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Osnovni standard za oceno izpostavljenosti ljudi elektromagnetnim sevanjem opreme za uporovno varjenje in sorodne procese

Basic standard for the evaluation of human exposure to electromagnetic fields from equipment for resistance welding and allied processes

ICS 13.280; 25.160.10

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ICS

English version

Basic standard for the evaluation of human exposure to electromagnetic fields from equipment for resistance welding and allied processes

Norme de base destinée à l'évaluation de l'exposition humaine aux champs électromagnétiques émanant du matériel de soudage par résistance et des techniques connexes

Grundnorm für die Bewertung der menschlichen Exposition gegenüber elektromagnetischen Feldern von Einrichtungen zum Widerstandsschweißen und für verwandte Verfahren

This draft European Standard is submitted to CENELEC members for CENELEC enquiry.
Deadline for CENELEC: 2007-02-23.

It has been drawn up by CLC/TC 26B.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CENELEC in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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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 draft European Standard was prepared by the Technical Committee CENELEC TC 26B, "Electric resistance welding". It is submitted to CENELEC enquiry.

Contents

Figures

Tables

1 Scope

This European Standard applies to equipment for resistance welding and allied processes designed for use in industrial and domestic establishments.

This European Standard establishes a suitable evaluation method for determining the electromagnetic fields in the space around the equipment and defines standardized operating conditions and measuring distances. It provides a method to show conformity with guidelines or requirements concerning human exposure to electromagnetic fields.

The Council Directive 73/23/EEC [41], Article 2, stipulates that the Member States take all appropriate measures to ensure that electrical equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in safety matters in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which is was made. The principal elements of those safety objectives are listed in Annex I Clause 2.b. This document may be used in conjunction with EN 50445 for demonstration of conformity to the Council Directive with reference to human exposure to electromagnetic fields (EMF). There are additional requirements covered by Article 2 and Annex I Clause 2.b, which are not included in this document.

The Council Recommendation 1999/519/EC [1] provides Basic Restrictions and Derived Reference Levels for exposure of the general public. This document may be used for demonstration of resistance welding equipment conformity to the Council Recommendation on this basis, but there may be additional specific national or international requirements which are not included.

The ICNIRP Guidelines, on limits of exposure to static magnetic fields as well as for limiting exposure in time-varying electric, magnetic and electromagnetic fields, provide Basic restrictions and Derived Reference Levels for both occupational and general exposure. This document may be used for demonstration of equipment conformity to ICNIRP Guidelines on this basis, but there may be additional national or international requirements which are not included.

It is also possible to use this document as a basis to demonstrate conformity of resistance welding equipment to other national and international guidelines or requirements with regard to human exposure from EMF, for example Council Directive 2004/40/EC [43] on the minimum health and safety requirements regarding the exposure of workers to the risk arising from physical agents (electromagnetic fields), or the requirements of the Directive 1998/37/EC [42]. In these cases, other restrictions and levels than those referenced above may be used.

Other standards can apply to products covered by this document. In particular this document is not designed to evaluate the electromagnetic compatibility with other equipment; nor does it reflect any product safety requirements other than those specifically related to human exposure to electromagnetic fields.

The frequency range covered is 0 Hz to 300 GHz.

NOTE 1 Typical allied processes are resistance hard and soft soldering or resistance heating achieved by means comparable to resistance welding equipment.

NOTE 2 Procedures to demonstrate conformity are not specified for the whole frequency range.

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.

