IEC 62822-3

Edition 2.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Electric welding equipment – Assessment of restrictions related to human exposure to electromagnetic fields (0 Hz to 300 GHz) – Part 3: Resistance welding equipment

Matériels de soudage électrique – Évaluation des restrictions relatives à l'exposition humaine aux champs électromagnétiques (0 Hz à 300 GHz) – Partie 3: Matériels de soudage par résistance

IEC 62822-3:2023-05(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 25.160.30

ISBN 978-2-8322-7056-1

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRIC WELDING EQUIPMENT – ASSESSMENT OF RESTRICTIONS RELATED TO HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS (0 HZ TO 300 GHZ) –

Part 3: Resistance welding equipment

FOREWORD

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IEC 62822-3 has been prepared by IEC technical committee 26: Electric welding. It is an International Standard.

This second edition cancels and replaces the first edition published in 2017. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) inclusion of the uncertainties in the results of the assessment;
b) simplification of the methods of exposure assessment.

The text of this International Standard is based on the following documents:

Draft	Report on voting
26/744/FDIS	26/745/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62822 series, published under the general title *Electric welding equipment – Assessment of restrictions related to human exposure to electromagnetic fields (0 Hz to 300 GHz),* can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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ELECTRIC WELDING EQUIPMENT – ASSESSMENT OF RESTRICTIONS RELATED TO HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS (0 HZ TO 300 GHZ) –

Part 3: Resistance welding equipment

1 Scope

This part of IEC 62822 applies to equipment for resistance welding and allied processes designed for occupational use by professionals and for use by laymen.

More generally, this document covers equipment for which the welding current flows in an electrical circuit whose geometry cannot be changed and regardless of the technology of the current generator (for example LF-AC, MF-DC for spot or seam welding or capacitive discharge used for stud welding).

NOTE 1 Allied processes such as resistance hard and soft soldering or resistance heating achieved by means comparable to resistance welding equipment are included as well.

This document specifies procedures for the assessment of human exposure to magnetic fields produced by resistance welding equipment. It covers non-thermal biological effects in the frequency range from 0 Hz to 10 MHz and defines standardized test scenarios.

NOTE 2 The general term “field” is used throughout this document for “magnetic field”.

NOTE 3 For the assessment of exposure to electric fields and thermal effects, the methods specified in IEC 62311 or relevant basic standards will apply.

This document aims to propose methods for providing EMF exposure data that can be used to assist in the assessment of the workplace, especially when the conditions of use of the equipment are not known. When these are technically constrained (for example, a double hand control imposes the position and posture of the user), the data can be directly exploitable if they fall within the scope specified by the manufacturer or the integrator.

Other standards can apply to products covered by this document. In particular this document cannot be used to demonstrate electromagnetic compatibility with other equipment. It does not specify any product safety requirements other than those specifically related to human exposure to electromagnetic fields.

This document proposes several methods to assess the exposure to EMF, from simple to sophisticated, with the latter providing more precise assessment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60050-851:2008, *International Electrotechnical Vocabulary (IEV) – Part 851: Electric welding* (available at www.electropedia.org)

IEC 60974-1, *Arc welding equipment – Part 1: Welding power sources*

IEC 60974-6, *Arc welding equipment – Part 6: Limited duty equipment*

IEC 61786-1, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 1: Requirements for measuring instruments*

IEC 61786-2:2014, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 2: Basic standard for measurements*

IEC 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 62311, *Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)*

IEC 62822-1:2016, *Electric welding equipment – Assessment of restrictions related to human exposure to electromagnetic fields (0 Hz to 300 GHz) – Part 1: Product family standard*

3 Terms, definitions, quantities, units, constants and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-851, IEC 60974-1, IEC 60974-6, and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
basic restriction
restriction on exposure to electric, magnetic and electromagnetic fields that is based directly on established health effects and biological considerations

Note 1 to entry: Basic restrictions are also named dosimetric reference limits (DRLs) and exposure limit values (ELVs).

