuisance fields, E_1 and E_2. Percentage of locations for the simplified multiplication method: 45%.*

• : 50 transmitters

$E_1 - E_2$: difference between nuisance fields of the two strongest interfering transmitters

$\Delta E = E_M - E_P$: difference between the values of usable field strength obtained with either the simplified multiplications method (E_M), or the power sum method (E_p).

Curves A : limiting curve obtained for the case of 2 nuisance fields, E_1 and E_2

B : limiting curve obtained for the case of 10 nuisance fields, E_1 and 9 times the value of E_2

In Figs. 1 and 2 values of

$$\Delta E = E_M - E_P = f(E_1 - E_2)$$

are plotted for 50 ΔE values obtained for the first (in alphabetical order) 50 out of 345 transmitters operating at present in the Federal Republic of Germany. These 50 values are thought to be representative of these 345 VHF/FM transmitters. Moreover, two limiting curves, A and B, have been included between which all the 50 values obtained are situated. These limiting curves take account of the n interfering sources $E_1 \ldots E_n$ in different ways: for the lower limiting curve (A) only nuisance fields E_1 and E_2 are taken into account, whereas for the upper limiting curve (B) there are $(n - 2) = 8$ additional sources of interference equal in severity with E_2:

$$E_2 = E_3 = E_4 = \ldots = E_{10}$$

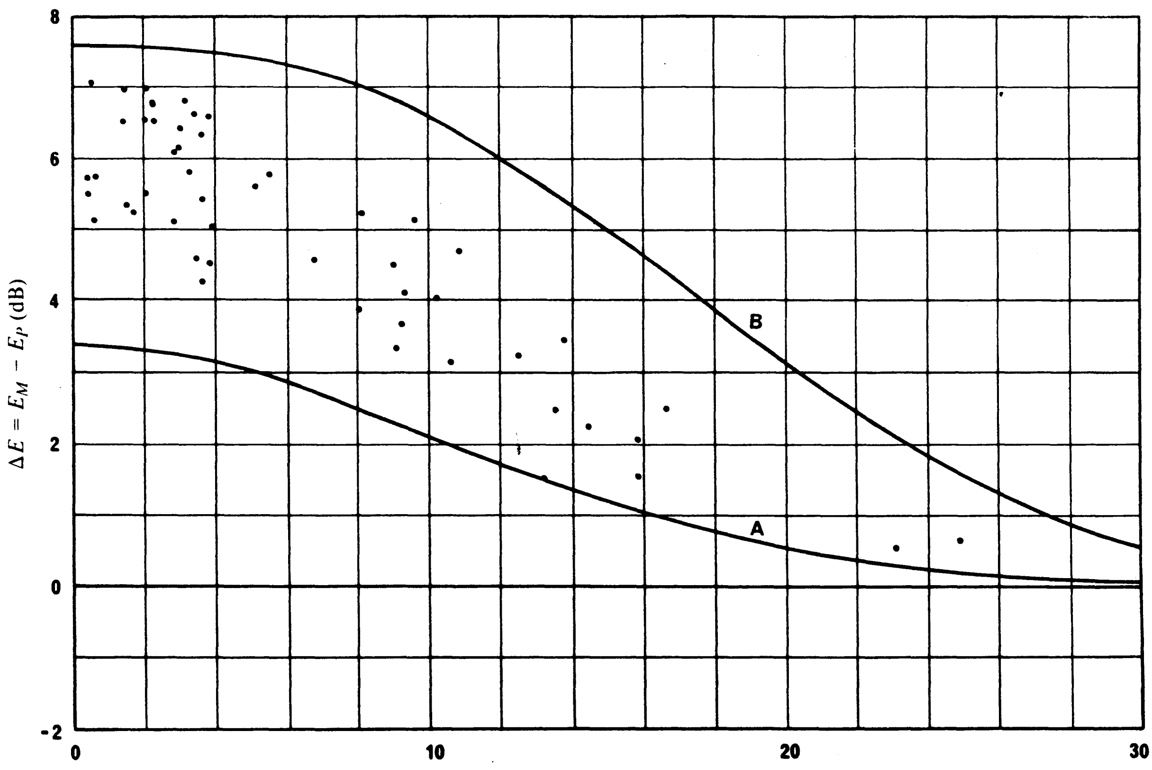

FIGURE 2 – *Difference in usable field strength, ΔE, as a function of the difference between nuisance fields, E_1 and E_2. Percentage of locations for the simplified multiplication method: 50%.*

•	: 50 transmitters
$E_1 - E_2$	: difference between nuisance fields of the two strongest interfering transmitters
$\Delta E = E_M - E_P$	: difference between the values of usable field strength obtained with either the simplified multiplications method (E_M), or the power sum method (E_P)
Curves A	: limiting curve obtained for the case of 2 nuisance fields, E_1 and E_2
B	: limiting curve obtained for the case of 10 nuisance fields, E_1 and 9 times the value of E_2

It can be seen from Figs. 1 and 2 that in the majority of cases the simplified multiplication method yields values which are up to about 7 dB higher than those obtained with the power sum method, depending on the network configuration.

Almost identical results were obtained from an analysis of usable field-strengths of 1177 UK assignments obtained in the Region 1 VHF/FM Plan, Geneva, 1984 as indicated below:

Percentage of assignments	*Ratio (dB) of usable field-strengths exceeded Simplified multiplication: power sum*
4	7
50	5
85	3

Note. – Calculations took account of the first 20 interfering sources.
– Results for simplified multiplication method based on 50% location probability.

It should be noted that all the above comparisons relate to the VHF bands. Differences between the two methods will be greater at UHF because of the larger values of standard deviation with location.

4.3 Consideration of location correlation between the fields

If there is no location correlation between the wanted and interfering fields, the overall standard deviation of variation with location is derived from:

$$\sigma = \sqrt{\sigma_n^2 + \sigma_s^2} = \sigma_n\sqrt{2} \quad (5)$$

where σ_n and σ_s, the standard deviations with location of wanted and interfering signals respectively, are considered identical and equal to:

- 8.3 dB for bands I to III,
- 9.5 + 0.405 g dB in bands IV and V (g being a function of Δh, see Annex I, § 2).

