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**Draft CEPT/ECC/RECOMMENDATION xxx**

# RADIATION LIMITS FOR CABLE TRANSMISSION NETWORKS

Recommendation proposed by the Working Group "Spectrum Engineering" (WGSE)

*Text of the Recommendation adopted by the "European Communications Committee" (ECC):*

## Foreword

This Recommendation specifies radiation limits for cable transmission networks together with the associated measurement guidance. It should be used as a generic guide for Administrations in the development of ETSI or CENELEC standards, and also for guidance in the absence of relevant standards.

This Recommendation covers frequencies below 30 MHz. A subsequent Recommendation will cover frequencies above 30 MHz utilised by cable networks.

It is considered appropriate that this Recommendation should be reviewed every three years, in the light of changing technologies and regulatory requirements. This review should involve consultation with the relevant technical and working groups within CEPT, ETSI and CENELEC.

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"The European Conference of Postal and Telecommunications Administrations,

*considering*

a) that the Radio Frequency spectrum is a common resource and it is necessary to minimise unnecessary interference, making the best use of the most modern and cost-effective techniques ;

b) that protection from unwanted disturbance emissions radiated by telecommunication networks is specifically called for in ITU-R RR S15.12 and provided for in Council Directive 89/336/EEC ;

c) that the rapid deployment of high data rate cable transmission systems (e.g. xDSL, PLT, CATV, LANs…) raises the question of limiting emission from such networks, so as to enable radio services to operate as intended ;

d) that an ERC report dealing with “PLT, xDSL, cable communications (including cable TV) and their effect on radiocommunication services” is under preparation and defines protection requirements for the various radio services concerned ;

e) that there are many different civil and military radio services allocated in these frequencies ;

f) that it is therefore important for CEPT countries to define common radiation limits for electromagnetic fields emanating from such cable transmission networks ;

g) that CEPT and ETSI have developed a Memorandum of Understanding describing the relative responsibilities of the two bodies. The MoU text is available from the ECO ;

h) that it was urgent to cover first frequencies up to 30 MHz, but that future work is planned to cover higher frequencies

*noting*

that the European Commission has issued a standardisation mandate under EMC Directive 89/336/EEC to CEN, CENELEC and ETSI to produce EMC harmonised standards for telecommunication networks. This mandate concerns the preparation of harmonised standards covering EMC aspects of wire-line telecommunication networks and their in-house extensions. These standards should cover the types of networks, which are currently operational or which are under development, including, but not limited to those using power lines, coaxial cables and classical telephone wires.

recommends

1. that the appropriate radiation limits applicable to cable transmission networks utilizing frequencies below 30 MHz, including their in-house extension, are those given in Annex 1 ;

2. that the guidance on measurement methods applicable to such electromagnetic fields in the vicinity of cable transmission networks is the one given in Annex 2 ;

3. that, the limits and measurement methods specified within this Recommendation should be considered in the development of ETSI or CENELEC standards.

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**Annex 1 : limits applicable to cable transmission networks**

***Option 1 :***

| Frequency Range MHz | (Peak) Disturbance Field Strength Limit dB(µV/m) | Measurement Distance | Measuring Bandwidth |
|---|---|---|---|
| 0.009 - 0.15 | 40-20*log f (MHz) | 3 metres | 200 Hz |
| 0.15 – 1 | 40-20*log f (MHz) | 3 metres | 9 kHz |
| 1 – 30 | 40-8.8*log f (MHz) | 3 metres | 9 kHz |

Option 1 is supported by Austria, Germany[1], Finland, France, Romania and Switzerland

***Option 2 :***

| Frequency Range MHz | (Peak) Disturbance Field Strength Limit dB(µV/m)* | Measurement Distance | Measuring Bandwidth |
|---|---|---|---|
| 0.15 - 1 | 20 - 20*log (f/MHz) | 3 metres | 9 kHz |
| 1 - 30 | 20 - 7.7*log (f/MHz) | 3 metres | 9 kHz |

* Measured with a loop antenna in dBµA/m and converted to an equivalent E-field by the factor of 51.5 dB, corresponding to the free space impedance of 120* π ohm.

