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BSI Standards Publication

Industrial electroheating and electromagnetic processing equipment — Requirements on touch currents, voltages and electric fields from 1 kHz to 6 MHz

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/27, Electroheating.

A list of organizations represented on this committee can be obtained on request to its secretary.

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INDUSTRIAL ELECTROHEATING AND ELECTROMAGNETIC PROCESSING EQUIPMENT – REQUIREMENTS ON TOUCH CURRENTS, VOLTAGES AND ELECTRIC FIELDS FROM 1 kHz TO 6 MHz

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62996, which is a technical specification, has been prepared by IEC technical committee 27: Industrial electroheating and electromagnetic processing.

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

Draft TS	Report on voting
27/1005/DTS	27/1010/RVDTS

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

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

In this document, the following print types are used:

- terms defined in Clause 3: in bold type.
- in Table A.4 and Table A.5, the resulting voltage limits are bolded, for clarity.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Touch and touch currents and voltages constitute a very important category of electrical safety issues particularly for electroheating (EH) equipment and equipment for electromagnetic processing of materials (EPM). The equipment manufacturer is mandated to adequately reduce any hazard from touching live equipment parts. For being able to do so, assessments and verifications are necessary for determination of hazards.

During the drafting of IEC 60519-1:2015, it became apparent that there was a need for a technical specification providing an overview, a guidance and requirements for users of that standard, and dealing with the nearest higher frequency interval above that of IEC 61140 and IEC 60204 (all parts). A revised IEC 61140:2016 covers issues up to 1 kHz (up to 200 Hz in earlier editions). Thus, this document deals with touch and touch currents and voltages in the frequency range from 1 kHz to 6 MHz. This range was adopted due to deviating frequency dependence of skin impedances below 1 kHz.

In principle, cases with strong external electric fields where the person is not touching the live insulated or bare live conductor are closely related to cases where the person is actually touching an insulated live conductor. These cases of currents in parts of the body by capacitive coupling are therefore included in this document.

NOTE A parallel IEC technical specification IEC TS 62997:2017 is developed by TC 27, dealing with the magnetic nearfields from 1 Hz to 6 MHz.

The upper frequency limit 6 MHz is chosen due to

– higher frequencies not being expected in internal frequency converters for DC voltage transformation in equipment,
– the free space wavelength of 6 MHz being 50 m, which results in wave phenomena that essentially not exist with or at objects with less than 10 % spatial dimensions of this,
– the fact that the power penetration depth limitation by the equivalent complex permittivity of body tissues has not yet set in at 6 MHz, so currents can be considered to be the same across the two touch areas and their patterns are as with low frequencies, and
– industrial processing frequencies below this limit are typically low impedance; higher impedance dielectric heating has its lowest ISM frequency at 6,8 MHz and is dealt with in IEC 60519-9.

Separation of electric shock (by a current between two parts of the body, creating an internal electric field by the tissue impedance) and induced electric shock (by an internally induced electric field caused by an external alternating magnetic field) is generally possible in the frequency interval considered in this document, since the latter requires a very high current in the conductor generating the magnetic field and conductor resistive losses are low by design. However, touching of such a conductor can occur and both mechanisms will then have to be assessed.

Impedance considerations for skin and other parts of the body are usually not included in sufficient detail in most existing standards, technical specifications and guidelines. With the exception of IEC 60601 (all parts) for medical equipment, no IEC standards provide reasonably complete touch current and voltage specifications. Equivalent test circuits tend to be too general and in some instances even contradictory to established literature data. This specification includes references to relevant IEC, IEEE, ICNIRP, EN and scientific literature data. Additional inputs are from numerical calculations with model situations, and volunteer studies.

Local overheating of particularly skin regions can be the dominating hazard at frequencies higher than some tens of kilohertz. Hazard limits are then to be based on skin impedances, thermal properties and touch as well as current path cross section area considerations. In addition, awareness, perception and withdrawal considerations become crucial. All these factors are dealt with in this document, in a more detailed way than in any other IEC publication.

Even if the scope of IEC TC 27 is limited to industrial electroheating and electromagnetic processing of materials, this document can fill an important gap, with its generally applicable and detailed specifications for higher frequencies than alternating current. It is therefore expected to be of more general use. It should, however, be observed that in particular skin impedances behave non-linearly for frequencies below about 1 kHz.

INDUSTRIAL ELECTROHEATING AND ELECTROMAGNETIC PROCESSING EQUIPMENT – REQUIREMENTS ON TOUCH CURRENTS, VOLTAGES AND ELECTRIC FIELDS FROM 1 kHz TO 6 MHz

1 Scope

This document addresses the safety assessments in the frequency range between 1 kHz and 6 MHz and provides limits for touch and touch currents for industrial installations or equipment for electroheating (EH) and electromagnetic processing of materials (EPM). Indirect contact by capacitive currents to parts of an earthed human body in an open space are also included, since the current is then distributed analogously in the part of the body and differs from cases of induced electric shock.

NOTE 1 Induced electric shock phenomena are caused by the alternating magnetic field external to a current-carrying conductor, inducing an electric field in a part of the body in the vicinity of or directly contacting it. The causes are thus different from those causing electric shock phenomena and are dealt with in IEC TS 62997 on magnetic nearfield safety, developed by TC 27.

The overall safety requirements for the various types of EH or EPM equipment and installations in general result from the joint application of the general requirements specified in IEC 60519-1:2015 and related particular requirements covering specific types of installations or equipment. This document complements IEC 60519-1:2015.

NOTE 2 This document complements Annex B in IEC 60519-1:2015.

On contacting, this document is based primarily on a movement of the primary contact area in relation to the live part, resulting in a contact or **touch current**. The awareness, perception and reaction times differ in comparison with a situation where a person is, for example, leaning towards or holding a conductor which subsequently becomes live, or a similar fault condition. Different considerations are then applicable and are dealt with in a detailed way in this document.

Since high impedances for dry skin will result in the lowest **touch current** and the dryness is typically variable, data for only moist and wet skin are used in this document.

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 60417, *Graphical symbols for use on equipment* (available at http://www.graphical-symbols.info/equipment)

IEC 60519-1:2015, *Safety in installations for electroheating and electromagnetic processing – Part 1: General requirements*

3 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 60519-1:2015 and the following apply.