However, equation (5) is the particular case, for location correlation coefficient $\rho = 0$, of the general expression:

$$\sigma = \sqrt{\sigma_n^2 - 2\rho\sigma_n\sigma_s + \sigma_s^2}$$

Positive values of ρ will thus result in reduced values of σ and hence also of resultant usable field-strength when using the simplified multiplication method.

Figure 3 shows the relationship between the usable field strengths obtained by the simplified multiplication method (s.m.m), the power-sum method and the log-normal method. For simplicity, the calculations are based on the case in which all interfering field strengths are of equal magnitude. The data given in Figure 3 and also in [Bobkova and Pavliouk, 1987] show that the log-normal method consistently provides intermediate values between the results calculated by the simplified multiplication method (limit case when $\rho = 0$) and the power-sum method. The curve C (log-normal method) is closest to the curve B. (s.m.m. for $\rho = 0.25$).

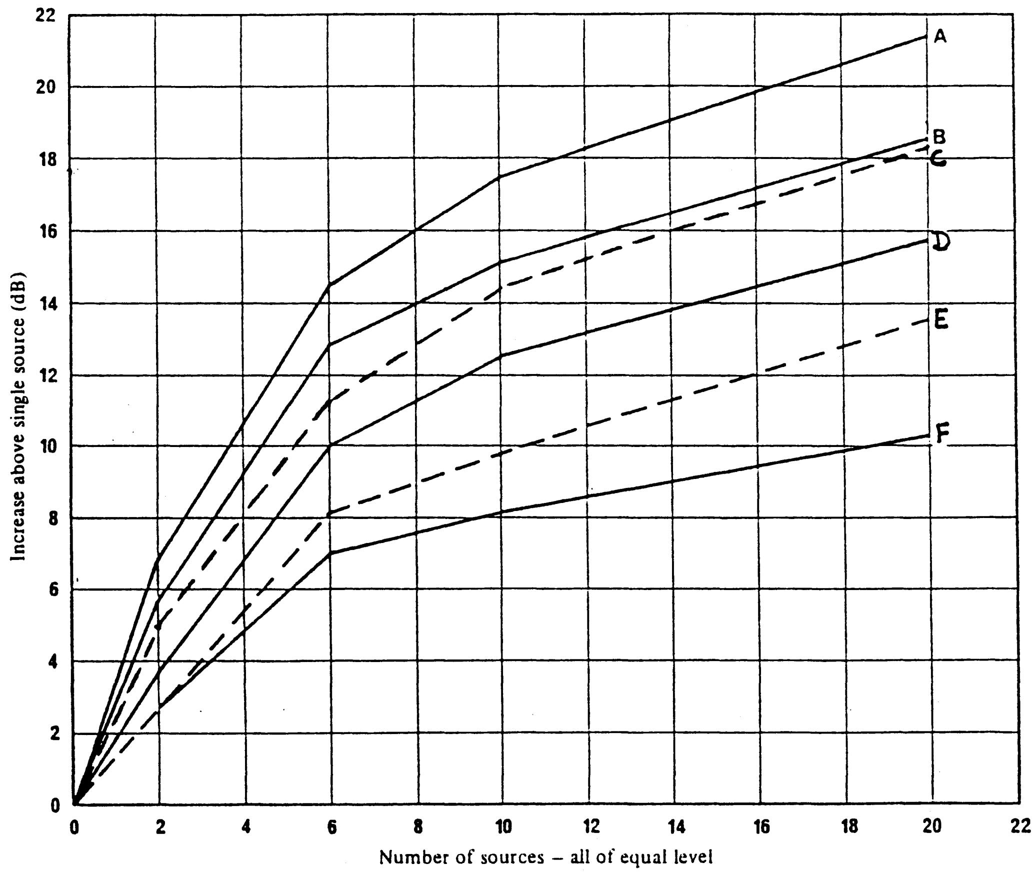

FIGURE 3

A: s.m.m. for ρ = 0

B: s.m.m. for ρ = 0.25

C: log-normal method

D: s.m.m. for ρ = 0.5

E: power-sum method

F: s.m.m. for ρ = 0.75

A series of tests has been carried out in the United Kingdom, at both VHF and UHF, to establish the typical values of ρ occurring in practice. Most of these gave results within the range 0.25 to 0.75 with a tendency for the higher values to occur when signals arrived from the same direction; also, as might be expected, for values lower than the above range (but still positive), to occur when one of the transmitters lies within the area under investigation. ".

Figure 4 shows the difference in the values of usable field-strength (ΔE_u) obtained by the log-normal method (E_r) and by the simplified (E_{rs}) log-normal method $\Delta E_u = E_r - E_{rs}$ for the case in which there are six equivalent interfering fields at the receiving location, as occurs in the case of the regular network (Report 944). The abscissa shows the difference in the values of (ΔE_s) interfering field-strength E_{si} and the minimum usable field-strength: $\Delta E_s = E_{si} - E_{min}$.

Figure 4 shows that for the case $E_{si} \geq E_{min} + 2$ dB, both methods produce identical results: when $E_{si} = E_{min}$, the difference is only 0.1 dB. The maximum difference, 1.7 dB, is obtained when $E_{si} \leq E_{min} - 10$ dB, i.e. when the active interference level is very low and the size of the wanted transmitter's service area depends entirely and exclusively on the selected value of minimum usable field-strength.

