

TECHNICAL REPORT



Assessment of contact current related to human exposure to electric, magnetic and electromagnetic fields
(standards.iteh.ai)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ASSESSMENT OF CONTACT CURRENT RELATED TO HUMAN EXPOSURE TO ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS

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IEC TR 63167, which is a Technical Report, has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
106/422/DTR	106/436A/RVDTR

Full information on the voting for the approval of this Technical Report 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.

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

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INTRODUCTION

In the guidelines limiting human exposure to electric, magnetic and electromagnetic fields (EMF guidelines), limits for the contact current are given to avoid adverse indirect effects, i.e. electric shocks and burn hazards caused by contact with a conductive object located in an electric and/or magnetic field, when the object has an electric potential owing to electric or magnetic induction to the object.

At the moment, no standardized method for evaluating the contact current, in the context of human exposures to the above fields has been well established. On the other hand, there is a huge amount of knowledge, as well as many standards and regulations on the issue of electrical safety (i.e. direct contact with live part of conductive object) to avoid severe electric shock hazards. Therefore, the evaluation methods used in the field of electrical safety might be useful references. This document summarizes general information on the assessment of contact current related to human exposure to electric, magnetic and electromagnetic fields.

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ASSESSMENT OF CONTACT CURRENT RELATED TO HUMAN EXPOSURE TO ELECTRIC, MAGNETIC AND ELECTROMAGNETIC FIELDS

1 Scope

This document, which is a Technical Report, provides general information on the assessment of contact current related to human exposure to electric, magnetic and electromagnetic fields. The contact currents in this context occur when a human body comes into contact with a not electrified conductive object exposed to an electric and/or magnetic field at a different electric potential owing to electric and/or magnetic induction to the object. This is distinguished from the issue of electrical safety where contact with live parts of a conductive object is dealt with.

In reference to the international EMF guidelines [1]-[4]¹, the frequency range of contact current covered in this document is direct current to 110 MHz, and only steady-state (continuous) contact currents are covered. Transient contact currents (spark discharges) which may occur immediately before the contact with the object are not covered.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1

contact current

current flowing into the body resulting from contact with a conductive object in an electric, magnetic or electromagnetic field

3.2

electric field strength

magnitude of a field vector at a point that represents the force (F) on an infinitely small charge (q) divided by the charge

3.3

exposure

state that occurs when a person is subjected to an electric, magnetic or electromagnetic field, or to a contact current other than those originating from physiological processes in the body and other natural phenomena

¹ Numbers in square brackets refer to the Bibliography.

3.4**indirect effect**

effect resulting from physical contact between a person and a not electrified object, such as a metallic structure in an electric, magnetic or electromagnetic field, at an electric potential that is at least at a point of the object different from the potential of the person

3.5**touch current**

electric current flowing through a human body when it touches one or more accessible parts of an installation or of equipment

Note 1 to entry: The term “leakage current” had also been used as a synonym for touch current in the field of electrical safety.

3.6**spark discharge**

transfer of current through an air gap prior to making contact with another conductive object at a different potential

4 Abbreviated terms

AM	amplitude modulation
EMF	electric, magnetic or electromagnetic field
EV	electric vehicle
FM	frequency modulation
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
IH	induction heating
MPE	maximum permissible exposure
MRI	magnetic resonance imaging
PC	personal computer
RF	radio frequency
WPT	wireless power transfer

5 Contact current in EMF exposure guidelines

Clause 5 overviews contact currents described in the EMF guidelines [1]-[4].

In the frequency range up to approximately 10 MHz (dominantly up to 100 kHz), the flow of electric current from an object in a field to the body of an individual may result in the stimulation of muscles and/or peripheral nerves. With increasing current, this may be manifested as perception, pain from an electric shock and/or burn, the inability to release the object, difficulty in breathing and, at higher currents, cardiac ventricular fibrillation.

In the frequency range of about 100 kHz to 110 MHz, shocks and burns can result either from an individual touching an ungrounded metal object that has acquired a charge in a field or from contact between a charged individual and a grounded metal object.

In the EMF guidelines, reference levels for steady state (continuous) contact current are given for frequencies up to 110 MHz to avoid shock and burn hazards (see Annex A). The reference levels are not intended to avoid ventricular fibrillation, which is the basis of standards for electrical safety. The upper frequency of 110 MHz is the upper frequency limit of the FM broadcast band. Here, the transient currents resulting from spark discharges [5], which can

occur when an individual comes into very close proximity with an object at a different electric potential, are not considered in the reference levels of contact current. Instead, the effect of spark discharge is considered in the reference levels of electric field exposure for the general public by including a sufficient margin to prevent surface electric-charge effects such as perception by most people.

It is noteworthy that different methods for evaluation of conformity to the guidelines are provided for multiple-frequency exposure for low-frequency (below 100 kHz) and high-frequency (above 10 kHz) ranges. In the frequencies between 10 kHz and 100 kHz, both evaluation methods are applied (see Annex A).

6 Consideration in evaluating contact currents

6.1 General

Clause 6 describes items to be considered in evaluating contact currents:

- a) assumed situations of human exposure to a contact current (6.2);
- b) methods for evaluating a touch current used in electrical safety standards for references (6.3);
- c) some proposed methods for evaluating contact currents (6.4).

6.2 Assumed situations of human exposure to contact current

6.2.1 General

There are several situations to be considered for human exposure to a contact current. Different cases have to be considered depending on the type of coupling between fields (electric or magnetic) and human bodies/objects. <https://standards.iteh.ai/catalog/standards/sist/203f3c70-a964-4ca3-9860-72851dc9b/iec-tr-63167-2018>

6.2.2 Capacitive coupling (power line)

An electric field induces, by capacitive coupling (electrostatic induction), a voltage in a person or a conductive object that is isolated from the ground. When a person touches an object having a different potential, a contact current flows so as to cancel the potential difference. This can be categorized into two cases: (a) an isolated person touches a grounded object and (b) a grounded person touches an isolated object (especially a large object such as a bus or a truck) [6]. Comprehensive studies have been carried out for typical cases encountered under overhead transmission lines [7].

6.2.3 Inductive coupling (power line)

By inductive coupling (electromagnetic induction), a magnetic field induces a voltage, especially in long conductive objects such as telecommunication lines, fences and gas pipelines, having at least one reasonable grounding, when they are installed close to and parallel to magnetic field sources such as overhead power lines [8]. When a person touches the object, a contact current flows. In particular, in the case of fault condition in overhead power lines, the limit values for the open-circuit voltage in telecommunication lines are set by an international regulation-setting body [9]. In contrast to the capacitive coupling, grounding a conductive object at a large distance from the point of contact will actually increase the amplitude of the open-circuit voltage, thereby increasing the contact current.

6.2.4 Induction heating equipment

Induction heating (IH) equipment is heating equipment using the Joule effect produced by magnetically induced currents. For a domestic IH cooker, a metal pan or pot is heated by a magnetic field, and when a person touches a conductive part of the pan or pot, a contact current can occur typically in the frequency ranges of around 20 kHz to 100 kHz. The method used to evaluate human exposure to magnetic fields produced by IH cookers is standardized