SLOVENSKI STANDARD
SIST EN 50496:2009

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Določ evanje izpostavljenosti delavca elektromagnetnim sevanjem in ocena tveganja na mestu oddajnika

Determination of workers' exposure to electromagnetic fields and assessment of risk at a broadcast site

Ermittlung der Exposition von Arbeitnehmern gegenüber elektromagnetischen Feldern und Bewertung des Risikos am Standort eines Rundfunksenders

Détermination de l'exposition des travailleurs aux champs électromagnétiques et évaluation des risques sur un site de radiodiffusion

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Determination of workers' exposure to electromagnetic fields and assessment of risk at a broadcast site

Détermination de l'exposition
des travailleurs
aux champs électromagnétiques
et évaluation des risques
sur un site de radiodiffusion

Ermittlung der Exposition
von Arbeitnehmern gegenüber
elektromagnetischen Feldern
und Bewertung des Risikos
am Standort eines Rundfunksenders

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 106X, Electromagnetic fields in the human environment.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50496 on 2008-09-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-09-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-09-01

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1 Scope

The object of this standard is to provide methods for assessing compliance with the requirements of the Directive 2004/40/EC [8] at a site operating one or more broadcast transmitters.

This standard covers the frequency range up to 40 GHz.

NOTE The Council and European Parliament Directive 2004/40/EC will be transposed into national legislation in all the EU member countries. It is recommended that users of this standard consult the national legislation related to this transposition in order to identify the national regulations and requirements. These national regulations and requirements may have additional requirements that are not covered by this standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[1] EN 50413, Basic standard on measurement and calculation procedures for human exposure to electric, magnetic and electromagnetic fields (0 Hz - 300 GHz)

[2] EN 50420, Basic standard for the evaluation of human exposure to electromagnetic fields from a stand alone broadcast transmitter (30 MHz - 40 GHz)

[3] EN 50475, Basic standard for the calculation and the measurement of human exposure to electromagnetic fields from broadcasting service transmitters in the HF bands (3 MHz - 30 MHz)

[4] EN 50499, Procedure for the assessment of the exposure of workers to electromagnetic fields

[5] EN 62226-2-1, Exposure to electric or magnetic fields in the low and intermediate frequency range - Methods for calculating the current density and internal electric field induced in the human body - Part 2-1: Exposure to magnetic fields - 2D models (IEC 62226-2-1)

[6] IEEE C95.3, Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields

[7] Council Recommendation 1999/519/EC of 12 July 1999 on the limitation of exposure of the general public to electromagnetic fields (0 Hz to 300 GHz) (Official Journal L 199 of 30 July 1999)

[8] Directive 2004/40/EC of the Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (Electromagnetic fields) – Official Journal of 30 April 2004

[9] International Commission on Non-Ionizing Radiation Protection, Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz), Health Physics Vol. 74, No 4, pp 494-522, 1998

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
action values
the magnitude of directly measurable parameters, provided in terms of electric field strength (E), magnetic field strength (H), magnetic flux density (B), power density (S_{eq}), limb induced current (I_L) and contact current (I_C) at which one or more of the specified measures in [8] must be undertaken. Compliance with these values will ensure compliance with the relevant exposure limit values of [8]

3.2
AIMD
Active Implantable Medical Device

3.3
antenna
device that serves as a transducer between a guided wave (e.g. coaxial cable) and a free space wave, or vice versa

3.4
near-field region
region generally in proximity to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The near-field region is further subdivided into the reactive near-field region, which is closest to the radiating structure and that contains most or nearly all of the stored energy, and the radiating near-field region where the radiation field predominates over the reactive field, but lacks substantial plane-wave character and is complicated in structure

3.5
broadcasting service
radiocommunication service in which the transmissions are intended for direct reception by the general public. This service may include sound transmissions, television transmissions or other types of transmission e.g. data

3.6
broadcast site
site operating one or more broadcast transmitters

3.7
contact current
current flowing into the body resulting from contact with a conductive object in an electromagnetic field. This is the localised current flow into the body (usually the hand, for a light brushing contact). Shocks and burns can be the adverse indirect effects. Contact current relates to a short term effect and cannot be time-averaged

3.8
induced current
current flowing inside a human body resulting directly from an exposure to an electromagnetic field

3.9
employer
any natural or legal person who has an employment relationship with the worker and has responsibility for the undertaking and/or establishment (Directive 89/391/EEC)

