

RECOMMENDATION 561-2*

DEFINITIONS OF RADIATION IN LF, MF AND HF BROADCASTING BANDS

(1978-1982-1986)

The CCIR

UNANIMOUSLY RECOMMENDS

that the following terminology should be used to define and determine the radiation from sound-broadcasting transmitters:

1. Cymomotive force (c.m.f.) (in a given direction)

The product formed by multiplying the electric field strength at a given point in space, due to a transmitting station, by the distance of the point from the antenna. This distance must be sufficient for the reactive components of the field to be negligible; moreover, the finite conductivity of the ground is supposed to have no effect on propagation.

The cymomotive force (c.m.f.) is a vector; when necessary it may be expressed in terms of components along axes perpendicular to the direction of propagation.

The c.m.f. is expressed in volts; it corresponds numerically to the field strength in mV/m at a distance of 1 km.

2. Effective monopole-radiated power (e.m.r.p.) (in a given direction)

The product of the power supplied to the antenna and its gain relative to a short vertical antenna in the given direction. (Radio Regulations, No. 157.)

Radio Regulations No. 154 (c) defines the gain of an antenna in a given direction relative to a short vertical antenna G_v as the gain relative to a loss-free reference antenna consisting of a linear conductor, much shorter than one quarter of a wavelength, normal to the surface of a perfectly conducting plane which contains the given direction.

The reference antenna, when fed with a power of 1 kW, is considered to radiate an e.m.r.p. of 1 kW in any direction in the perfectly conducting plane and produces a field strength of 300 mV/m at 1 km distance (equivalent to a c.m.f. of 300 V).

An e.m.r.p. of 1 kW is assumed in the derivation of the ground-wave propagation curves of Recommendation 368. An e.m.r.p. of 1 kW at all angles of elevation is assumed in the presentation of the sky-wave curves of Recommendation 435.

Note 1 — Definitions 1 and 2 are mainly used in LF and MF broadcasting.

3. Equivalent isotropically radiated power (e.i.r.p.)

The product of the power supplied to the antenna and the antenna gain G_i in a given direction relative to an isotropic antenna (absolute or isotropic gain) (Radio Regulations, No. 155).

The idealized reference antenna, when fed with a power of 1 kW, is considered to provide an e.i.r.p. of 1 kW in all directions and to produce a field strength of 173 mV/m at 1 km distance.

4. Effective radiated power (e.r.p.) (in a given direction)

The product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction (Radio Regulations, No. 156).

Radio Regulations No. 154 (b) defines the gain of an antenna in a given direction relative to a half-wave dipole G_d as the gain relative to a loss-free reference antenna isolated in space whose equatorial plane contains the given direction.

The reference antenna, when fed with a power of 1 kW, is considered to radiate an e.r.p. of 1 kW in any direction in the equatorial plane and produces a field strength of 222 mV/m at 1 km distance.

Note 1 — Definitions 3 and 4 are mainly used in HF broadcasting.

Note 2 — The relationship between the radiated power expressed in the different units is given in Annex I.

Note 3 — For information, some guidance on the determination of the radiated power is given in Annex II.

Note 4 — For information, radiated power standards for propagation curves are discussed in Annex III.

* This Recommendation should be brought to the attention of the CMV.

ANNEX I

RELATIONSHIP BETWEEN RADIATED POWERS EXPRESSED IN DIFFERENT UNITS

1. Relationship between e.m.r.p. and c.m.f.

The value of the e.m.r.p. is related to the c.m.f. (V) by the expression:

$$\text{e.m.r.p.} = (\text{c.m.f.}/300)^2 \text{ kW}$$

Table I gives some practical examples of c.m.f. and e.m.r.p. in the absence of losses.

TABLE I

Transmitter power (kW)	Antenna	Gain relative to a short vertical antenna (dB)	c.m.f. (V)	c.m.f. (dB (300 V))	e.m.r.p. (kW)
0.01	} short vertical	0	30	-20	0.01
0.1		0	95	-10	0.1
1		0	300	0	1
10		0	950	+10	10
100	} $\lambda/2$ vertical	2	3 800	+22	160
300		2	6 600	+27	475
1000		2	12 000	+32	1600

2. Relationship between e.r.p. and e.i.r.p.

The value of the e.r.p. is related to the e.i.r.p. by the expression:

$$\text{e.r.p.} = 0.61 \text{ e.i.r.p. (linear scale)}$$

$$\text{e.r.p.} = \text{e.i.r.p.} - 2.2 \text{ dB (logarithmic scale)}$$

ANNEX II

DETERMINATION OF THE RADIATED POWER

1. Vertical antennas

For vertical antenna systems which are actually in operation, the radiation in a horizontal direction is obtainable by measurements of field strength on a radial line over the range, 2λ to 15λ , from the antenna system. Here, λ is taken to be either the wavelength or the maximum dimensions of the antenna, whichever is the greater, in order to avoid the effect of reactive fields. If E is the field strength at distance, d , the product, Ed , is plotted graphically against d . The line is extrapolated to $d = 0$, and the product (E_0d_0) gives the c.m.f. A method of extrapolation has been proposed by [Surutka and Gavrilov, 1983].

For a single mast, it is desirable to take the average of values for a few radials. For a multiple mast system, separate measurements are required on a number of radials to establish the radiated power as a function of bearing.

For directions above the horizontal, a correction should be derived theoretically from the behaviour over a perfectly conducting plane. Alternatively, field-strength measurements may be made from a helicopter.

For antenna systems which have not yet been constructed, or whenever for some other reason measurements cannot be made reliably, the radiated power may be estimated from a calculation of the antenna performance over a perfectly conducting surface, and from the estimated efficiency of the antenna system.