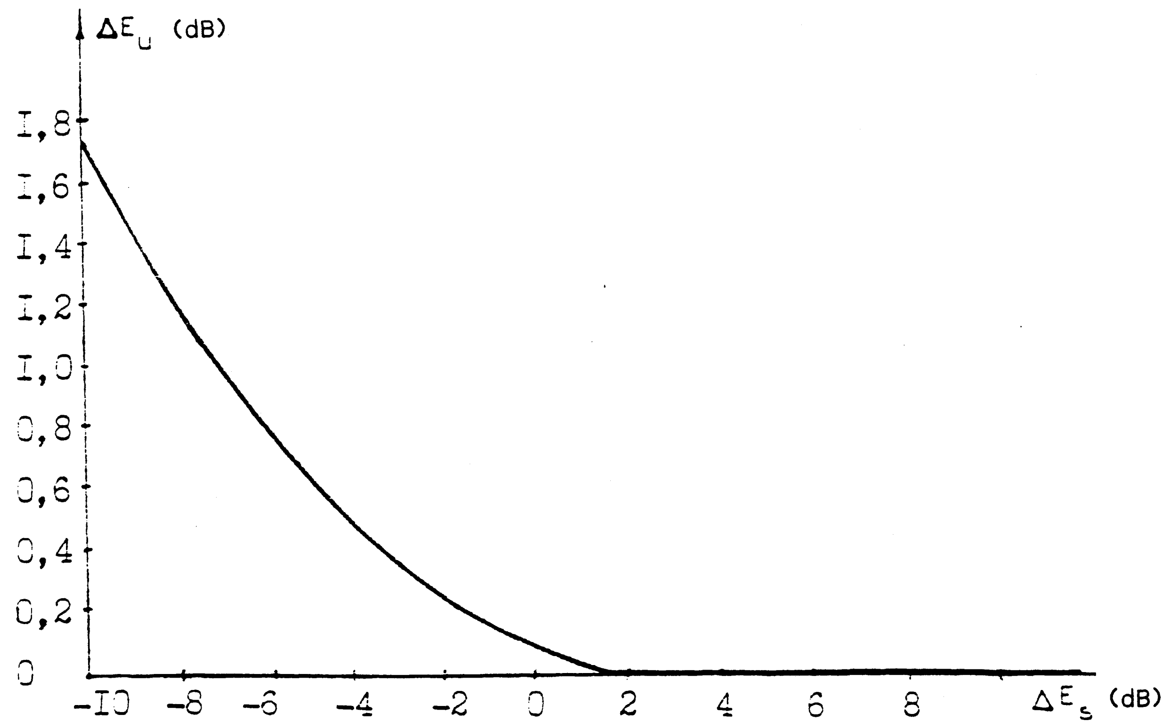

FIGURE 4

<u>Difference between the usable field-strength values obtained by the standard log-normal method and the simplified log-normal method</u>

5. Conclusions

The simplified multiplication method, the log-normal method and the simplified log-normal method are statistical in nature and can be used for interference assessments for any desired percentage of locations. In calculations for 50% of the receiving locations and 50% of the time, the simplified log-normal method is the most economical of these statistical methods in terms of calculation time. The power-sum method is likewise fairly simple, but its use leads to results which tend to be more optimistic than those obtained with the simplified multiplication method.

The inclusion of realistic values of correlation coefficient in a modified simplified multiplication method would substantially reduce the differences between this and the power-sum method, especially in those cases where the correlation coefficient lies between 0.5 and 0.75. However, further studies are needed to provide values of the location correlation coefficient, ρ, which can be applied in different types of terrain.

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ANNEX I

HOW TO USE THE SIMPLIFIED MULTIPLICATION METHOD FOR CALCULATING USABLE FIELD STRENGTHS (IN FM SOUND BROADCASTING)

1. Introduction

It has been proposed, on an international level [CCIR, 1961], to determine the influence of interfering transmitters (co-channel, adjacent channel and image channel) by means of the simplified multiplication method, which was developed by the [*Ad hoc* Committee 1949, 1950] and is described in detail in [Grosskopf, 1952]. In the following, a step-by-step explanation of the method is given for the practical user without deeper theoretical justification.

2. The concept of the usable field strength

The usable field strength E_u, is a quantity characterizing the coverage situation. To calculate the usable field strength, it is necessary to determine all those transmitters:

- which lie within a definite range of the wanted transmitter (according to experience: up to 800 km), according to the value of Δf);
- which might cause interference in relation to the required protection ratio (A_i).

For the n interfering transmitters, so determined, the nuisance field, E_{si}, is:

$$E_{si} = P_i + E_{ni(50,\,T)} + A_i + B_i \qquad (6)$$

where:

$E_{ni(50,\,T)}$: field-strength (dB(μV/m)) of the unwanted signal normalized to 1 kW effective radiated power (e.r.p.) at 50% locations for T% time (from field-strength curves of Recommendation 370);

P_i: e.r.p. (dB(kW)) of the interfering transmitter;

A_i: protection ratio (dB);

B_i: receiving antenna discrimination (dB).

The usable field strength, E_u, is a function of the n nuisance fields, E_{si}, and is calculated according to the formula:

$$p_c = \prod_{i=1}^{n} L(x_i) \qquad (7)$$

with:

$$x_i = \frac{E_u - E_{si}}{\sigma_n \sqrt{2}}$$

where:

p_c: the coverage probability. To initiate the iterative process of calculating E_u a predetermined value, p_{cp}, of the coverage probability is given, e.g. $p_{cp} = 0.5$. With the value of E_u obtained at the end of the iterative process the coverage probability is $p_c = p_{cp} = 0.5$, i.e. 50% of locations.

Note. – p_c can be set to any other value of coverage probability (e.g. 45% → $p_c = 0.45$).

L: the probability integral for a normal distribtion:

$$L(x) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} \left[\exp\left(-t^2/2\right)\right] \mathrm{d}t \qquad (8)$$

In this function x is the difference between the levels of the usable field strength, E_u, and the nuisance field, E_{si}, related to σ, the standard deviation (with location) of the resulting difference in level.

Identical values are assumed for the standard deviations (with location) of the wanted and interfering field-strength levels: $\sigma_n = \sigma_s$. Thus, the standard deviation of the resulting level difference is:

$$\sigma = \sqrt{\sigma_n^2 + \sigma_s^2} = \sigma_n \sqrt{2}$$

The value $\sigma_n = 8.3$ dB is assumed for the frequency bands I to III. For band IV/V this value is dependent on the terrain attenuation, g, and σ is then calculated according to the formula $\sigma_n = 9.5 + 0.405\,g$. The attenuation correction factor g (dB) can be derived from Δh (see Recommendation 370).

3. Calculation of the probability integral

3.1 *Tabular evaluation*

The probability integral in the form:

$$\varphi(x) = \frac{2}{\sqrt{2\pi}} \int_0^x \left[\exp(-t^2/2)\right] \mathrm{d}t \tag{9}$$

can be found evaluated in Table I.

