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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Rolling stock – Protective provisions against electrical hazards

Applications ferroviaires – Matériel roulant – Dispositions de protection contre les dangers électriques

IEC 61991:2019-05(en-fr)

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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 61991 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This second edition cancels and replaces the first edition, published in 2000. This edition constitutes a technical revision. It is based on EN 50153:2014.

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

a) Replacement of several reference standards.
b) Several terms and abbreviated terms are introduced;
c) Table 2 – Voltage bands for France is moved to Annex B as Table B.1, Table 3 – Voltage bands for Italy is deleted;
d) Annex B and Annex C are introduced.
e) Annex B includes special national conditions.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
9/2467/FDIS	9/2487/RVD

Full information on the voting for the approval of this International Standard 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

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- withdrawn,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

INTRODUCTION

It is generally accepted that safety depends on human factors, based on the normal behaviour of the operators involved, as well as upon technical factors.

For these reasons, this document leaves a choice to the contracting parties between two alternatives in several instances. These alternatives consist of either the provision of operating rules, regulations and procedures, or the application of technical measures such as mechanical or electrical interlocking devices.

A list of the cases for which the contracting parties (e.g. user and manufacturer) shall reach agreement before signing the contract is included in Annex A.

RAILWAY APPLICATIONS – ROLLING STOCK –

Protective provisions against electrical hazards

1 Scope

This document defines requirements applied in the design and manufacture of electrical installations and equipment to be used on rolling stock to protect persons from electric shocks.

This document is applicable to rolling stock of rail transport systems, road transport systems if they are powered by an external supply (e.g. trolley buses), magnetically levitated transport systems, and to the electrical equipment installed in these systems.

This document does not apply to:

– mine railways in mines,
– crane installations, moving platforms and similar transport systems on rails,
– funicular railways,
– temporary constructions.

The requirements for the fixed installations about the protection against the vehicles' potential are not covered 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 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

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

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61310-1, *Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, acoustic and tactile signals*

IEC 62128-1:2013, *Railway applications – Fixed installations – Electrical safety, earthing and the return circuit – Part 1: Protective provisions against electric shock*

IEC 62313, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

IEC 62497-1, *Railway applications –Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

IEC 62995:2018, *Railway applications – Rolling Stock – Rules for installation of cabling*

3 Terms, definitions and abbreviated terms

3.1 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

NOTE For more information relating to definitions of parts of the fixed installations, refer to IEC 62128-1 from which these definitions are derived.

3.1.1 Definitions concerning persons

3.1.1.1
<electrically> instructed person
person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards which electricity can create

[SOURCE: IEC 60050-195:1998, 195-04-02]

3.1.1.2
ordinary person
person who is neither a skilled person nor an instructed person

[SOURCE: IEC 60050-195:1998, 195-04-03]

3.1.1.3
<electrically> skilled person
person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create

[SOURCE: IEC 60050-195:1998, 195-04-01]

3.1.2 Other definitions

3.1.2.1
closed electrical operating area
room or location which serves exclusively for the operation of electrical equipment and is kept secure by a means appropriate to the voltage and location

Note 1 to entry: Access to such areas is permitted only to (electrically) skilled persons and (electrically) instructed persons.

Note 2 to entry: The definition of closed electrical operating area can be suitable for underfloor or upperroof cabinets. Generally speaking, it is any location (inside or outside the car body) which is kept secured because of the voltage that can be assumed to be present on the equipment inside it. Access to such areas is not allowed for ordinary persons.

3.1.2.2
contact line
conductor system for supplying electrical energy to rolling stock through current-collecting equipment

[SOURCE: IEC 60050-811:2017, 811-33-01, modified – The term “vehicle” has been replaced by “rolling stock” and Note 1 to entry has been omitted.]

