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BASIC SAFETY PUBLICATION

Protection against electric shock – Common aspects for installations and equipment

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PROTECTION AGAINST ELECTRIC SHOCK – COMMON ASPECTS FOR INSTALLATION AND EQUIPMENT

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61140 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This fourth edition cancels and replaces the third edition published in 2001 and Amendment 1:2004. This edition constitutes a technical revision.

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

a) Introduction of the content of IEC 60449
b) Better distinction between provisions and measures
c) Consideration of effects other than ventricular fibrillation
d) Additional protection was introduced
e) ELV defined as part of LV
f) Devices suitable for isolation required for automatic disconnection of supply (LV)
g) Requirements relating to current in the protective conductor were moved to the main body of the standard

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

FDIS	Report on voting
64/2076/FDIS	64/2091/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.

It has the status of a basic safety publication in accordance with IEC Guide 104.

The reader's attention is drawn to the fact that Annex C lists all of the “in-some-country” clauses on differing practices of a less permanent nature relating to the subject of this standard.

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

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

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 publication using a colour printer.

~~INTRODUCTION~~

PROTECTION AGAINST ELECTRIC SHOCK – COMMON ASPECTS FOR INSTALLATIONS AND EQUIPMENT

1 Scope

This International Standard is a basic safety publication primarily intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

It is not intended to be used as a stand-alone standard.

According to IEC Guide 104, technical committees, when preparing, amending, or revising their publications, are required to make use of any basic safety publication such as IEC 61140.

This International Standard applies to the protection of persons and ~~animals~~ livestock against electric shock. The intent is to give fundamental principles and requirements which are common to electrical installations, systems and equipment or necessary for their coordination, without limitations with regard to the magnitude of the voltage or current, or the type of current, and for frequencies up to 1 000 Hz.

~~This standard has been prepared for installations, systems and equipment without a voltage limit.~~

~~NOTE~~ Some clauses in this standard refer to low-voltage and high-voltage systems, installations and equipment. For the purposes of this standard, low-voltage is any rated voltage up to and including 1 000 V a.c. or 1 500 V d.c.. High voltage is any rated voltage exceeding 1 000 V a.c. or 1 500 V d.c..

~~The requirements of this standard apply only if they are incorporated, or are referred to, in the relevant standards. It is not intended to be used as a stand-alone standard.~~

It should be noted that, for an efficient design and selection of protective measures, the type of voltage that may occur and its waveform needs to be considered, i.e. a.c. or d.c. voltage, sinusoidal, transient, phase controlled, superimposed d.c., as well as a possible mixture of these forms. The installations or equipment may influence the waveform of the voltage, e.g. by inverters or converters. The currents flowing under normal operating conditions and under fault conditions depend on the described voltage.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

~~IEC 60050(131): *International Electrotechnical Vocabulary (IEV) – Chapter 131: Electric and magnetic circuits*~~

~~IEC 60050(195): 1998, *International Electrotechnical Vocabulary (IEV) – Part 195: Earthing and protection against electric shock*~~
~~Amendment 1 (2001)~~

~~IEC 60050(351):1998, *International Electrotechnical Vocabulary – Part 351: Automatic control*~~

~~IEC 60050(826):1982, *International Electrotechnical Vocabulary – Chapter 826: Electrical installations of buildings*~~
~~Amendment 2 (1995)~~

IEC 60038, *IEC standard voltages*

IEC 60068 (all parts), *Environmental testing*

IEC 60071-1~~:1993~~, *Insulation coordination – Part 1: Definitions, principles and rules*

IEC 60071-2~~:1996~~, *Insulation coordination – Part 2: Application guide*

~~IEC 60364-4-41, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock*~~

~~IEC 60364-4-443:1995, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltages – Section 443: Protection against overvoltages of atmospheric origin or due to switching*~~

IEC 60364-5-54:~~1980~~ 2011, *Low-voltage electrical installations ~~of buildings~~ – Part 5-54: Selection and erection of electrical equipment – ~~Chapter 54:~~ Earthing arrangements and protective conductors*

~~IEC 60364-6-61:1986, *Electrical installations of buildings – Part 6: Verification – Chapter 61: Initial verification*~~

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

~~IEC 60417-2, *Graphical symbols for use on equipment – Part 2: Symbol originals*~~

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

~~IEC 60446:1999, *Basic and safety principles for man-machine interface, marking and identification – Identification of conductors by colours or numerals*~~