Since

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} \left[\exp(-t^2/2)\right] \mathrm{d}t = 1$$

and

$$\frac{1}{\sqrt{2\pi}} \int_{-\infty}^{0} \left[\exp(-t^2/2)\right] \mathrm{d}t = 1/2$$

it follows that:

$$L(x) = \frac{\varphi(x)}{2} + 1/2$$

3.2 *Evaluation using Hastings approximation*

If the calculations are to be done with a computer (or programmable pocket or table calculator) the following rational approximation is very useful:

for $x \geqslant 0$:

$$L(x) = 1 - \frac{1}{(2\pi)^{1/2}} e^{-x^2/2} H(y)$$

for $x < 0$:

$$L(x) = 1 - L(-x) \tag{10}$$

where:

$$H(y) = C_5 y^5 + C_4 y^4 + C_3 y^3 + C_2 y^2 + C_1 y^1$$

and:

$y = [1 + 0.2316419\,|x|]^{-1}$

$C_5 = 1.330274429$

$C_4 = -1.821255978$

$C_3 = 1.781477937$

$C_2 = -0.356563782$

$C_1 = 0.319381530$

By means of equation (10) the integration in equation (8) and also the use of tables can be avoided when evaluating the probability integral. The error involved by using this approximation is less than 10^{-7}.

4. Practical calculation procedures to determine the usable field strength

Since it is impossible to solve equation (7) explicitly for E_u for a predetermined value p_{cp} (e.g. $p_{cp} = 0.5$) it must be solved iteratively. We begin with an initial value for E_u, which, according to experience, should be some 6 dB larger than the largest of the E_{si}, and determine, successively, for each E_{si}:

$$z_i = E_u - E_{si} = \Delta_i$$

$$x_i = \frac{\Delta_i}{\sigma_n \sqrt{2}} \qquad \text{(in bands I to III: } x_i = \Delta_i/11.738\text{)}$$

$\varphi(x_i)$ from Table I

$$L(x_i) = \frac{\varphi(x_i)}{2} + \frac{1}{2}$$

As for the standard deviation, a value $\sigma_n = 8.3$ dB is assumed to apply for bands I to III, it seems appropriate to introduce Table II where $L(x_i)$ is presented as a function of Δ_i for $\sigma_n = 8.3$ dB. In bands IV and V, where $\sigma_n = 9.5 + 0.405\ g$, Table II may also be used once the Δ_i values have been corrected according to:

$$\Delta_i' = \Delta_i \cdot \frac{8.3}{9.5 + 0.405\ g}$$

p_c is then determined by means of equation (7). If p_c is different from p_{cp} (e.g. $p_{cp} = 0.5$), the value so obtained is used as a basis to correct, as a part of the iterative process, the initial E_u value. From experience, the correction may be assumed to correspond approximately to:

$$\Delta E_u \approx \frac{p_{cp} - p_c}{0.05} \text{dB}$$

Then the determination of E_u has to be continued by repeating, with the corrected E_u, the determination of new Δ_i and $L(x_i)$ for each E_{si} and of a new p_c. This procedure has to be carried out until the correction ΔE_u falls below the accuracy limit. Table III gives an example for the iterative determination of E_u in the presence of 5 nuisance fields ($\sigma_n = 8.3$ dB). The values of $L(x_i)$ are taken from Table II.

TABLE I – *Probability integral* $\varphi(x) = \frac{2}{\sqrt{2\pi}} \int_0^x [\exp(-t^2/2)]\, dt$

x	$\varphi(x)$	x	$\varphi(x)$	x	$\varphi(x)$	x	$\varphi(x)$
0.00	0.0000	0.60	0.4515	1.20	0.7699	1.80	0.9281
01	0.0080	61	0.4581	21	0.7737	81	0.9297
02	0.0160	62	0.4647	22	0.7775	82	0.9312
03	0.0239	63	0.4713	23	0.7813	83	0.9328
04	0.0319	64	0.4778	24	0.7850	84	0.9342
0.05	0.0399	0.65	0.4843	1.25	0.7887	1.85	0.9357
06	0.0478	66	0.4907	26	0.7923	86	0.9371
07	0.0558	67	0.4971	27	0.7959	87	0.9385
08	0.0638	68	0.5035	28	0.7995	88	0.9399
09	0.0717	69	0.5098	29	0.8029	89	0.9412
0.10	0.0797	0.70	0.5161	1.30	0.8064	1.90	0.9426
11	0.0876	71	0.5223	31	0.8098	91	0.9439
12	0.0955	72	0.5285	32	0.8132	92	0.9451
13	0.1034	73	0.5346	33	0.8165	93	0.9464
14	0.1113	74	0.5407	34	0.8198	94	0.9476
0.15	0.1192	0.75	0.5467	1.35	0.8230	1.95	0.9488
16	0.1271	76	0.5527	36	0.8262	96	0.9500
17	0.1350	77	0.5587	37	0.8293	97	0.9512
18	0.1428	78	0.5646	38	0.8324	98	0.9523
19	0.1507	79	0.5705	39	0.8355	99	0.9534
0.20	0.1585	0.80	0.5763	1.40	0.8385	2.00	0.9545
21	0.1663	81	0.5821	41	0.8415	05	0.9596
22	0.1741	82	0.5878	42	0.8444	10	0.9643
23	0.1819	83	0.5935	43	0.8473	15	0.9684
24	0.1897	84	0.5991	44	0.8501	20	0.9722
0.25	0.1974	0.85	0.6047	1.45	0.8529	2.25	0.9756
26	0.2041	86	0.6102	46	0.8557	30	0.9786
27	0.2128	87	0.6157	47	0.8584	35	0.9812
28	0.2205	88	0.6211	48	0.8611	40	0.9836
29	0.2282	89	0.6265	49	0.8638	45	0.9857
0.30	0.2358	0.90	0.6319	1.50	0.8664	2.50	0.9876
31	0.2434	91	0.6372	51	0.8690	55	0.9892
32	0.2510	92	0.6424	52	0.8715	60	0.9907
33	0.2586	93	0.6476	53	0.8740	65	0.9920
34	0.2661	94	0.6528	54	0.8764	70	0.9931
0.35	0.2737	0.95	0.6579	1.55	0.8789	2.75	0.9940
36	0.2812	96	0.6629	56	0.8812	80	0.9949
37	0.2886	97	0.6680	57	0.8836	85	0.9956
38	0.2961	98	0.6729	58	0.8859	90	0.9963
39	0.3035	99	0.6778	59	0.8882	95	0.9968
0.40	0.3108	1.00	0.6827	1.60	0.8904	3.00	0.99730
41	0.3182	01	0.6875	61	0.8926	10	0.99806
42	0.3255	02	0.6923	62	0.8948	20	0.99863
43	0.3328	03	0.6970	63	0.8969	30	0.99903
44	0.3401	04	0.7017	64	0.8990	40	0.99933
0.45	0.3473	1.05	0.7063	1.65	0.9011	3.50	0.99953
46	0.3545	06	0.7109	66	0.9031	60	0.99968
47	0.3616	07	0.7154	67	0.9051	70	0.99978
48	0.3688	08	0.7199	68	0.9070	80	0.99986
49	0.3759	09	0.7243	69	0.9090	90	0.99990
0.50	0.3829	1.10	0.7287	1.70	0.9109	4.00	0.99994
51	0.3899	11	0.7330	71	0.9127		
52	0.3969	12	0.7373	72	0.9146	4.417	$1-10^{-5}$
53	0.4039	13	0.7415	73	0.9164		
54	0.4108	14	0.7457	74	0.9181	4.892	$1-10^{-6}$
0.55	0.4177	1.15	0.7499	1.75	0.9199	5.327	$1-10^{-7}$
56	0.4245	16	0.7540	76	0.9216		
57	0.4313	17	0.7580	77	0.9233		
58	0.4381	18	0.7620	78	0.9249		
59	0.4448	19	0.7660	79	0.9265		
0.60	0.4515	1.20	0.7699	1.80	0.9281		