Option 2 is supported by Ireland and Norway

***Option 3 :***

| **Frequency (MHz)** | **Magnetic field strength peak limit at 1 m in dBµA/m** | **Measurement Distance** | **Measuring Bandwidth** |
|---|---|---|---|
| 0.009 to 0.15 | - 18 - 20·log f (MHz) | 1 metre | 200 Hz |
| 0.15 to 1.6 | - 1.5 - 20·log f (MHz) | 1 metre | 9 kHz |

Option 3 is supported by the United Kingdom[2].

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[1] The limits are given in terms of the electric field strength. Below 30 MHz these limits apply for the magnetic field strength, assuming an intrinsic impedance of 377 Ohm.
These limits are taken from Germany's Usage Provision 30 ("NB30") providing for free use of frequencies. In the case of frequency usages in and along conductors for which no free use is provided for, the geographical, temporal and technical conditions may be laid down for each individual case in either the national frequency usage plan or the required frequency assignment by the national Regulatory Authorities, on the basis of proportionality and after hearing the parties concerned. Where safety-related radio communication services are concerned, account is to be taken in particular of the extent to which a specific threat to safety is to be feared.

[2] The UK administration believes that these limits should apply only to the cables and wires and not to the equipment connected to such cables and wires. In addition, these limits should only apply in the case of a complaint about interference and should not be used for certification purposes. The specified limits apply across the entire frequency range identified, there are no additional requirements such as prohibited frequencies.
Following notification of the draft UK Regulations in August 2001 under Directive 98/34EC, the Commission issued a detailed opinion in December querying the legal basis. The UK administration therefore proposes meeting representatives of the Commission in January to discuss the Commission's detailed opinion.

## Annex 2 : Guidance on measurement method applicable to cable transmission networks

### 1 Introduction

This annex provides guidance on a procedure for in-situ measurements of unwanted disturbance emissions caused by telecommunication networks that make use of the radio frequency spectrum to convey a range of services over non-radio paths.

### 2 Terms and abbreviations

For the purposes of this procedure, the following definitions shall apply:

**Antenna reference point:** The geometric centre of the antenna or the reference point referred to in the antenna calibration procedure.

**Detector weighting factor:** The difference of indication of the Quasi-Peak detector to the Peak detector for a specific signal.

**Disturbance emissions:**

**Electromagnetic disturbance:** Any electromagnetic phenomenon that may degrade the performance of a device, equipment or system, or adversely affect living or inert matter. (IEC – IEV 161-01-05)

**Emission:** The phenomenon by which electromagnetic energy emanates from a source. (IEC – IEV 161-01-08)

**Radio disturbance emissions:**

**Disturbance field strength:** Field strength produced at a given location by an electromagnetic disturbance, measured under specified conditions.
(IEC – IEV 161-04-02)

**Radio (frequency) disturbance:** Electromagnetic disturbance having components in the radio frequency range. (IEC – IEV 161-01-13)

**Telecommunication networks:** Any physical assembly of devices, cables and connecting hardware used for the exchange of telecommunication messages.

**Unwanted radiated emissions:**

**Unwanted emission:** A signal that may impair the reception of a wanted signal. (IEC – IEV 161-01-03)

**Unwanted disturbance emissions:** Radiated emissions caused by conducted currents or voltages that are generated as part of the function of a telecommunication network but which do not need to be radiated.

### 3 Cable transmissions Network Operating Parameters

The basic operating parameters needed are; the spectrum amplitude and frequency characteristics and the operating mode or modes which cause maximum signal disturbance emission levels at all, or any particular, frequencies of interest.

It may also be necessary to discover whether; spectrum amplitude variations can result from dynamic power control and whether frequency spectrum characteristics can vary according to data transfer rate requirements.