3.1.2
coupling-coefficient
CC_{YX}
relation allowing to estimate Y from X

EXAMPLE CC_{EI} gives the maximum induced electric field inside a region of the human body according a unit welding current.

Note 1 to entry: Keeping in mind that the electric conductivity can be frequency dependent, a conversion between CC_{JI} and CC_{EI} or CC_{JB} and CC_{EB} is possible with the relation given in Formula (1)

$$\boldsymbol{J}(j\omega) = \sigma(j\omega) \cdot \boldsymbol{E}(j\omega) \tag{1}$$

where

J is the electric current density, expressed in ampere per square meter;

E is the electric field strength, expressed in volt per meter;

σ is the conductivity, expressed in siemens per meter;

ω is the angular frequency ($2 \cdot \pi \cdot f$), expressed in radians per second".

3.1.3
exposure index
EI
result of the evaluation of exposure to (both sinusoidal and non-sinusoidal) EMF, expressed as a fraction or percentage of the permissible values

Note 1 to entry: Fractions higher than 1 (100 %) exceed the permissible values.

3.1.4
general public
individuals of all ages and of varying health conditions

3.1.5
intracorporeal
situated or occurring within the body

3.1.6
layman
operator who does not weld in the performance of his profession and may have little or no formal instruction in welding

[SOURCE: IEC 60050-851:2008, 851-11-14, modified – "arc welding" was replaced with "welding".]

3.1.7
non-thermal effect
stimulation of muscles, nerves or sensory organs as a result of human exposure to EMF

3.1.8
occupational exposure
exposure of workers to EMF at their workplaces, generally under known conditions, and as a result of performing their regular or assigned job activities

Note 1 to entry: A worker is any person employed by an employer, including trainees and apprentices.

3.1.9
reference level
directly measurable quantity, derived from basic restrictions, provided for practical exposure assessment purposes

Note 1 to entry: Reference levels are also named exposure reference levels (ERLs) and action levels (AIs).

Note 2 to entry: Respect of the reference levels will ensure respect of the relevant basic restriction. If the reference levels are exceeded, it does not necessarily follow that the basic restriction will be exceeded.

3.1.10
resistance welding system
combination of power source, transformer, cabling and welding circuit

3.1.11
sensory effect
transient disturbed sensory perceptions and minor change in brain functions as a result of human exposure to EMF

3.1.12
standardized configuration
configuration reflecting the normal operator positions

3.1.13
standardized distance
distance from the axis of a part of the welding circuit to the closest surface of the body in standardized configurations

3.1.14
welding circuit
conductive material through which the welding current is intended to flow

Note 1 to entry: In resistance welding, the workpieces are not part of the welding circuit for the purposes of this document.

[SOURCE: IEC 60050-851:2008, 851-14-10, modified – the two notes to entry have been deleted, and a new note to entry has been added.]

3.2 Quantities and units

The internationally accepted SI units are used throughout this document.

Symbols throughout this document set in bold type are vector quantities.

Physical quantity	Symbol	Unit	Dimension
Electric conductivity	σ	Siemens per metre	$S \cdot m^{-1}$
Electric current	I	Ampere	A
Electric current density	$\boldsymbol{J}$	Ampere per square metre	$A \cdot m^{-2}$
Electric field strength	$\boldsymbol{E}$	Volt per metre	$V \cdot m^{-1}$
Frequency	f	Hertz	Hz
Magnetic flux density	$\boldsymbol{B}$	Tesla	T ($V \cdot s/m^2$)
Magnetic permeability	μ	Henry per metre	$H \cdot m^{-1}$
Wavelength	λ	Metre	m

3.3 Constants

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

3.4 Symbols

Symbols used in this document are expanded hereafter.