3.10
exposure limit values
limits on exposure to electromagnetic fields in [8] which are based directly on established health effects and biological considerations. Compliance with these limits will ensure that workers exposed to electromagnetic fields are protected against all known adverse health effects of electromagnetic fields

3.11
local safety Instruction
safety instructions relating to a specific broadcast site and containing the information specified in Clause 8:

– it must include all the necessary safety-related indications and, if applicable, point out the possible risk of exposure to electromagnetic fields where these are at levels above the worker action values;
– it could include all the necessary safety-related indications and, if applicable, point out the possible risk of exposure to electromagnetic fields where these are at levels above the limits for the general public

3.12
transmitter
device to generate the radio frequency broadcast signal which is fed into the antenna system

3.13
worker
any person employed by an employer, including trainees and apprentices but excluding domestic servants (Directive 89/391/EEC)

3.14
work place
location where workers have access as part of their duties;
particular place of work within the broadcast site as for example the area near a transmitter with an open enclosure, the area inside a transmitting antenna, on a ladder inside a broadcast mast / tower and platforms under and above the antennas, the area around feed lines, etc.

4 Assessment methods

4.1 Worker exposure assessment

The assessment should be done using the steps outlined below:

– collection of technical data (Clause 5);
– determination of exposure levels by calculation or measurement (Clause 6). This includes checking of operating procedures in the different exposure work places (Clause 8).

The results of the assessment process are:

– zoning of exposure work places (Clause 7);
– information and training (Clause 9);
– assessment report (Clause 10).

In the case of simultaneous exposure to multiple sources, the combined exposure shall be considered, referring to Annex A.

4.2 Use of public exposure assessment

If an evaluation has already been undertaken in accordance with the provisions of Council Recommendation 1999/519/EC [7], and the restrictions as specified therein are respected, then the exposure limit values for workers of [8] are also met.

4.3 Assessment after technical modification

After technical modification like maintenance or repair of the installation or the environment, it is necessary to consider repeating or revising the assessment. This is particularly necessary if an additional transmitter or antenna is added to a site where there are already one or more transmitters.

5 Collection of technical data

Information on the following items may be needed:

– with regard to the surrounding area

- information on the nature of the field from any external sources should be obtained from the operators of those sources. Examples of useful information are the frequency, the type of service, and whether the transmissions are intermittent. However, it should be noted that much of the detailed information may be commercially sensitive.

– with regard to the site

- the area controlled e.g. information on property, fencing, where the controlled area is bounded,
- the site map showing all facilities, e.g. buildings, towers, anchor cables, earth net…,
- the several areas
  - where a public assessment has been done in compliance with [7] or national regulation,
  - where workers have access without specific care,
  - where workers have only access under specific circumstances.

– with regard to ELF emissions, the location of all 50 Hz site power supplies or transformers connected to low voltage networks.

– with regard to the radio-frequency emissions, for each relevant source

- the mechanical configuration of the antennas, geometric dimensions, construction drawings, position in the mast, etc.,
- radiation pattern, polarisation and gain of antennas,
- maximum and nominal power transmitter,
- frequency, type of modulation (AM, FM, COFDM, etc.), channel bandwidth,
- feeder type and length, attenuation/meter,
- additional losses (combiners, patch panels, antenna cables and power dividers).

- with regard to scheduling

  - transmitting time table (especially for short wave),
  - permitted operating configuration.

6 Determination of exposure levels by calculation or measurement

The collection of data permits to take into account the identification of sources of electromagnetic fields in or around the site during the assessment. However, this standard does not directly address product performance standards, which are intended to limit electromagnetic field (EMF) emissions under specified test conditions.

6.1 Methodologies

The work place is often in near field conditions where the situation is rather more complicated than in the far field. This is because the maxima and minima of the *E* and *H* fields do not occur together along the direction of propagation as they do in the far field. In the near field, the electromagnetic field structure may be highly inhomogeneous, and there may be substantial variations from the plane-wave impedance of 377 ohms; that is, there may be preponderant E fields in some regions and preponderant H fields in others. At 50 Hz, the E or the H- field may be very dominant, or both E and H field may be present.

As a consequence, for each type of electromagnetic source, it is not possible to specify specific methodologies in this document. Therefore this standard refers to other appropriate standards to define the appropriate methodologies [1].