Publication	Year	Title
EN 50392	2004	Generic standard to demonstrate the compliance of electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (0 Hz – 300 GHz)
ISO 669	2000	Resistance welding – Resistance welding equipment – Mechanical and electrical requirements
ISO Guide	1993	Guide to the expression of uncertainty in measurement, International Organization for Standardization, Geneva, Switzerland, ISBN 92-67-10188-9, First Ed., 1993

3 Definitions

3.1 General

3.1.1
averaging time (t_{avg})
appropriate time over which exposure is averaged for purposes of determining conformity

3.1.2
basic restrictions
restrictions on exposure to electric, magnetic and electromagnetic fields that are based directly on established health effects and biological considerations

3.1.3
compliance boundary
volume outside which any point of investigation is deemed to be compliant

3.1.4
conductivity (σ)
ratio of the conduction – current density in a medium to the electric field strength

3.1.5
contact current
current flowing into the body by touching a conductive object in an electromagnetic field

3.1.6
coupling factor K
the coupling factor K is used to enable exposure assessment for complex exposure situations, such as non-uniform magnetic field or perturbed electric field. The coupling factor K has different physical interpretations depending on whether it relates to electric or magnetic field exposure. The value of the coupling factor K depends on the model used for the field source and the model used for the human body

3.1.7
effective reference level B_{eff}
level provided for practical exposure assessment purposes using a broadband measurement, and derived from frequency dependent reference levels considering the spectral content of the field

3.1.8
EMF
electric, magnetic or electromagnetic field

3.1.9
exposure
occurs whenever and wherever a person is subjected to electric, magnetic or electromagnetic fields or to contact current other than those originating from physiological processes in the body and other natural phenomena

3.1.10
exposure level
value of the quantity used when a person is exposed to electromagnetic fields or contact currents

3.1.11
exposure, partial-body
results when fields are substantially non-uniform over the body

3.1.12
exposure, non-uniform
results when fields are non-uniform over volumes comparable to the whole human body

3.1.13
hot spot
a localized area of higher field

3.1.14
induced current density (J)
electromagnetic field induced current per unit area inside the body

3.1.15
magnetic field strength (H)
the magnitude of a field vector in a point that results in a force ($\vec{F}$) on a charge (q) moving with velocity ($\vec{v}$)

$$\vec{F} = q(\vec{v} \times \mu \vec{H}) \qquad (1)$$

or magnetic flux density divided by permeability of the medium, see "magnetic flux density"

3.1.16
magnetic flux density (B)
the magnitude of a field vector that is equal to the magnetic field (H) multiplied by the permeability (μ) of the medium

$$B = \mu H \qquad (2)$$

3.1.17
permeability (μ)
property of a material which defines the relationship between magnetic flux density B and magnetic field strength H

NOTE 1 It is commonly used as the combination of the permeability of free space μ_0 and the relative permeability for specific dielectric materials μ_R

$$\mu = \mu_R \mu \qquad (3)$$

NOTE 2 Permeability is expressed in henry per metre ($H\ m^{-1}$).

3.1.18
point of investigation (POI)
location in space at which the value of E-field, H-field or power density is evaluated

NOTE This location is defined in Cartesian, cylindrical or spherical co-ordinates relative to the reference point on the EUT.

3.1.19
root-mean-square (r.m.s.)

effective value or the value associated with joule heating, of a periodic signal

NOTE The r.m.s. value is obtained by taking the square root of the mean of the squared value of a function.

$$x_{\text{rms}} = \sqrt{\frac{1}{T}\int_{0}^{T} x^2(t)\mathrm{d}t} \quad \textit{(expression in time domain)} \tag{4}$$

where x(t) is the signal at time t, T is the signal period or multiples of it

$$x_{\text{rms}} = \sqrt{\sum_{n} x_n^2} \quad \textit{(expression in frequency domain)} \tag{5}$$

where x_n is the magnitude of spectral component at nth frequency, expressed as r.m.s. value.

3.1.20
reference levels
directly measurable parameters provided for practical exposure assessment purposes

NOTE They are derived from basic restrictions. Respect of the reference level will ensure respect of the relevant basic restriction. If the reference level is exceeded, it does not necessarily follow that the basic restriction will be exceeded.

3.1.21
response time
the response time is the time required for field strength indicated by a measurement instrument to reach 90 % of its final value when the instrument is exposed to a defined step function of field strength.

