

CONSOLIDATED VERSION

VERSION CONSOLIDÉE



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 3-1: Exposure to electric fields – Analytical and 2D numerical models

Exposition aux champs électriques ou magnétiques à basse et moyenne fréquence – Méthodes de calcul des densités de courant induit et des champs électriques induits dans le corps humain –

Partie 3-1: Exposition à des champs électriques – Modèles analytiques et numériques 2D



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CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Exposure to electric field	8
3 General procedure.....	11
3.1 Shape factor.....	11
3.2 Procedure	11
4 Human body models.....	12
4.1 General.....	12
4.2 Surface area	12
4.3 Semi-spheroidal model.....	13
4.4 Axisymmetrical body model	15
5 Calculation of induced current	16
5.1 General.....	16
5.2 Semi-spheroid	16
5.3 Axisymmetrical models.....	20
5.4 Comparison of the analytical and numerical models	27
6 Influence of electrical parameters	28
6.1 General.....	28
6.2 Influence of permittivity	28
6.3 Influence of conductivity.....	28
6.4 Non-homogeneous conductivity.....	29
7 Measurement of currents induced by electric fields.....	29
7.1 General.....	29
7.2 Current flowing to the ground	29
Annex A (normative) Analytical solutions for a spheroid in a uniform electric field.....	31
Annex B (normative) Human body axisymmetrical model	34
Annex C (informative) Child body model	39
Annex D (informative) Example of use of this standard	41
Annex E (informative) Numerical calculation methods.....	45
Bibliography.....	53
Figure 1 – Illustration of the phenomenon of currents induced by electric field in a human body standing on the ground	10
Figure 2 – Potential lines of the electric field generated by an energised wire in the absence of any objects (all distances in metres)	10
Figure 3 – A realistic body model.....	12
Figure 4 – Scheme of the semi-spheroid simulating a human being standing on a zero potential plane	13
Figure 5 – Equivalent spheroid radius, R , versus height, L , and for different mass, M	15
Figure 6 – The axisymmetrical body model for the reference man (left) and woman (right).....	15

Figure 7 – Conductive spheroid exposed to electric field.....	16
Figure 8 – Calculation of the <i>shape factor for electric field</i> K_E for an a spheroid exposed to an unperturbed electric field.....	17
Figure 9 – Current density J_S induced by an unperturbed electric field (1 kV/m, 50 Hz) in a spheroid versus parameter L/R (values in $\mu\text{A}/\text{m}^2$).....	18
Figure 10 – Dimensions and mesh of the semi-spheroid	19
Figure 11 – Distortion of power frequency electric field lines close to the conductive semi-spheroid	19
Figure 12 – Calculated induced current density $J_A(h)$ in the body standing in a vertical 50 Hz electric field of 1 kV/m	21
Figure 13 – Computation domain	23
Figure 14 – Mesh of the man body model and distortion of power frequency electric field lines close to model.....	23
Figure 15 – Distribution of potential lines and 50 Hz electric field magnitude (man model)	24
Figure 16 – Computation of induced currents J_A along a vertical axis, and distribution of induced currents in the man model at 50 Hz	25
Figure 17 – Mesh of the woman body model and distortion of power frequency electric field lines close to model.....	25
Figure 18 – Distribution of potential lines and 50 Hz electric field magnitude (woman model)	26
Figure 19 – Computation of induced currents J_A along a vertical axis, and distribution of induced currents in the woman model at 50 Hz	27
Figure A.1 – Conductive spheroid exposed to electric field	31
Figure B.1 – Normalised axisymmetrical models. Left: man, Right: woman	36
Figure C.1 – Computation of induced currents J_Z along a vertical axis, and distribution of induced currents in the 10 years reference child model.....	40
Figure E.1 – Spheroid model.....	46
Figure E.2 – Space potential model	47
Figure E.3 – Exemple of charge simulation method using rings.....	48
Figure E.4 – Superficial charges integral equation method, cutting of the body into N elements.....	49
Figure E.5 – Mesh of the body using finite element method	50
Figure E.6 – Impedance method	51
Figure E.7 – Yee-method: Electric and magnetic grids for spatial discretization	52
Table 1 – Data for reference man and reference woman	13
Table 2 – Values of $\arcsin(e) / e$ for different values of L/R	14
Table 3 – Derived data using spheroid model at 50 Hz	20
Table 4 – Electric field E_{BR} required to produce basic restrictions J_{BR} or E_{iBR} in the neck at 50 Hz.....	22
Table 5 – Comparison of values of the shape factor for electric field K_E and corresponding current densities for an unperturbed 50 Hz electric field of 1 kV/m.....	28
Table B.1 – Measures from antropomorphic survey used to construct vertical dimensions of axisymmetrical model [56]	35