TABLE II

Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$
.0	.50000	7.000	5.0	.66493	4.121	10.0	.80288	2.217	15.0	.89936	1.071	20.0	.95580	.457
.1	.50340	6.932	5.1	.66803	4.074	10.1	.80523	2.188	15.1	.90085	1.054	20.1	.95659	.448
.2	.50680	6.864	5.2	.67112	4.028	10.2	.80757	2.158	15.2	.90233	1.038	20.2	.95737	.440
.3	.51020	6.796	5.3	.67419	3.981	10.3	.80989	2.129	15.3	.90379	1.022	20.3	.95813	.432
.4	.51359	6.729	5.4	.67726	3.936	10.4	.81219	2.101	15.4	.90524	1.005	20.4	.95889	.424
.5	.51699	6.663	5.5	.68031	3.890	10.5	.81448	2.072	15.5	.90667	.989	20.5	.95964	.416
.6	.52038	6.596	5.6	.68335	3.845	10.6	.81675	2.044	15.6	.90808	.974	20.6	.96037	.408
.7	.52378	6.531	5.7	.68638	3.801	10.7	.81900	2.016	15.7	.90948	.958	20.7	.96109	.401
.8	.52717	6.466	5.8	.68939	3.756	10.8	.82124	1.989	15.8	.91086	.943	20.8	.96180	.393
.9	.53056	6.401	5.9	.69239	3.712	10.9	.82345	1.962	15.9	.91222	.928	20.9	.96251	.386
1.0	.53395	6.337	6.0	.69538	3.669	11.0	.82565	1.935	16.0	.91357	.913	21.0	.96320	.379
1.1	.53733	6.273	6.1	.69836	3.626	11.1	.82784	1.908	16.1	.91491	.898	21.1	.96388	.372
1.2	.54071	6.209	6.2	.70132	3.583	11.2	.83000	1.882	16.2	.91623	.884	21.2	.96455	.365
1.3	.54409	6.147	6.3	.70427	3.541	11.3	.83215	1.856	16.3	.91753	.869	21.3	.96521	.358
1.4	.54747	6.084	6.4	.70721	3.499	11.4	.83428	1.830	16.4	.91882	.855	21.4	.96586	.351
1.5	.55084	6.022	6.5	.71013	3.457	11.5	.83639	1.804	16.5	.92009	.841	21.5	.96650	.344
1.6	.55421	5.960	6.6	.71304	3.416	11.6	.83848	1.779	16.6	.92135	.827	21.6	.96713	.338
1.7	.55758	5.899	6.7	.71593	3.375	11.7	.84056	1.754	16.7	.92259	.814	21.7	.96775	.331
1.8	.56094	5.839	6.8	.71881	3.334	11.8	.84262	1.729	16.8	.92382	.800	21.8	.96836	.325
1.9	.56430	5.778	6.9	.72168	3.294	11.9	.84466	1.705	16.9	.92503	.787	21.9	.96896	.318
2.0	.56765	5.719	7.0	.72453	3.254	12.0	.84669	1.681	17.0	.92623	.774	22.0	.96955	.312
2.1	.57099	5.659	7.1	.72737	3.215	12.1	.84869	1.657	17.1	.92742	.761	22.1	.97013	.306
2.2	.57434	5.600	7.2	.73019	3.176	12.2	.85068	1.633	17.2	.92858	.748	22.2	.97071	.300
2.3	.57767	5.542	7.3	.73300	3.137	12.3	.85265	1.610	17.3	.92974	.736	22.3	.97127	.294
2.4	.58100	5.484	7.4	.73579	3.098	12.4	.85461	1.587	17.4	.93088	.723	22.4	.97183	.289
2.5	.58433	5.426	7.5	.73857	3.060	12.5	.85654	1.564	17.5	.93200	.711	22.5	.97237	.283
2.6	.58765	5.369	7.6	.74134	3.023	12.6	.85846	1.541	17.6	.93312	.699	22.6	.97291	.277
2.7	.59096	5.312	7.7	.74408	2.985	12.7	.86036	1.519	17.7	.93421	.687	22.7	.97344	.272
2.8	.59427	5.256	7.8	.74682	2.948	12.8	.86225	1.497	17.8	.93530	.676	22.8	.97396	.266
2.9	.59757	5.200	7.9	.74954	2.912	12.9	.86412	1.475	17.9	.93637	.664	22.9	.97447	.261
3.0	.60086	5.144	8.0	.75224	2.875	13.0	.86596	1.453	18.0	.93742	.653	23.0	.97497	.256
3.1	.60415	5.089	8.1	.75492	2.839	13.1	.86780	1.432	18.1	.93846	.641	23.1	.97546	.251
3.2	.60743	5.035	8.2	.75760	2.804	13.2	.86961	1.411	18.2	.93949	.630	23.2	.97595	.246
3.3	.61070	4.980	8.3	.76025	2.768	13.3	.87141	1.390	18.3	.94051	.619	23.3	.97643	.241
3.4	.61396	4.926	8.4	.76289	2.733	13.4	.87319	1.369	18.4	.94151	.609	23.4	.97690	.236
3.5	.61722	4.873	8.5	.76551	2.699	13.5	.87495	1.349	18.5	.94250	.598	23.5	.97736	.231
3.6	.62046	4.820	8.6	.76812	2.664	13.6	.87670	1.329	18.6	.94347	.588	23.6	.97781	.227
3.7	.62370	4.768	8.7	.77071	2.630	13.7	.87843	1.309	18.7	.94443	.577	23.7	.97826	.222
3.8	.62693	4.715	8.8	.77328	2.597	13.8	.88014	1.289	18.8	.94538	.567	23.8	.97870	.217
3.9	.63015	4.664	8.9	.77584	2.563	13.9	.88183	1.270	18.9	.94632	.557	23.9	.97913	.213
4.0	.63336	4.612	9.0	.77838	2.530	14.0	.88351	1.251	19.0	.94724	.547	24.0	.97956	.209
4.1	.63657	4.561	9.1	.78091	2.497	14.1	.88517	1.232	19.1	.94815	.538	24.1	.97997	.204
4.2	.63976	4.511	9.2	.78342	2.465	14.2	.88681	1.213	19.2	.94905	.528	24.2	.98038	.200
4.3	.64294	4.461	9.3	.78591	2.433	14.3	.88844	1.195	19.3	.94994	.519	24.3	.98078	.196
4.4	.64611	4.411	9.4	.78838	2.401	14.4	.89005	1.176	19.4	.95081	.509	24.4	.98118	.192
4.5	.64928	4.362	9.5	.79084	2.370	14.5	.89164	1.158	19.5	.95167	.500	24.5	.98157	.188
4.6	.65243	4.313	9.6	.79328	2.339	14.6	.89322	1.140	19.6	.95252	.491	24.6	.98195	.184
4.7	.65557	4.264	9.7	.79571	2.308	14.7	.89478	1.123	19.7	.95336	.482	24.7	.98232	.180
4.8	.65870	4.216	9.8	.79811	2.277	14.8	.89632	1.105	19.8	.95418	.474	24.8	.98269	.176
4.9	.66182	4.168	9.9	.80050	2.247	14.9	.89785	1.088	19.9	.95500	.465	24.9	.98305	.173