This step function is defined as a change in field strength from less than 1 % of the full scale deflection (fsd) of the measurement instrument to 100 % of fsd occurring in a time of 1/4 of the period of the waveform at the frequency of interest

3.1.22
unperturbed field
unperturbed fields are external to the human body. They are the fields to which a person would be exposed if they were present at the measurement position. These fields are measured in the absence of a person and may differ from fields measured with a person present

3.2 Specific for resistance welding and similar applications

3.2.1
conventional load
the load condition with the electrodes short-circuiting as defined in ISO 669:2000

3.2.2
current flow time
duration defined from the start time of current conduction to the time when its current has decreased to 10 % level of the measured welding current value, which is applied only to d.c. current for determination of minimum value of the hold time

NOTE Annex A gives further information on the definition of current flow time.

3.2.3
duty factor (symbol X)
the ratio for a given interval of the on-load duration to the total time

NOTE This ratio, lying between 0 and 1, may be expressed as a percentage.

3.2.4
equipment for resistance welding and allied processes
all equipment associated with carrying out the processes of resistance welding or allied processes consisting of e.g. power source, electrodes, tooling and associated control equipment, which may be a separate unit or part of a complex machine

3.2.5
expert (competent person, skilled person)
person who can judge the work assigned and recognize possible hazards on the basis of professional training, knowledge, experience and knowledge of the relevant equipment

NOTE Several years of practice in the relevant technical field may be taken into consideration in assessment of professional training.

3.2.6
hand-held integrated transformer gun
a resistance welding equipment with built-in transformer and all conductors carrying their welding current, which is intended to be held in the hand during use

3.2.7
hand-held separated transformer gun
a resistance welding equipment with separate transformer, which is intended to be held in the hand during use

3.2.8
industrial and professional use
use intended only for experts or instructed persons

3.2.9
instructed person
person informed about the tasks assigned and about the possible hazards involved in neglectful behaviour

NOTE If necessary, the person has undergone some training.

3.2.10
maximum short-circuit current output (I_{2cc})
equipment rated output current with conventional load as defined in ISO 669:2000 Clause 10

3.2.11
phase control
a typical current control technique in resistance welding, e.g. by changing the firing angle in each half-weld cycle of a.c. current

3.2.12
processes allied to resistance welding
the following processes, which are carried out on machines comparable to resistance welding equipment, are considered as allied to resistance welding e.g.: resistance brazing and soldering or resistance heating

3.2.13
stationary resistance welding equipment
a resistance welding equipment which is stationary, the operator handle the piece to be welded

3.2.14
suspended integrated transformer gun
a resistance welding equipment with built-in transformer and all conductors carrying their welding current, which is intended to be suspended and hand-guided by the operator to position the equipment in the correct welding position

3.2.15
suspended separated transformer gun
a resistance welding equipment with separate transformer, which is intended to be suspended and hand-guided by the operator to position the equipment in the correct welding position

3.2.16
weld time
current flow time given as a number of cycles of the mains frequency or as time duration

NOTE Annex A gives further information on the definition of weld time.

3.2.17
welding cable(s)
flexible conductor(s) used to connect the power source and the welding tool in some types of resistance welding equipment

NOTE Typical examples of these equipments are the car-body production and repair welding-station.

3.2.18
welding circuit
a circuit that includes all conductive material through which the welding current is intended to flow

3.2.19
welding current
current value accumulated over the weld time and indicated by the r.m.s. value, which is applicable for a.c. and d.c. current. In the case of pulsed current, e.g. a capacitor discharged current, the welding current is indicated by the peak value

NOTE Annex A gives further information on how to calculate the welding current values.

4 Physical quantities, units and constants

4.1 Quantities and units

The internationally accepted SI units are used throughout this document.

Quantity	Symbol	Unit	Dimension
Current density	J	Ampere per square metre	A m^{-2}
Electric conductivity	σ	Siemens per metre	S m^{-1}
Frequency	f	Hertz	Hz
Magnetic field strength	H	Ampere per metre	A m^{-1}
Magnetic flux density	B	Tesla	T (Vs m^{-2})
Permeability	μ	Henry per metre	H m^{-1}

4.2 Constants

Physical constant	Symbol	Magnitude
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ H m^{-1}

5 Conformity assessment methods

5.1 General

This European Standard defines, as far as possible, suitable points of investigation for different types of equipment, that represent the highest exposure positions during practical use. These points of investigation are based on previous experience and measurement, taking into account typical operator positions, and have been selected to protect against effects on central nervous system tissues in the head and trunk of the body.