IEC TS 60479-1:~~1994~~ 2005, *Effects of current on human beings and livestock – Part 1: General aspects*

IEC TR 60479-5, *Effects of current on human beings and livestock – Part 5: Touch voltage threshold values for physiological effects*

IEC 60529~~:1989~~, *Degrees of protection provided by enclosure~~s~~ (IP Code)*

~~IEC 60601 (all parts), *Medical electrical equipment*~~

~~IEC 60601-1:1988, *Medical electrical equipment – Part 1: General requirements for safety*~~

IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

IEC 60664-1:~~1992~~ 2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 60990~~:1999~~, *Methods of measurement of touch current and protective conductor current*

IEC TS 61201:~~1992~~ 2007,~~ *Extra-low-voltage (ELV) – Limit values*~~ *Use of conventional touch voltage limits – Application guide*

IEC 62271-102, *High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches*

IEC Guide 104~~:1997~~, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:~~1999~~ 2014, *Safety aspects – Guidelines for their inclusion in standards*

3 Terms and definitions

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

NOTE An index of definitions is given in Annex B.

3.1
electric shock
physiological effect resulting from an electric current through a human~~ or animal~~ body or livestock

Note 1 to entry: Physiological effects include, for example, perception, muscular contractions and tetany, difficulty in breathing, disturbances of heart function, immobilization, cardiac arrest, breathing arrest, burns or other cellular damage.

Note 2 to entry: Physiological effects resulting from EMF are not considered in this standard.

[SOURCE: IEC 60050-195:1998, 195-01-04, modified – "through a human body or livestock" replaces "passing through a human or animal body"; addition of 2 Notes to entry]

3.1.1
basic protection
protection against electric shock under fault-free conditions

[SOURCE: IEC 60050-195:1998, 195-06-01]

~~NOTE For low-voltage installations, systems and equipment, basic protection generally corresponds to protection against direct contact as used in IEC 60364-4-41.~~

3.1.2
fault protection
protection against electric shock under single fault conditions

[SOURCE: IEC 60050-195:1998/AMD1:2001, 195-06-02]

~~NOTE For low-voltage installations, systems and equipment, basic protection generally corresponds to protection against direct contact as used in IEC 60364-4-41.~~

3.1.3
additional protection
protection against electric shock in addition to basic protection and/or fault protection

[SOURCE:IEC 60050-826:2004, 826-12-07, modified – "protection against electric shock" replaces "protective measure"]

3.1.4
single fault condition
condition in which one means for protection against electric shock is defective or one fault is present which could cause a hazard

Note 1 to entry: If a single fault condition results in one or more other fault conditions, all are considered as one single fault condition.

3.2
~~(~~electric~~)~~ circuit
arrangement of devices or media through which electric current can flow

~~[IEV 131-01-01]~~

Note 1 to entry: See also IEC 60050-826:2004, ~~826-05-01~~ 826-14-01 for electrical installations of buildings.

3.3
~~(~~electrical~~)~~ equipment
item used for such purposes as generation, conversion, transmission, ~~storage,~~ distribution or utilization of electric energy, such as electric machines, transformers, ~~apparatus,~~ switchgear and controlgear, measuring instruments, protective devices, ~~accessories for wiring systems, appliances~~ wiring systems, current-using equipment

[SOURCE: IEC 60050-826:2004, ~~826-07-01, modified~~ 826-16-01]

3.4
live part
~~conductor or~~ conductive part intended to be energized in normal ~~operation~~ conditions, including a neutral conductor or mid-point conductor, but by convention not a PEN conductor or PEM conductor or PEL conductor

Note 1 to entry: This concept does not necessarily imply a risk of electric shock.

~~NOTE 2 For definitions of PEM and PEL see IEV 195-02-13 and 195-02-14.~~

[SOURCE: IEC 60050-195:1998, 195-02-19, modified – "…normal conditions, including a neutral conductor or mid-point conductor" replaces "normal operation, including a neutral conductor.."]

3.5
hazardous-live-part
live part which, under certain conditions, can give a harmful electric shock

Note 1 to entry: In case of high voltage, a hazardous voltage may be present on the surface of solid insulation. In such a case the surface is considered to be a hazardous-live-part.

[SOURCE: IEC 60050-195:1998, 195-06-05]

3.6
exposed-conductive-part
conductive part of equipment, which can be touched and which is not normally live, but which can become live when basic insulation fails

Note 1 to entry: A conductive part of electrical equipment which can become live only through contact with an exposed-conductive-part which has become live, is not considered to be an exposed-conductive-part itself.