TABLE II *(continued)*

Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$	Δ	$L(x)$	$-\log L(x)$
25.0	.98341	.169	30.0	.99470	.054	35.0	.99857	.014	40.0	.99967	.003	45.0	.99994	.001
25.1	.98376	.165	30.1	.99483	.052	35.1	.99861	.014	40.1	.99968	.003	45.1	.99994	.001
25.2	.98410	.162	30.2	.99496	.051	35.2	.99864	.014	40.2	.99969	.003	45.2	.99994	.001
25.3	.98443	.158	30.3	.99508	.050	35.3	.99868	.013	40.3	.99970	.003	45.3	.99994	.001
25.4	.98476	.155	30.4	.99520	.049	35.4	.99872	.013	40.4	.99971	.003	45.4	.99995	.001
25.5	.98509	.152	30.5	.99532	.047	35.5	.99875	.013	40.5	.99972	.003	45.5	.99995	.001
25.6	.98541	.148	30.6	.99543	.046	35.6	.99879	.012	40.6	.99973	.003	45.6	.99995	.001
25.7	.98572	.145	30.7	.99554	.045	35.7	.99882	.012	40.7	.99974	.003	45.7	.99995	.000
25.8	.98603	.142	30.8	.99565	.044	35.8	.99886	.012	40.8	.99975	.003	45.8	.99995	.000
25.9	.98633	.139	30.9	.99576	.043	35.9	.99889	.011	40.9	.99975	.002	45.9	.99995	.000
26.0	.98662	.136	31.0	.99587	.042	36.0	.99892	.011	41.0	.99976	.002	46.0	.99996	.000
26.1	.98691	.133	31.1	.99597	.041	36.1	.99895	.011	41.1	.99977	.002	46.1	.99996	.000
26.2	.98719	.130	31.2	.99607	.040	36.2	.99898	.010	41.2	.99978	.002	46.2	.99996	.000
26.3	.98747	.127	31.3	.99617	.039	36.3	.99901	.010	41.3	.99978	.002	46.3	.99996	.000
26.4	.98775	.125	31.4	.99626	.038	36.4	.99904	.010	41.4	.99979	.002	46.4	.99996	.000
26.5	.98802	.122	31.5	.99636	.037	36.5	.99906	.009	41.5	.99980	.002	46.5	.99996	.000
26.6	.98828	.119	31.6	.99645	.036	36.6	.99909	.009	41.6	.99980	.002	46.6	.99996	.000
26.7	.98854	.116	31.7	.99654	.035	36.7	.99912	.009	41.7	.99981	.002	46.7	.99997	.000
26.8	.98879	.114	31.8	.99663	.034	36.8	.99914	.009	41.8	.99982	.002	46.8	.99997	.000
26.9	.98904	.111	31.9	.99671	.033	36.9	.99917	.008	41.9	.99982	.002	46.9	.99997	.000
27.0	.98928	.109	32.0	.99680	.032	37.0	.99919	.008	42.0	.99983	.002	47.0	.99997	.000
27.1	.98952	.106	32.1	.99688	.032	37.1	.99921	.008	42.1	.99983	.002	47.1	.99997	.000
27.2	.98976	.104	32.2	.99696	.031	37.2	.99924	.008	42.2	.99984	.002	47.2	.99997	.000
27.3	.98999	.102	32.3	.99704	.030	37.3	.99926	.007	42.3	.99984	.002	47.3	.99997	.000
27.4	.99021	.099	32.4	.99711	.029	37.4	.99928	.007	42.4	.99985	.002	47.4	.99997	.000
27.5	.99043	.097	32.5	.99719	.028	37.5	.99930	.007	42.5	.99985	.001	47.5	.99997	.000
27.6	.99065	.095	32.6	.99726	.028	37.6	.99932	.007	42.6	.99986	.001	47.7	.99997	.000
27.7	.99086	.093	32.7	.99733	.027	37.7	.99934	.007	42.7	.99986	.001	47.7	.99998	.000
27.8	.99107	.091	32.8	.99740	.026	37.8	.99936	.006	42.8	.99987	.001	47.8	.99998	.000
27.9	.99127	.089	32.9	.99747	.026	37.9	.99938	.006	42.9	.99987	.001	47.9	.99998	.000
28.0	.99147	.087	33.0	.99753	.025	38.0	.99940	.006	43.0	.99988	.001	48.0	.99998	.000
28.1	.99167	.085	33.1	.99760	.024	38.1	.99941	.006	43.1	.99988	.001	48.1	.99998	.000
28.2	.99186	.083	33.2	.99766	.024	38.2	.99943	.006	43.2	.99988	.001	48.2	.99998	.000
28.3	.99205	.081	33.3	.99772	.023	38.3	.99945	.006	43.3	.99989	.001	48.3	.99998	.000
28.4	.99223	.079	33.4	.99778	.022	38.4	.99946	.005	43.4	.99989	.001	48.4	.99998	.000