These parameters can best be determined at a high (S+N)/N ratio by using a current clamp and scanning measuring receiver with panoramic display to monitor the conducted current at one or both ends of the telecommunication line. The co-operation of the telecommunication operator will probably be needed to exercise the system as required.

It will be necessary to ensure that the telecommunications system is operating with its maximum signal levels and in the mode, if any, previously identified as resulting in maximum disturbance field levels. If the system is interactive, it will be particularly important to check for the presence of the reverse path (upstream) signals if these are in the same frequency range as the one of interest.

## 4 General conditions and Selection of Measuring Points

If measurements are made at a single frequency the antenna orientation should be adjusted to give the maximum coupling to the telecommunication network under investigation.

If measurements are to be made at a large number of frequencies or over a swept frequency range, at the standard distance used for getting an overview, separate measurement runs should be made with the antenna in each of three orthogonal directions, X, Y & Z. The data for each measurement run should be stored and for each frequency, the effective field strength ($H_{eff.}$) must be calculated using the following formula.

$H_{eff} = \sqrt{(X^2 + Y^2 + Z^2)}$ V/m (where X, Y, Z are in V/m)

It might be useful to use a portable receiver with a signal level indicator, or other convenient tracing technique, to identify and record the exact locations where radiated disturbance emission levels appear to be highest. If it is intended, or subsequently found necessary, to make conducted current measurements for identification purposes, the points identified with the portable receiver are expected to be suitable, provided that the transmission line is accessible.

## 5 Measurement Distance

The standard measurement distance is defined in Annex 1. In general terms, this distance should be the length between the reference point of the measuring antenna and the nearest part of the telecommunication network.

If the standard measurement distances is not possible than further guidance is given in section 9 or 10.

If the part of the telecommunication network being measured is inaccessible, within or behind a wall, duct or similar structure, the measurement distance **d** shall be taken from the front edge of the wall or duct.

If a measurement is being made outside a building or other structure carrying telecommunication network equipment or cabling, the measurement distance **d** shall be taken from the external wall of the building.

If the part of the telecommunication network being measured is below ground, the measurement distance **d** shall be taken from a point representing the vertical projection of the telecommunication network on to the surface of the ground.

If the part of the telecommunication network being measured is overhead, the measurement distance **d** shall be taken from a point representing the vertical projection of the telecommunication network on to the surface of the ground.

## 6 Detector and Measurement Bandwidth

It is important to note that the proposed emission limits are Peak Limits but, in order to minimise the uncertainty arising from the use of a Peak detector in a noisy environment, a Quasi-Peak detector may be used instead for the measurements.

To enable direct comparison between measured Quasi-Peak levels and the Peak Limits, it will be necessary to use a detector-weighting factor that must be added to the Quasi-Peak level. The detector weighting factor will depend on the measuring bandwidth and signal architecture of the telecommunication network being examined.

Unless the weighting factor is already known and has been agreed with the telecommunication network operator, it must be established during the preliminary investigation stage. This is most easily and accurately achieved by using a current clamp to sample the telecommunication network at a point providing a clean signal with at least 20 dB (S+N) / N ratio.

The measurement bandwidths, as defined in Annex 1, are:

- 200 Hz in the frequency band from 9 kHz to 150 kHz

- 9 kHz in the frequency band from 150 kHz to 30 MHz

This measurement bandwidths corresponds with the one defined in CISPR 16-1.

## 7 Measuring Equipment in the frequency range 9 kHz to 30 MHz

The following calibrated equipment, as specified in CISPR 16-1, is required:

A Measuring Receiver
A Magnetic Loop Antenna with tripod

If necessary, other specialised equipment such as resonant loop antennas, electric field antennas, current clamps… may also be used. In the case of measuring the electrical field strength it should be used an active dipole or an comparable dipole.