Table B.2 – Measures from antropomorphic survey used to construct the radial dimensions of axisymmetrical model [56]	35
Table B.3 – Normalised model dimensions.....	37
Table B.4 – Axisymmetric model dimensions for reference man and reference woman whose mass and height are defined by ICRP [38] and are given in Table 1	38
Table C.1 – Reference values provided by ICRP for male and female children.....	39
Table C.2 – Dimensions of the reference children (in m excepted SB_R in m ²)	39
Table C.3 – Results of analytical method for the reference children	40
Table D.1 – Normalised dimensions of the women model.....	41
Table D.2 – Calculation of the dimensions for a specific person	42

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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 3-1: Exposure to electric fields –
Analytical and 2D numerical models**

FOREWORD

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This Consolidated version of IEC 62226-3-1 bears the edition number 1.1. It consists of the first edition (2007-05) [documents 106/125/FDIS and 106/128/RVD] and its amendment 1 (2016-10) [documents 106/376/FDIS and 106/378/RVD]. The technical content is identical to the base edition and its amendment.

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions are in green text, deletions are in strikethrough red text. A separate Final version with all changes accepted is available in this publication.

International Standard IEC 62226-3-1 has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

This standard is to be used in conjunction with the first edition of IEC 62226-1:2004, *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 1: General*.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This International Standard constitutes Part 3-1 of IEC 62226 series, which will regroup several international standards and technical reports within the framework of the calculation of induced current densities and internal electric fields.

A list of all parts of the IEC 62226 series, published under the general title *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*, can be found on the IEC website.

The committee has decided that the contents of the base publication and its amendment will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

Public interest concerning human exposure to electric and magnetic fields has led international and national organisations to propose limits based on recognised adverse effects.

This standard applies to the frequency range for which the exposure limits are based on the induction of voltages or currents in the human body, when exposed to electric and magnetic fields. This frequency range covers the low and intermediate frequencies, up to 100 kHz. Some methods described in this standard can be used at higher frequencies under specific conditions.

The exposure limits based on biological and medical experimentation about these fundamental induction phenomena are usually called “basic restrictions”. They include safety factors.

The induced electrical quantities are not directly measurable, so simplified derived limits are also proposed. These limits, called “reference levels” are given in terms of external electric and magnetic fields. They are based on very simple models of coupling between external fields and the body. These derived limits are conservative.

Sophisticated models for calculating induced currents in the body have been used and are the subject of a number of scientific publications. These models use numerical 3D electromagnetic field computation codes and detailed models of the internal structure with specific electrical characteristics of each tissue within the body. However such models are still developing; the electrical conductivity data available at present has considerable shortcomings; and the spatial resolution of models is still progressing. Such models are therefore still considered to be in the field of scientific research and at present it is not considered that the results obtained from such models should be fixed indefinitely within standards. However it is recognised that such models can and do make a useful contribution to the standardisation process, specially for product standards where particular cases of exposure are considered. When results from such models are used in standards, the results should be reviewed from time to time to ensure they continue to reflect the current status of the science.

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 3-1: Exposure to electric fields – Analytical and 2D numerical models

1 Scope

This part of IEC 62226 applies to the frequency range for which exposure limits are based on the induction of voltages or currents in the human body when exposed to electric fields.

This part defines in detail the coupling factor K – introduced by the IEC 62226 series to enable exposure assessment for complex exposure situations, such as non-uniform magnetic field or perturbed electric field – for the case of simple models of the human body, exposed to uniform electric fields. The coupling factor K has different physical interpretations depending on whether it relates to electric or magnetic field exposure. It is the so called “shape factor for electric field”.

This part of IEC 62226 can be used when the electric field can be considered to be uniform, for frequencies up to at least 100 kHz.

This situation of exposure to a “uniform” electric field is mostly found in the vicinity of high voltage overhead power systems. For this reason, illustrations given in this part are given for power frequencies (50 Hz and 60 Hz).

2 Exposure to electric field

Alternating electric fields are generated by energised conductors (i.e. under voltage). In the immediate vicinity of domestic electrical equipment, such as lights, switches, food mixers and irons, local electric-field strengths about 100 V/m may be found. Such fields are non-uniform, but their strengths are far below the levels recommended in safety guidelines, so there is no need of calculation of induced currents in such exposure situations.

Higher electric-field strengths may be found in the vicinity of high voltage equipment such as electric power line. In the frequency range covered by this standard, it is considered that exposure from power lines is the only significant exposure source for public regarding safety guidelines limits.

Guidelines on human exposure to electric fields are generally expressed in terms of induced current density or internal electric field. These quantities cannot be measured directly and the purpose of this document is to give guidance on how to assess these quantities induced in the human body by external (environmental) electric fields E_0 .