3.1.2.3
contact wire
electric conductor of an overhead contact line with which the current collectors make contact

[SOURCE: IEC 60050-811:2017, 811-33-15]

3.1.2.4
direct contact
electric contact of persons or animals with live parts

[SOURCE: IEC 60050-195:1998, 195-06-03]

3.1.2.5
double insulation
insulation comprising both basic insulation and supplementary insulation

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

3.1.2.6
earth
conductive mass of the earth, whose electrical potential at any point is conventionally taken as equal to zero

3.1.2.7
electrical operating area
room or location which serves primarily for the operation of electrical equipment and is normally entered only by skilled persons or (electrically) instructed persons

Note 1 to entry: Generally speaking, an electrical operating area is any location (mainly inside the car body) where electrical equipment operates. The above is the main function of this area but not the only one. In fact, normally the area is not kept secured and protection against direct contact is achieved by other means (e.g. (electrically) protective obstacles).

3.1.2.8
electric shock
physiological effect resulting from an electric current passing through a human or animal body

[SOURCE: IEC 60050-195:1998, 195-01-04]

3.1.2.9
extra-low voltage
voltage not exceeding the relevant voltage limit of band II specified in Table 1

[SOURCE: IEC 60050-826:2004, 826-12-30, modified – The term “band I” has been replaced by “band II” and “IEC 60449” has been replaced by “Table 1”.]

3.1.2.10
equipotential bond
electrical connection putting various exposed conductive parts at a substantially equal potential

Note 1 to entry: This can be abbreviated as ‘bond’ or ‘bonding’.

3.1.2.11
exposed conductive part <of electrical equipment>
conductive part of electrical equipment, which can be touched and which is not normally live, but can become live when basic insulation fails

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

3.1.2.12
indirect contact
electric contact of persons or animals with exposed conductive parts which have become live under fault conditions

[SOURCE: IEC 60050-195:1998, 195-06-04]

3.1.2.13
interlocking device
device which makes the operation of a switching device dependent upon the position or operation of one or more other pieces of equipment

[SOURCE: IEC 60050-441:2000, 441-16-49]

3.1.2.14
insulate, verb
prevent electric conduction between conductive elements by means of insulating materials

[SOURCE: IEC 60050-151:2001, 151-15-36]

3.1.2.15
insulation

all the materials and parts used to insulate conductive elements of a device

[SOURCE: IEC 60050-151:2001, 151-15-41]

3.1.2.16
live part <in electric traction>
conductor or conductive part intended to be energized in normal use

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

Note 2 to entry: By convention, this does not include the running rails and parts connected to them.

[SOURCE: IEC 60050-811:2017, 811-36-23]

3.1.2.17
locking system
system which comprises interlocking devices and physically prevents access to live parts unless the supply of electrical energy to the live parts has been isolated and made safe

3.1.2.18
mechanical locking
use of a lock or bolted /screwed fixings to prevent access panels or doors being opened and require the use of a key or tool to remove

3.1.2.19
multi-stage insulation
insulation system having more than one stage of insulation and an intermediate frame between consecutive stages

[SOURCE: IEC 60322:2001, 3.4, modified – Notes have been deleted.]

3.1.2.20
nominal voltage <of a system>
suitable approximate value of voltage used to designate or identify a system

Note 1 to entry: The voltages are expressed by the value between poles, ripple-free for DC and by the RMS value between phases for AC.

Note 2 to entry: The actual voltage can differ from the nominal voltage by a quantity within permitted tolerances. For further information about traction systems supply voltages, see IEC 60850.

[SOURCE: IEC 60050-601:1985, 601-01-21, modified – Notes to entry have been added.]

3.1.2.21
PELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and
– under single fault conditions, except earth faults in other electric circuits

[SOURCE: IEC 60050-826:2004, 826-12-32, modified – Note has been deleted.]