6.1.1 Exposure from power supplies

The annex on AC electricity supplies in EN 50499 [4] gives guidance for assessing 50 Hz power supplies and in particular criteria for power sources which are deemed to comply without any further assessment.

6.1.2 Exposure from transmitters from 9 kHz to 100 kHz

Methodologies of measurement and calculation are defined in EN 62226-2-1 [5] and IEEE 95.1 [6].

6.1.3 Exposure from transmitters from 100 kHz to 30 MHz

Methodologies of measurement and calculation are defined in:

– EN 50475 [3] for 3 MHz to 30 MHz;

– between 100 kHz and 3 MHz: under consideration in CENELEC/TC 106X WG3.

Information can also be found in ITU-R BS.1698.

6.1.4 Exposure from transmitters from 30 MHz to 40 GHz

Methodologies of measurement and calculation are defined in EN 50420 [2].

Information can also be found in ITU-R BS.1698.

Subclause 6.3 gives the process for use of a broadband field meter in a mast. Assessment of both the E and H fields may need to be performed.

6.2 Additional considerations

6.2.1 Use of action values

Compliance with the action values will ensure compliance with the relevant exposure limit values. If the measured or calculated value exceeds the action values, it does not necessarily follow that the exposure limit values will be exceeded.

6.2.2 Multiple exposure

With regard to simultaneous exposure to multiple frequency fields, it is important to identify multiple sources of exposure or simultaneous exposure to multiple frequency fields and to use appropriate methods of assessment, measurement and/or calculation capable of analysing the characteristics of the waveforms and nature of biological interactions (see flowchart in Figure 1).

Once identified, the combination of different frequency components should be carried out separately for thermal effects and electrical stimulation.

The formulae in Annex A apply to the relevant frequencies under practical exposure situations and have to be used to establish compliance to the action levels or exposure limits for all the frequencies together.

6.2.3 Averaging

6.2.3.1 Time averaging

These following rules come from the ICNIRP Guidelines [9].

Exposure limit value

- For frequencies up to 10 GHz: all SAR values are to be averaged over any 6 min period.
- For frequencies between 10 GHz and 300 GHz: Power densities are to be averaged over any 20 cm^2 of exposed area and any 68/f^{1,05} min period (where *f* is in GHz) to compensate for progressively shorter penetration depth as the frequency increases.

Action value

- For frequencies between 100 kHz and 10 GHz: S_{eq}, E^2, H^2, B^2 and $I_L{}^2$ are to be averaged over any 6 min period.

  Particular case: For E^2, H^2, S_{eq} in case of specific modulation (like FM and digital OFDM emissions for instance), the field strength can be averaged over a lower period due to the constant power transmitted, because average value is equal to the instantaneous value in this case.
- For frequencies exceeding 10 GHz: S_{eq}, E^2, H^2, and B^2 are to be averaged over any 68/f^{1,05} min period (*f* in GHz).

6.2.3.2 Spatial averaging

In case of whole body exposure, from basic physics, spatial averaging in the typical situation like in a FM/TV mast, where a worker is moving in an EMF produced by a constant intensity source can be considered to be equivalent to time averaging on a stationary worker from source whose intensity varies with time.

The length of averaging path is given by the product of the averaging time, (6 min), and the velocity of movement of the worker along that path. An assessment of the appropriate speed needs to be made.

Consider, for example a worker who moves in a FM/TV mast with a velocity of 10 m per minute, then the integration path is 60 m. A typical use of this rule is the case when a worker climbs a ladder near several stages of antenna located between 2 platforms.

For instance, if the field strength is locally twice the action value between these platforms then the worker can be allowed to pass through this area if he will stay there no longer than ($6/2^2$=1,5 min). Therefore, he would have climbed a length around 15 m during this 1 min 30 s. This is possible, providing the fact that below and above this area, that means on the platforms, the exposure is negligible.

NOTE 1 The field strength can not exceed reasonably twice the action level because of the time necessary to climb between 2 platforms.

NOTE 2 Averaging is allowed providing local exposure is not exceeded. If the field strength does not exceed twice the action value, local exposure is under the exposure limit according the ration between whole body SAR and local SAR (factor of 25 if expressed in power and factor of 5 if expressed in field).

The workers shall be informed and the information shall be recorded in the assessment report (Clause 10).