SLOVENSKI STANDARD
SIST EN 50475:2008

01-september-2008

Osnovni standard za izraļ unavanje in merjenje izpostavljenosti ljudi elektromagnetnim sevanjem radijskih oddajnikov v obmoļ ju HF (3 MHz - 30 MHz)

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)

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Grundnorm für die Berechnung und Messung der Exposition von Personen gegenüber elektromagnetischen Feldern von Rundfunksendern in den KW-Bändern (3 MHz bis 30 MHz)

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Norme de base pour le calcul et la mesure de l'exposition humaine aux champs électromagnétiques des émetteurs de service de radiodiffusion dans les bandes HF (3 MHz a 30 MHz)

Ta slovenski standard je istoveten z: **EN 50475:2008**

ICS:

13.280	Varstvo pred sevanjem	Radiation protection

SIST EN 50475:2008 **en,fr,de**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50475

June 2008

ICS 13.280

English version

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)

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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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 50475 on 2008-04-01.

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)	2009-04-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-04-01

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https://standards.iteh.ai/catalog/standards/sist/274fdf9d-6e72-49ab-9da2-be38286c4937/sist-en-50475-2008

SIST EN 50475:2008

Contents

iTeh STANDARD PREVIEW
(standards.iteh.ai)
SIST EN 50475:2008
https://standards.iteh.ai/catalog/standards/sist/274fdf9d-6e72-49ab-9da2-be38286c4937/sist-en-50475-2008

SIST EN 50475:2008

Figures

Tables

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SIST EN 50475:2008
https://standards.iteh.ai/catalog/standards/sist/2746ff9d-6c72-49eb-9da2-bc38296c4037/sist-en-50475-2008

SIST EN 50475:2008

1 Scope

This standard applies to short wave broadcast transmitters and installations operating in the frequency range 3 MHz to 30 MHz.

The objective of the standard is to specify, for such a frequency band, basic information allowing the definition of a method for assessment of compliance related to human exposure to radio frequency electromagnetic fields.

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.

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

EN 55016 series, *Specification for radio disturbance and immunity measuring apparatus and methods* (CISPR 16 series)

ENV 13005:1999, *Guide to the expression of uncertainty in measurement*

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3 Terms and definitions

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

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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) and power density (S), at which one or more of the specified measures in 2004/40/EC [2] must be undertaken. Compliance with these values will ensure compliance with the relevant exposure limit values of 2004/40/EC [2]

3.2
antenna
device that serves as a transducer between a guided wave (e.g. coaxial cable) and a free space wave, or vice versa

3.3
basic restriction
restrictions on exposure to time-varying electric, magnetic, and electromagnetic fields that are based directly on established health effects as given in 1999/519/EC [1]

3.4
broadcasting service
radio communication 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

3.5
compliance distance
minimum distance from the antenna to a point of investigation where field level is deemed to be compliant to the limits

SIST EN 50475:2008

3.6
compliance boundary
surface around the antenna outside of which all field levels are deemed to be compliant to the limits

3.7
contact current (IC)
contact current between a person and an object exposed to the field, is expressed in amperes (A). A conductive object in an electric field can be charged by the field

3.8
current density (J)
current density is defined as the current flowing through a unit cross section perpendicular to its direction in a volume conductor such as the human body or part of it, expressed in amperes per square meter (A/m²)

3.9
electric field strength (E)
magnitude of a field vector at a point that represents the force (***F***) on a positive small charge (*q*) divided by the charge

$$E = \frac{F}{q}$$

Electric field strength is expressed in units of volt per meter (V/m)

3.10
exposure limit values
limits on exposure to electromagnetic fields as given in 2004/40/EC [2] 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

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SIST EN 50475:2008
https://standards.iteh.ai/catalog/standards/sist/274fdf9d-6e72-49ab-9da2-be38286c4937/sist-en-50475-2008

3.11
induced current
current induced inside the body as a result of direct exposure to electromagnetic fields, expressed in the unit ampere (A)