To minimise the possibility of earth loops affecting the measurement, it is recommended that both the Measuring Receiver and Loop Antenna have an independent power source with no ground connection. (e.g. battery power)

## 8 Measurement of the magnetic field at the standard distance

Mount the loop antenna on a tripod, at the location previously identified as having the maximum disturbance field, so that it is at the appropriate measurement distance from the telecommunications network.

Set the measuring receiver to the frequency and detector required and rotate the loop antenna for maximum telecommunication network signal indication.

Measurement of magnetic fields radiated from telecommunications networks in this part of the spectrum is complicated by the presence of large numbers of high-level radio transmissions. In view of this it will be necessary to identify some quiet frequencies in the gaps between radio transmissions such that the background noise and any ambient signals are below the applicable limits. This should be done without altering the antenna position and ideally with the telecommunications network switched off.

If the network cannot be switched off, then the following alternatives may be used:
1. Orientate the loop for minimum coupling to the network emission and check that the background noise and any ambient signals are below the applicable limits.
2. Orientate the loop for maximum coupling and then increase the measurement distance and check that there is a corresponding reduction in the measured field strength.

The quiet frequencies identified will be used as test frequencies. The receiver operator should assess the background noise levels on each manually. The number of quiet frequencies required would depend on whether overall compliance measurements are intended or whether a smaller scale interference complaint is being investigated. The receiver operator should assess the background noise levels on each manually. Using the measuring bandwidth and detector specified, record the highest settled noise level (in dB(µV/m)) observed over a sufficient period. Any short duration isolated peaks should be ignored.

With the telecommunications network operating, repeat the measurements on all the previously identified quiet frequencies using the same procedure specified above. Record the results and calculate the difference between the levels with the telecommunication network operating normally and with it switched off.

If the ambient level is still higher than the limit, a current clamp may be used to confirm the difference.

## 9 Measurement of the magnetic field at a reduced distance

If the relevant limits call for a standard measurement distance of 3 metres but this is not achievable, for example due to space limitations within buildings, a 1 metre measurement may be made. In this case, the procedure is exactly the same as if the standard measuring distance was 1 metre but the result is adjusted using the scaling factor from the following equation :

$$E_{dist} = E_{meas} + n \cdot 20 \log \frac{d_{meas}}{d_{S\tan d}}$$

The field strengths $E_{meas}$ and $E_{dist}$ are in dB; exponent $n = 1$.

$d_{meas}$ : Measurement distance in m (1 m)

$d_{Stand}$: Standard distance (3 m)

## 10 Measurement of the magnetic field at a extended distance

If, owing to local conditions, a measurement distance of more than 3 metres is to be chosen, then two measuring points located at the measuring axis rectangular to the telecommunication cable tract are to be determined. As a guide, the distance between the two points should be as large as possible. The level of the disturbing field strength shall be measured as described before. Eventually decisive are the local conditions and measurability of the disturbance field strength.

The measurement results in dB(µV/m) are to be plotted in a diagram over the logarithm of the distance. The straight line interconnecting the measurement results represents the decrease in field strength at the axis measured. If the decrease in the field strength level cannot be determined, then additional measuring points shall be chosen. The field strength level at standard measurement distance is to be read from the diagram using the interconnecting line.

## 11 Measurement of the electric field at the standard distance

Electric field strength would only be measured in cases where the disturbance emission was believed to be a predominantly electric field. This need for this may be indicated when the magnetic field limit was not exceeded but interference to a radio service utilising an electric field antenna could not be resolved.

An electric field strength limit would have the same value as the magnetic field limit that is currently expressed as an equivalent electric field limit, assuming the free space field conversion of 51.5 dB. (20 log 377 Ω)

## 12 Treatment of measurement uncertainty

For compliance testing, the provisions for the measurement uncertainty apply in favour of the telecommunications network and to the disadvantage of the radio communications service. Half of the relevant measurement uncertainty is to be subtracted from the (possibly corrected) measurement result and this value shall be compared with the specified limit.

For investigation of reported cases of complaints on radio interference, the measurement uncertainty is not accounted for in the measurement result.