3.1.2.22
<electrically> protective obstacle
part preventing unintentional direct contact, but not preventing direct contact by deliberate action

[SOURCE: IEC 60050-195:1998, 195-06-16]

3.1.2.23
power circuit
circuit carrying the current of the machines and equipment, such as the converters and traction motors, which transmit the traction output

[SOURCE: IEC 60050-811:2017, 811-25-03]

3.1.2.24
protective conductor
conductor provided for purposes of safety, for example protection against electric shock

[SOURCE: IEC 60050-195:1998, 195-02-09]

3.1.2.25
protective-equipotential-bonding
equipotential bonding for the purposes of safety

[SOURCE: IEC 60050-195:1998, 195-01-15]

3.1.2.26
SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and
– under single fault conditions, including earth faults in other electric circuits

[SOURCE: IEC 60050-826:2004, 826-12-31, modified – Note has been deleted.]

3.1.2.27

total insulation
insulation composed of basic insulation as provision for basic protection, and supplementary insulation as provision for fault protection, or providing basic and fault protection by reinforced insulation, in accordance with IEC 61140:2016, 7.4

[SOURCE: IEC 60050-851:2008/AMD1:2014, 851-15-11, modified – “equipment with” has been replaced with “insulation composed of” and “IEC 61140:2011,7.3” has been replaced with “IEC 61140:2016,7.4”.]

3.1.2.28
Unit <electrically connected>
minimum operational formation comprising one or more vehicles coupled together

3.2 Abbreviated terms

AC Alternating Current
DC Direct Current
ELV Extra Low Voltage
EMU Electric Multiple Unit
PELV Protective Extra Low Voltage
RMS root-mean-square value (effective value)
SELV Safety Extra Low Voltage

4 Classification of voltage bands

4.1 General principles

In this document, the applicable protective measures are based on the highest value of the nominal supply voltage which the equipment or the electrical circuits are subjected to.

The voltages are classified into bands according to the nominal value as shown in Table 1. Different rules apply to each of these bands.

The power supply of the various circuits installed in railway rolling stock can be from different sources such as:

– batteries,
– transformers,
– voltage dividers,
– rotating machines,
– static converters,
– capacitors,
– special sources.

Table 1 – Voltage bands

Band	Nominal voltage U_n	
	AC V	DC V
I	$U \leq 25$	$U \leq 60$
II	$25 < U \leq 50$	$60 < U \leq 120$
III	$50 < U \leq 1\,000$	$120 < U \leq 1\,500$
IV	$U > 1\,000$	$U > 1\,500$

NOTE The special national conditions for France are listed in Annex B, Clause B.2.

4.2 Connections between circuits

Circuits operating at different nominal voltages connected by power conversion equipment which provides a sufficient insulation between them are individually classified at the nominal voltage of each circuit.

If the conducting paths referred to in this subclause include capacitive or inductive connections, whose impedance is low enough to induce hazardous voltages into any circuit under either normal or fault conditions, then all the circuits so connected are classified at the nominal voltage of the highest voltage circuit.

NOTE This condition can apply to circuits connected, for example, by means of a chopper converter with impedance coupling.

Where circuits are linked conductively to a higher voltage source other than directly by circuit bonds connected to the vehicle body (for example by an auto-transformer or potential divider), all circuits in the group are treated as if energized at the nominal voltage of the source, unless the conditions of 4.3 have been met.

4.3 Exceptions

If voltage conversion from one band to another involves overvoltage detection resulting in disconnection of the primary or the secondary circuit, or having other means capable of preventing excessive voltage in the secondary circuit, then the secondary circuit is permitted to be classified according to the highest voltage at which the detection equipment will operate. Where overvoltage detection is used the integrity of the equipment should be evaluated as appropriate.

Circuits not connected to the vehicle body, for example floating supplies, are permitted to be classified in any voltage band. The band selected should be appropriate, taking due account of the various potentials possible in such circuits under normal or fault conditions so as to ensure that the requirements of this document are met.

The limit between bands III and IV is allowed to be lowered to take account of special national conditions.