28.5	.99241	.077	33.5	.99784	.022	38.5	.99948	.005	43.5	.99989	.001	48.5	.99998	.000
28.6	.99259	.075	33.6	.99790	.021	38.6	.99950	.005	43.6	.99990	.001	48.6	.99998	.000
28.7	.99276	.073	33.7	.99795	.021	38.7	.99951	.005	43.7	.99990	.001	48.7	.99998	.000
28.8	.99293	.072	33.8	.99801	.020	38.8	.99953	.005	43.8	.99990	.001	48.8	.99998	.000
28.9	.99309	.070	33.9	.99806	.020	38.9	.99954	.005	43.9	.99991	.001	48.9	.99998	.000
29.0	.99326	.068	34.0	.99811	.019	39.0	.99955	.005	44.0	.99991	.001	49.0	.99999	.000
29.1	.99341	.067	34.1	.99816	.019	39.1	.99957	.004	44.1	.99991	.001	49.1	.99999	.000
29.2	.99357	.065	34.2	.99821	.018	39.2	.99958	.004	44.2	.99992	.001	49.2	.99999	.000
29.3	.99372	.064	34.3	.99826	.018	39.3	.99959	.004	44.3	.99992	.001	49.3	.99999	.000
29.4	.99387	.062	34.4	.99831	.017	39.4	.99961	.004	44.4	.99992	.001	49.4	.99999	.000
29.5	.99402	.061	34.5	.99835	.017	39.5	.99962	.004	44.5	.99992	.001	49.5	.99999	.000
29.6	.99416	.059	34.6	.99840	.016	39.6	.99963	.004	44.6	.99993	.001	49.6	.99999	.000
29.7	.99430	.058	34.7	.99844	.016	39.7	.99964	.004	44.7	.99993	.001	49.7	.99999	.000
29.8	.99444	.056	34.8	.99849	.015	39.8	.99965	.004	44.8	.99993	.001	49.8	.99999	.000
29.9	.99457	.055	34.9	.99853	.015	39.9	.99966	.003	44.9	.99993	.001	49.9	.99999	.000

TABLE III

Approximation		1		2		3	
i	E_{si} (dB)	E_u = 78 dB		E_u = 76.6 dB		E_u = 76.44 dB	
		z_i (dB)	$L(x_i)$	z_i (dB)	$L(x_i)$	z_i (dB)	$L(x_i)$
1	64	14	0.8835	12.6	0.8585	12.44	0.8554
2	72	6	0.6954	4.6	0.6524	4.44	0.6474
3	60	18	0.9374	16.6	0.9214	16.44	0.9193
4	50	28	0.9915	26.6	0.9883	26.44	0.9878
5	45	33	0.9975	31.6	0.9964	31.44	0.9963
p_c			0.5696		0.5082		0.5010
ΔE_u (dB)			≈ −1.4		≈ −0.16		≈ −0.02

The result of the iterative computation is E_u = 76.42 dB.

The necessity to carry out numerous multiplications using at least four-digit numbers suggests a further simplification of the method consisting in substituting the $L(x_i)$ by the logarithms of their reciprocal value. This would reduce the computation work to a summation of the $-\log L(x_i)$ values. To further facilitate the computation of ΔE_u, it is appropriate to select a basis for these logarithms in such a way that ΔE_u immediately results from a comparison of the sum with $-\log p_{cp}$ (logarithm to the same basis), e.g. $-\log 0.5$ (50%).

For convenience, the logarithms of $-L(x_i)$ are included in Table II. As an example these logarithms are used in Table IV. The underlying interference problem is identical in Tables III and IV and so are the results.

TABLE IV

Approximation		1		2		3	
i	E_{si} (dB)	E_u = 78 dB		E_u = 76.7 dB		E_u = 76.45 dB	
		z_i (dB)	$-\log L(x_i)$	z_i (dB)	$-\log L(x_i)$	z_i (dB)	$-\log L(x_i)$
1	64	14	1.251	12.7	1.519	12.45	1.575
2	72	6	3.669	4.7	4.264	4.45	4.386
3	60	18	0.653	16.7	0.814	16.45	0.848
4	50	28	0.087	26.7	0.116	26.45	0.123
5	45	33	0.025	31.7	0.035	31.45	0.037
–	$-\log p_c$ $-\log 0.5$ (1)		5.685 −7.000		6.748 −7.000		6.969 −7.000
ΔE_u (dB)			≈ −1.3		≈ −0.25		≈ −0.03

(1) For p_{cp} = 0.5;
for other values of p_{cp}: $-\log p_{cp} = (-7 \log p_{cp})/\log 2$;
e.g. for p_{cp} = 0.45: $-\log p_{cp}$ = 8.064.