3.12
installation
a particular combination of several types of apparatus and, where applicable, other devices, which are assembled, installed and intended to be used permanently at a predefined location. In this standard, installation includes at least one short wave transmitter

3.13
magnetic field strength (H)
vector quantity obtained at a given point by subtracting the magnetization ***M*** from the magnetic flux density ***B*** divided by the permeability of free space μ_0

$$H = \frac{B}{\mu_0} - M$$

Magnetic field strength is expressed in the unit ampere per metre (A/m)

NOTE In vacuum, the magnetic field strength is at all points equal to the magnetic flux density divided by the permeability of free space: $\boldsymbol{H} = \boldsymbol{B} / \mu_0$

3.14
modulation
process by which a quantity that characterises an oscillation or wave is constrained to follow the values of a characteristic quantity of a signal

NOTE Two modulations, in particular, are used for this standard: AM (Amplitude Modulation) and COFDM (Coded Orthogonal Frequency Division Multiplex); it must also be taken into consideration when carrying out measurements and calculations to determine whether or not the limits are being exceeded by adding the modulation factor to the carrier r.m.s. value.

SIST EN 50475:2008

3.15
reference levels
reference levels of exposure are provided by 1999/519/EC [1] for comparison with measured values of physical quantities; compliance with all reference levels will ensure compliance with basic restrictions. If measured values are higher than reference levels, it does not necessarily follow that the basic restrictions have been exceeded, but a more detailed analysis is necessary to assess compliance with the basic restrictions

3.16
root-mean-square (r.m.s.)
r.m.s. value is obtained by taking the square root of the average of the square of the value of the periodic function taken throughout one period

3.17
shortwave broadcasting
the frequency band between 3 MHz and 30 MHz is called the short wave band. Broadcast transmission in this frequency range is therefore called shortwave broadcasting

3.18
site
area including a short wave installation and with restricted access for public

3.19
specific absorption rate (SAR)
time derivative of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of given mass density (ρ):

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$$\mathrm{SAR} = \frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{dW}}{\mathrm{dm}}\right) = \frac{\mathrm{d}}{\mathrm{dt}}\left(\frac{\mathrm{dW}}{\rho \mathrm{dV}}\right)$$

SAR is expressed in units of watt per kilogram (W/kg).

SIST EN 50475:2008
https://standards.iteh.ai/catalog/standards/sist/274fdf9d-6e72-49ab-9da2-be38286c4937/sist-en-50475-2008

3.20
transmitter
device to generate radio frequency power for the purpose of communication

4 Physical quantities and units

The internationally accepted SI-units are used throughout the standard.

Quantity	Symbol	Unit	Dimensions
Current density	J	ampere per square meter	A/m²
Electric field strength	E	volt per meter	V/m
Frequency	f	hertz	Hz
Magnetic field strength	H	ampere per meter	A/m
Specific absorption rate	SAR	watt per kilogram	W/kg
Wavelength	λ	meter	m
Electric conductivity	σ	siemens per meter	S/m
Mass density	ρ	kilogram per cubic meter	kg/m³

SIST EN 50475:2008

5 Applicability of compliance assessment methods

In short wave broadcasting services, horizontally polarized, there are two field regions at the ground level (the far field region does not exist at ground level):

– the reactive near-field region; this region is defined by $r \leq \lambda/4$ where r is the distance from the antenna to the point of investigation;

– the radiating near-field; this region is defined by $r > \lambda/4$ where r is the distance from the antenna to the point of investigation.

This standard describes measurement and calculation methods to define the exposure areas and the next tables (Table 1 and Table 2) will help to select an appropriate method.

Compliance of the results of the assessment with the appropriate reference level or action value will ensure compliance with the relevant limit (basic restriction or exposure limit value). However, it is always possible to test compliance directly with regards to basic restriction or exposure limit values, both expressed in SAR and current density.