Symbols	Meaning
*	Convolution product i.e. $B(t)$*$WL(t)$ means filtering $B(t)$ by $WL(t)$
t	Time
f	Frequency of a single frequency signal
$B(t)$	Magnetic flux density (magnetic field) in the time domain
$B(f)$	Magnetic flux density (magnetic field) in the frequency domain
$B_{RL}(f)$	B reference level at f
$W_{RL}(t)$	Time (impulse) response of the weighted filter according to the reference level
$W_{RL}(f)$	Frequency response of the weighted function according to the reference level
EI_{RL}	Exposure index according to the reference level
$I(t)$ / I	Welding current in the time domain/frequency domain
CC_{BI}	Coupling coefficient from I to B (frequency independent)
$\mathcal{F}^{-1}$	Inverse Fourier transform
dB/dt	Time derivate of the magnetic flux density
R	Disk radius of 2D geometric model
E_i	Induced or internal electric field
dI/dt	Time derivate of the welding current
$W_{BR}(t)$	Time (impulse) response of the weighted filter according to the basic restriction
$W_{BR}(f)$	Frequency response of the weighted function according to the basic restriction
$CC_{EB/2D}$	Coupling coefficient from B to E_i with geometric model
$CC_{EI/HM}$	Coupling coefficient from I to E_i with human model
EI_{BR}	Exposure index according to the exposure limit value (basic restriction)
k_E	Exposure index coefficient
CEI_{BR}	Current exposure index according to the basic restrictions

4 Requirements

Equipment shall be assessed as defined in Clause 5.

If the assessment is conducted using measured or calculated external field levels, 5.2 shall be applied in conjunction with Clause 6.

If the assessment is conducted using corporal quantities, 5.3 shall be applied in conjunction with Clause 6 if measurements are performed and in conjunction of Clause 7 if a human model is applied.

The results shall be reported as specified in Clause 9.

5 Assessment methods

5.1 General

Clause 5 provides basic assessment methods considering the direct effects of electromagnetic fields [2], [3], [4], [5], [6], [7], [8][1]. Evaluations are made either against basic restrictions or against derived reference levels. In international guidelines, different limits on basic restrictions and reference levels are defined for stimulation effects which are considered for exposure to low frequency magnetic fields.

There are five methods to assess the welding equipment exposure and to demonstrate conformity or give enough information to demonstrate it with the reference levels or basic restrictions, or both. Any of the five methods can be selected, depending on which is the most relevant for the exposure assessment. If one of the first four methods does not lead to compliance, another can be chosen. The ultimate method is the fifth (dosimetry with human model).

While the evaluation based on measuring incident magnetic fields against reference levels is the easiest method (see 5.2.2), the evaluation based on computed magnetic field from the welding current can predict the exposure, and it does not require a field meter (see 5.2.3). Those methods are necessarily more conservative than the assessment of exposure according to induced quantities against basic restrictions.

Thus, the evaluation of internal (or induced) E-field or current density against basic restrictions (5.3) is performed with more realistic exposure conditions considering mainly the heterogeneity of the magnetic field.

Evaluations of induced fields against basic restrictions using simple (geometric) models are methods of intermediate complexity (see 5.3.2 and 5.3.3). As these methods have to cover a large number of situations, they are conservative most of the time and in extreme cases, they become accurate.

Lastly, evaluation of induced fields against basic restrictions with an electrical representative human body is the most rigorous and reduces uncertainties. It requires simulation after a faithful modelling of the environment (see 5.3.4).

5.2 Methods based on reference levels

5.2.1 General

The assessments are based on external (incident) magnetic fields against reference levels.

Reference levels have been derived from the basic restrictions considering the conditions which maximized the exposure (whole body exposure to a uniform field). Such an assessment is conservative under all non-uniform and local exposure conditions, which is the case in most occupational exposure situations. Therefore, this method is simple but it overestimates exposure to welding equipment most of the time.

The exposure level is determined by a comparison of the magnetic field and the relevant exposure limits applicable to the affected regions of the body.

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1 Numbers in square brackets refer to the Bibliography.