NOTE 1 Equipment complying with the basic restriction or reference levels at the points of investigation defined in this European Standard are considered to be compliant with the requirements of the reference document that contains limits.

NOTE 2 Equipment that does not comply with these tests needs to be carefully evaluated to quantify the exposure in allrelevant operator positions. This evaluation shall define compliance boundaries that describe all the operator positions that are in conformity with the requirements. The equipment use shall be restricted according to the established compliance boundaries.

5.2 Resistance welding equipment EMF emission description

The primary source of EMF in a resistance welding equipment is the current flowing through the welding circuit, generating a low frequency magnetic field, this has the greatest effect on the levels of EMF.

The emission is a non homogeneous field at the proximity of equipment.

The parameters of the current (e.g. amplitude and wave shape), and the welding circuit characteristics (e.g. dimensions), are determined by the equipment itself. External factors e.g. characteristics of the workpiece have influence on the magnetic field, but are not taken into account by this European Standard.

The emission is present only during welding process, therefore only evaluation in operator position during welding is performed, no evaluation is required in positions used for equipment programming or set-up.

Therefore assessment can be performed mainly on these aspects and calculations should be based purely on these parameters and the configuration of the welding circuit as specified in this European Standard.

NOTE The fact that magnetic fields in the surrounding space of a resistance welding equipment are non-homogeneous has to be taken into account.

5.3 Assessment parameters

Test configurations, points of investigation, operating conditions and other parameters, which are valid for all evaluation procedures, are specified in Annex A.

5.4 Averaging

5.4.1 General

Time and spatial averaging shall be made in accordance with the relevant document containing limits.

The following paragraphs contain specific criteria for resistance welding equipment and shall be used if no or less detailed averaging procedures are provided by the document containing the limits.

5.4.2 Time averaging

For occupational exposure the d.c. components of the magnetic flux density or field strength values should be averaged over a time interval of 8 h, taking into account the duty cycle of the equipment and the welding current output sequence, as applicable. The reduction factor shall be calculated

– for constant d.c. current as

$$V_{rdc} = \sqrt{\frac{X}{100}} \qquad (6)$$

where

X is the duty cycle of the welding equipment, expressed in %, calculated by

$$X = \frac{I_{2p}^{\ 2}}{I_{2cc}^{\ 2}} \cdot 100$$

– for welding current output sequences as

$$V_{rdcs} = \sqrt{\frac{X}{100} \frac{1}{\tau_{cs}} \sum_{i=1}^{n} I_n \cdot t_n} \qquad (7)$$

where

X is the duty cycle of the welding equipment, expressed in %;
τ_{cs} is the sequence cycle time;
I_n is the d.c. level during time interval n;
t_n is the duration of interval n.

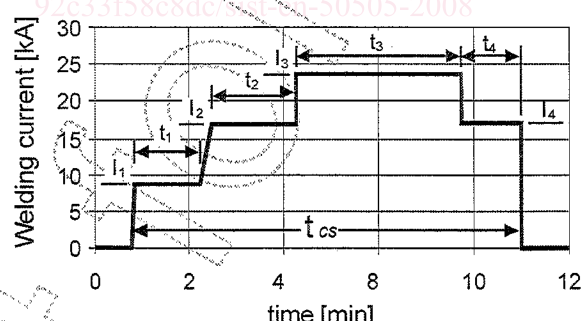

Figure 1 – Example for parameters of a welding current output sequence

For general public exposure of d.c. components or exposure to time-varying magnetic fields, time averaging shall be performed according the relevant document containing limits

5.4.3 Spatial averaging of magnetic field

Generally reference levels are intended to be spatially averaged values over the entire body of the exposed individual, but with the important proviso that the basic restrictions on localized exposure are not exceeded.