5.1 Reference level or action level values

Table 1 – Assessment methods for each antenna region

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https://standards.iteh.ai/catalog/standards/sist/274fdf9d-6e72-49ab-9da2-be38286c4937/sist-en-50475-2008

Assessment methods for each antenna region	
Reactive near field	**Radiating near field**
E **and** H field calculation Induced currents calculation [a] Contact current calculation	H field calculation Induced currents calculation [a]
E **and** H field measurement Induced currents measurement [a] Contact current measurement	H field measurement Induced currents measurement [a]

[a] Compliance of maximum value of E or H field to relevant level, without spatial averaging, gives conformity to induced current.

5.2 SAR and current density

Table 2 – Assessment methods for each antenna region

Assessment methods for each antenna region	
Reactive near field	**Radiating near field**
SAR and current density [a]	SAR and current density

[a] No standardised method of SAR evaluation in reactive near field is available.

SAR and current density evaluation can be based either on calculated or measured field levels.

SIST EN 50475:2008

6 SAR measurement and calculation (local and average SAR)

6.1 Approximate method for SAR calculation for frequencies below body resonance

Outside the reactive near field region, a quasi static approach is appropriate for SAR estimation when the frequency of the wave is below the resonance frequency of a human body (around 70 MHz in free space and 35 MHz when grounded). This approach is particularly applicable in the exposure analysis in the near-field region of large AM-broadcast antennas.

Measurement or calculation techniques permit the determination of the electric field E and the magnetic field H in the near field and far field of a broadcast antenna (frequency range 3 MHz to 30 MHz). For many configurations of broadcast antennas, the safety distance derived from reference levels is overly conservative as the true absorption in the human body is much lower due to near-field or polarisation effects. In principle, SAR-values for a human-body model may be derived by FDTD (Finite-Difference Time-Domain) analysis when the tangential electric and magnetic field components on a closed boundary around the body are known (Huygen's Principle). However, it is very expensive to assess at several locations the complete field around an appropriate volume of the human model. Hence a practical approach has to implement some simplifications.

In general, the time-varying electric and magnetic fields are vectors and have component values with respect to the three co-ordinate directions. However, at frequencies below resonance where the free-space wavelength of the field is much greater than the dimensions of the human body, a quasi-static calculation may be used for SAR assessment. When the electric and the magnetic field can be regarded as decoupled from each other, the contribution to the SAR is determined by separate field-component terms, each with a coefficient depending only on the incoming wave polarisation and on the shape and conductivity of the body, expressed generally as:

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$$SAR = a \cdot E_x + b \cdot E_y + c \cdot E_z + d \cdot H_x + e \cdot H_y + f \cdot H_z \,.$$

SIST EN 50475:2008
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For a general exposure assessment one needs to adopt an *average body model* to obtain representative SAR values, or better a body model which will lead to worst-case SAR values. This is supposed to be fulfilled by the body model of the Visible Human.

The Visible Man data set is the first result of the Visible Human Project of the National Library of Medicine, 8600 Rockville Pike, Bethesda, Maryland, USA. It is a digital image data set of a complete human male and consists of computed tomographic and magnetic resonance scans as well as cryosection images.

The SAR exposure assessment gives more restrictive values compared with limit values than the current density above a frequency range of about 3 MHz to 5 MHz.

6.2 Exposure situation

The energy absorbed by the human body is dependent on the polarisation and the direction of the plane wave incident on the body. Following it is assumed for the model that has three semi-axes, denoted by *a*, *b*, and *c*, with always *a* > *b* > *c*. The coordinate system is such that the greatest semi-axis length *a* is always along the *x*-co-ordinate axis corresponding to the body length; likewise semi-axis *b* is along the *y*-coordinate axis across the body (through the arms in a corresponding human body model), and the shortest semi-axis *c* along the *z*-coordinate axis (from the chest to the back).

The directions of the electric field vector E, the magnetic field vector H, and the propagation vector k of the incident plane wave are always denoted with respect to the *a*-, *b*-, and *c*-axes in that order. Thus, for example, "EHk" denotes E parallel to the *x*-axis, H parallel to the *y*-axis, and k parallel to the *z*-axis. For further details, see references [3] and [4].