RECOMMENDATION ITU-R SM.378-7*

Field-strength measurements at monitoring stations

(1953-1956-1963-1966-1978-1982-1986-1992-1995-2007)

Scope

This Recommendation is developed, to specify the accuracies for field-strength measurements at monitoring stations, and to set parameters for the measurement equipment.

Keywords

Field-strength measurements, monitoring stations, international registration, frequency assignment

The ITU Radiocommunication Assembly,

considering

a) that field-strength measurements are made at monitoring stations in the frequency range 9 kHz to 3 GHz and above (e.g. up to 40 GHz), depending on the tasks of the station;

b) that accurate measurements, for use in connection with the international registration and assignment of frequencies, may be desirable;

c) that the publication of field strength data from monitoring is also desirable,

recommends

1 that, to obtain the accuracies specified in *recommends* 3, the field-strength measuring equipment at monitoring stations should be installed and operated in accordance with Annex 1;

2 that, in order to reach the best accuracy concerning field-strength measurements at monitoring stations, the ITU-R Spectrum Monitoring Handbook should be used as a guidance;

3 that, except where there are limitations due to the receiver noise-level, atmospheric noise or external interference, the accuracy to be expected in field-strength measurements should be:

Frequency band	Accuracy of measurement (dB)
9 kHz to 30 MHz	±2
30 MHz to 3 GHz	±3

a lower degree of accuracy may sometimes be accepted for frequencies below 30 MHz;

4 that when, because of limitations of measuring instruments, interference, signal instability or for other reasons, the accuracies in *recommends* 3 are not obtainable, the measurements should nevertheless receive due consideration with the accuracy indicated.

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* Radiocommunication Study Group 1 made editorial amendments to this Recommendation in the years 2018 and 2019 in accordance with Resolution ITU-R 1.

Annex 1

1 Antenna installation

In order to obtain a field-strength measurement accuracy such as indicated in *recommends* 3, it is essential to use a calibrated antenna with its free space antenna factor (*k*-factor), and adapted to the frequency range to be measured.

1.1 Frequencies below 30 MHz

It is recommended that, for frequencies below 30 MHz, vertical or loop antennas be used. A vertical antenna shorter than one-quarter of a wavelength may be used, with a RF ground system consisting of either buried radial conductors at least twice the length of the antenna and spaced 30° or less apart, or an equivalent RF ground screen. An inverted cone type vertical antenna with a similar ground system may also be used with some advantage.

1.1.1 It is generally accepted that random variations in polarization of ionospheric waves are such that the vertically polarized component is, in general, substantially equal to the horizontal component.

1.1.2 The voltage developed at the output of a passive vertical antenna shorter than one quarter of a wavelength is substantially dependant on the frequency. Since the impedance of this antenna is capacitively reactive, the subsequent voltage response in a field-strength measuring instrument, when connected to a properly terminated transmission line, is essentially a direct function of frequency, resulting in a simple, relatively uniform calibration curve.

1.1.3 The voltage developed at the output of an active vertical antenna shorter than one-quarter of a wavelength is usually independent of frequency, since the amplifier input impedance is high compared to the impedance of the antenna element.

1.1.4 A conical form of a vertical antenna provides substantially greater gain than a short single element vertical antenna. It provides uniform impedance characteristics and reasonably smooth gain characteristics in the 2 to 30 MHz range; also it provides a uniform, frequency dependant (if passive) calibration curve at frequencies below about 2 MHz, depending upon size.

1.1.5 The interaction between wideband antennas such as inverted cones, the feeder and the receiver are complex due to the changing sensitivities, impedances and losses with frequency. It is desirable to enhance overall calibration accuracy to design field-strength facilities as a single entity rather than part of a larger switchable, multi-purpose facility.

1.2 Frequencies between 30 MHz and 1 GHz

Antennas for field-strength measurements at frequencies between 30 MHz and 1 GHz are recommended to conform to the following conditions.

1.2.1 The receiving antenna must have the same polarization as the transmitting antenna. Therefore short monopole antennas, half-wave dipoles and high-gain antennas are appropriate.

1.2.2 It is preferable that the antennas be located at a height of 10 m above the ground; if lower height measurements are unavoidable, then particular care must be taken to avoid mutual coupling with the ground or the vehicle roof especially with vehicle mounted systems.

1.2.3 Consideration must be given to surrounding terrain (possible obstructions), metallic objects etc., to minimize factors reducing accuracy. If at all possible, measurements should be taken at several adjacent locations (cluster observations) using the resultant average value, or by conducting continuously recorded measurements while moving.

1.3 Frequencies above 1 GHz

Antennas for field-strength measurements at frequencies above 1 GHz are usually directional. Their antenna factor (*k*-factor, see § 1.4) can be determined with high accuracy. Due to the directional characteristics of the antennas the influence of the environment on the measurement accuracy is normally low.

1.4 Antenna factor

The error in the determination of the antenna factor should be kept within 1 dB.

2 Receiver

The measuring receiver should have inherent stability with respect to gain, frequency, bandwidth and attenuation. Particular attention is drawn to the reference frequency to limit drifting effects on the overall accuracy of field-strength measurements. Local oscillators should have a low phase noise to avoid masking of weak signals.

2.1 A spectrum analyser can be used as a receiver, when set to zero-span, maximum hold on each frequency and the trace allowed to build up over a number of scans. A number of such measurements taken at regular (2 min) intervals are then averaged to produce the field-strength reading.

2.2 The measuring receiver or the spectrum analyser, when computer controlled, can be used to automate measurements and data storage and analysis.

3 Calibration

It is common practice to calibrate measuring receivers, antennas and antenna cables separately, using nationally or internationally accepted calibration procedures of references. But for maximum precision it is recommended to calibrate the antenna, feeder and receiver as a single entity, especially for frequencies below 30 MHz.

Fixed antenna systems should be recalibrated periodically referenced to a traceable standard. Typically this would be annually or following maintenance works to antenna or RF ground plane system or to other conducting objects, if any, in the vicinity.

VHF and other portable antennas should also be recalibrated periodically to maintain accreditation. Regular inspection for mechanical damage should also be carried out with repairs and recalibration as appropriate.