[SOURCE: IEC 60050-195:1998, 195-06-10]

3.7
extraneous-conductive-part
conductive part not forming part of the electrical installation and liable to introduce an electric potential, generally the electric potential of a local earth

[SOURCE: IEC 60050-195:1998, 195-06-11]

3.8
touch voltage

3.8.1
(effective) touch voltage
voltage between conductive parts when touched simultaneously by a ~~person or an animal~~ human or livestock

Note 1 to entry: The value of the effective touch voltage may be appreciably influenced by the impedance of the person or the ~~animal~~ livestock in electric contact with these conductive parts.

[SOURCE: IEC 60050-195:1998, 195-05-11, modified – "by a human or livestock" replaces "by a person or an animal"]

3.8.2
prospective touch voltage
voltage between simultaneously accessible conductive parts when those conductive parts are not being touched, by a ~~person or an animal~~ human or livestock

[SOURCE: IEC 60050-195:1998, 195-05-09, modified – "by a human or livestock" replaces "by a person or an animal"]

3.9
touch current
electric current passing through a human body or through ~~an animal body~~ livestock when it touches one or more accessible parts of an installation or of equipment

[SOURCE: IEC 60050-195:1998/AMD1:2001, 195-05-21, modified – "through livestock" replaces "through an animal body"]

3.10
insulation
set of properties which characterize the ability of an insulation to provide its function

Note 1 to entry: Examples of relevant properties are: resistance, breakdown voltage.

Note 2 to entry: Insulation can be a solid, a liquid or a gas (e.g. air), or any combination.

[SOURCE: IEC 60050-151:2001, 151-15-42, modified – Note 2 to entry added]

3.10.1
basic insulation
insulation of hazardous-live-parts which provides basic protection

Note 1 to entry: This concept does not apply to insulation used exclusively for functional purposes.

[SOURCE: IEC 60050-195:1998, 195-06-06]

3.10.2
supplementary insulation
independent insulation applied in addition to basic insulation, for fault protection

[SOURCE: IEC 60050-195:1998, 195-06-07]

3.10.3
double insulation
insulation comprising both basic insulation and supplementary insulation

[SOURCE: IEC 60050-195:1998, 195-06-08]

3.10.4
reinforced insulation
insulation of hazardous-live-parts which provides ~~a degree of~~ protection against electric shock equivalent to double insulation

Note 1 to entry: Reinforced insulation may comprise several layers which cannot be tested singly as basic insulation or supplementary insulation.

[SOURCE: IEC 60050-195:1998, 195-06-09, modified – ..provides “a degree” of …, deleted]

3.11
non-conducting environment
provision whereby a ~~person or an animal~~ human or livestock touching an exposed-conductive-part that has become hazardous-live is protected by the high impedance of his environment (e.g. insulating walls and floors) and by the absence of earthed conductive parts

[SOURCE: IEC 60050-195:1998, 195-06-21, modified – “animal” replaced by “livestock”]

3.12
(electrically) protective obstacle
part preventing unintentional ~~direct~~ contact by a human or livestock with a live part, but not preventing ~~direct~~ such contact by deliberate action

[SOURCE: IEC 60050-195:1998, 195-06-16, modified – "direct contact" replaced by "contact" and ”by a human or livestock with a live part”.. introduced]

~~NOTE Direct contact is defined in IEV 195-06-03.~~

3.13
(electrically) protective barrier
part providing protection against ~~direct~~ contact by a human or livestock with a live part from any usual direction of access

[SOURCE: IEC 60050-195:1998, 195-06-15, modified – "direct contact" replaced by "contact" and “by a human or livestock with a live part” … introduced]

~~NOTE Direct contact is defined in IEV 195-06-03.~~

3.14
(electrically) protective enclosure
electrical enclosure surrounding internal parts of equipment to prevent access to ~~hazardous~~ a live-part from any direction

Note 1 to entry: In addition, an enclosure generally provides protection against internal or external influences, e.g. ingress of dust or water or prevention of mechanical damage.

[SOURCE: IEC 60050-195:1998, 195-06-14, modified – "hazardous live-parts" replaced by "a live-part" and Note 1 to entry added]

3.15
arm's reach
zone of accessibility to touch extending from any point on a surface where persons usually stand or move about to the limits which a person can reach with the hand, in any direction, without assistance