The result of the iterative computation is E_u = 76.42 dB.

In addition to the procedure described above a number of other approaches to making use of the simplified multiplication method exist and are contained in a more complete description of the method [EBU, 1984]. Which of the procedures will be preferred may depend on the computation facilities available to the user.

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ANNEX II

USE OF THE LOG-NORMAL METHOD FOR USABLE FIELD STRENGTH CALCULATION (IN FM SOUND AND TELEVISION BROADCASTING)

1. Order of manual calculation of E_u by the log-normal method. The symbols used are defined in section 3.2.

The calculation is performed in the following order:

a) find a median value of the resultant of n interferers at the point under consideration and its standard deviation :

$$E_r = 0.1152\,\sigma^2 + 10 \log \left(\sum_i^n M_{si} \right) - 5 \log U \qquad \text{(dB)}$$

$$\sigma_r = 6.58\sqrt{\log U} \qquad \text{(dB)}$$

The value $\sigma = 8.3$ dB is assumed for the frequency bands I to III. For band IV/V this value is dependent on the terrain attenuation, g, and σ is then calculated according to the formula $\sigma = 9.5 + 0.405\,g$. The attenuation correction factor g (dB) can be derived from Δh (see Recommendation 370).

b) take $E_{u1} = E_r$ (see note)

c) determine the probability that $E_{u1} \geq E_r$:

$$p_i = L(\Delta E_r) = 0.5 + \frac{\varphi(\Delta E_r)}{2}$$

where:

$$\Delta E_r = \frac{E_{u1} - E_r}{\sigma_m}; \quad \sigma_m = \sqrt{\sigma^2 + \sigma_r^2}$$

The probability $\varphi(\Delta E_r)$ can be determined from section 3 of Annex I, so that $x = \Delta E_r$

d) determine the probability that $E_{u1} \geq E_{min}$:

$$p_2 = L(\Delta E_{min}) = 0.5 + \frac{\varphi(\Delta E_{min})}{2}$$

where: $$\Delta E_{min} = \frac{E_{u1} - E_{min}}{\sigma}$$

The probability $\varphi(\Delta E_{min})$ can be determined from section 3 of Annex I, so that $x = \Delta E_{min}$.

e) determine the probability of the simultaneous fulfilment of both inequalities:

$$p_c = p_1 \cdot p_2.$$

f) If the value obtained for p_c satisfies the given $p_{cp} = 0.5 \pm 0.01$, then the calculation is completed and $E_u = E_{u1}$. Otherwise, we find the value

$$E_{u2} = E_{u1} + \frac{0.5 - p_c}{0.05}$$

and the calculation is repeated from the second point with the new value of E_{u2}, and so on until the required precision is obtained.

Note - It should be noted that in cases where $E_{si\ max} - E_{min} \geq 16.5$ dB, the unknown usable field strength value is equal to the value obtained for E_r, and no further calculation is required.

2. Examples of manual calculation of usable field strength.

An example of the calculation of the usable field strength is given for the same values of E_{si} as in Table III of Annex I . This is shown in Table V with respect to two different values of E_{min} : 50 and 57 dB.

Table V shows that, after the calculation of the resultant interference E_r, equivalent to n interfering fields E_{si}, the calculation of the usable field strength E_u will require a minimum number of steps depending on the correlation of the value obtained for E_r with the value of E_{min}.

TABLE V

1. Calculation of median value of resultant interference and its standard deviation

i	E_{si}, dB	$E_r = 0.1152\,\sigma^2 + 10 \lg \sum_i M_{si} - 5 \lg U$ (dB)	$\sigma_r = 6.58(\lg U)^{1/2}$ (dB)
1	64		
2	72		
3	60	73.71	7.85
4	50		
5	45		

2. Calculation of the value of E_u when $E_{min} = 50$ dB

1) Approximation $E_{u1} = E_r = 73.71$ dB

$\Delta E_r = \dfrac{E_{u1} - E_r}{\sigma_m}$	$L(\Delta E_r)$	$\Delta E_{min} = \dfrac{E_{u1} - E_{min}}{\sigma}$	$L(\Delta E_{min})$	$p = L(\Delta E_r)\,L(\Delta E_{min})$
0	0.5	2.86	0.9978	0.4989

$$E_u = E_{u1} + \frac{0.5 - p_c}{0.05} = 73.71 + 0.02 = 73.73 \text{ dB}$$

3. Calculation of the value of E_u when $E_{min} = 57$ dB

1) Approximation $E_{u1} = E_r = 73.71$ dB

0	0.5	2.01	0.9772	0.488

$$E_{u2} = E_{u1} + \frac{0.5 - p_c}{0.05} = 73.71 + 0.23 = 73.94 \text{ dB}$$

2) Approximation $E_{u2} = 73.94$ dB

0.02	0.508	2.04	0.9798	0.498

$$E_u = E_{u2} + \frac{0.5 - p_c}{0.05} = 73.94 + 0.04 = 73.98 \text{ dB}$$

Table VI shows an example of calculation of usable field-strength by the simplified log-normal method (the values taken for E_{si}, E_{min} and σ are the same as those in Table V).

TABLE VI

Calculation of median resultant field-strength

i	E_{si}, dB	$U_s = \frac{(k-1)(\sum_i M_i^2 + M_{min}^2)}{(\sum_i M_i + M_{min})^2} + 1$	$E_{rs} = 0{,}1152\,\sigma^2 + 10 \lg(\sum_i M_i + M_{min}) - 5 \lg U_s$
1	64	1. E_{min} = 50 dB	
2	72	U_s = 26.2378	E_{rs} = 73.73 dB
3	60		
4	50	2. E_{min} = 57 dB	
5	45	U_s = 25.2356	E_{rs} = 73.95 dB

A comparison between Tables V and VI shows that the simplified log-normal method using a non-iterative procedure produces the same usable field-strength values as those obtained by the standard log-normal method.

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