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STANDARDS Australia

Australian/New Zealand Standard™

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

AS/NZS IEC 62226.2.1:2021

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Australian Industry Group
Australian Mobile Telecommunications Association
Australian Radiation Protection and Nuclear Safety Agency
Commercial Radio Australia
Communications, Electrical and Plumbing Union — Electrical Division
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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee TE-007, Human Exposure to Electromagnetic Fields.

The objective of this document is to introduce the coupling factor *K*, 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 aim of this document is to define in more detail this coupling factor *K*, for the case of simple models of the human body, exposed to non-uniform magnetic fields. It is thus called "coupling factor for non-uniform magnetic field".

This document is identical with, and has been reproduced from, IEC 62226-2-1:2004, *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 2-1: Exposure to magnetic fields — 2D models*.

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Part 2-1: Exposure to magnetic fields – 2D models

FOREWORD

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International Standard IEC 62226-2-1 has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

This Part 2-1 is intended 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.*

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The text of this standard is based on the following documents:

FDIS	Report on voting
106/79/FDIS	106/83/RVD

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

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

This International Standard constitutes Part 2-1 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, and will be published under the general title of *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*.

This series is planned to be published according to the following structure:

Part 1: General

Part 2: Exposure to magnetic fields

Part 2-1 : 2D models

Part 2-2 : 3D models

Part 2-3 : Guidelines for practical use of coupling factors

Part 3: Exposure to electric fields

Part 3-1: Analytical and 2D numerical models

Part 3-2: 3D numerical models

Part 4: Electrical parameters of human living tissues (Technical Report)

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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

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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 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 advancing. 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.

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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

1 Scope

This part of IEC 62226 introduces the coupling factor K, 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 aim of this part is to define in more detail this coupling factor K, for the case of simple models of the human body, exposed to non-uniform magnetic fields. It is thus called “coupling factor for non-uniform magnetic field”.

All the calculations developed in this document use the low frequency approximation in which displacement currents are neglected. This approximation has been validated in the low frequency range in the human body where parameter $\varepsilon\omega << \sigma$.

For frequencies up to a few kHz, the ratio of conductivity and permittivity should be calculated to validate this hypothesis.

2 Analytical models

2.1 General

Basic restrictions in guidelines on human exposure to magnetic fields up to about 100 kHz are generally expressed in terms of induced current density or internal electric field. These electrical quantities cannot be measured directly and the purpose of this document is to give methods and tools on how to assess these quantities from the external magnetic field.

The induced current density J and the internal electric field E_{i} are closely linked by the simple relation:

$$J = \sigma E_{\mathrm{i}} \tag{1}$$

where σ is the conductivity of living tissues.

For simplicity, the content of this standard is presented in terms of induced current densities J, from which values of the internal electric field can be easily derived using the previous formula.

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