



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS E 5051 : 2009

(JARI/JSA)

Rolling stock — Protective provisions against electrical hazards

ICS 45.060.01

Reference number : JIS E 5051 : 2009 (E)

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E 5051 : 2009

Date of Establishment: 2009-04-20

Date of Public Notice in Official Gazette: 2009-04-20

Investigated by: Japanese Industrial Standards Committee
Standards Board

Technical Committee on Railways and Rolling Stock

JIS E 5051 : 2009, First English edition published in 2010-09

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Land, Infrastructure, Transport and Tourism through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard by Japan Association of Rolling Stock Industries (JARI) /Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

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Rolling stock — Protective provisions against electrical hazards

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of **IEC 61991** published in 2000, with some modifications of the technical contents such as addition of terms and definitions in response to the actual situation in Japan, deletion of tables regarding voltage bands applied only in specific European countries, and addition of a provision regarding railways of ungrounded rail system.

The portions with dotted underlines and Annex JA are the matters that are not given in the corresponding International Standard. A list of such modifications, along with their explanations, is given in Annex JB.

1 Scope

This Standard offers a set of rules that are applied in the design and manufacture of electrical installations and equipment to be used on rolling stock so as to protect the persons from electric shocks.

This Standard is applicable to vehicles of rail transport systems, road vehicles powered by an external supply (trolley buses), magnetic levitated vehicles and to the electrical equipment installed in these vehicles.

This Standard does not apply to

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

Testing of vehicles against the requirements of this Standard is not included.

NOTE 1 For the relevant tests, see **JIS E 4041**.

NOTE 2 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 Standard, in several instances, leaves a choice to the contracting parties [e.g the user or the purchaser and the manufacturer (hereafter referred to as “contracting parties”)] between the alternatives which consist either in :

- a) the provision of operating rules, regulations and procedures in the instruction manual; or in
- b) the application of technical measures such as mechanical or elec-

trical interlocking devices.

A list of the cases for which the contracting parties shall reach agreement before signing the contract is included in Annex A.

NOTE 3 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows :

IEC 61991 : 2000 *Railway applications — Rolling stock — Protective provisions against electrical hazards* (MOD)

The symbols which denote the degree of correspondence in the contents between **JIS** and the corresponding International Standard are IDT (identical), MOD (modified) and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. For standards with the year indication, only the editions of the indicated year shall be applied and any revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent edition (including amendments) shall be applied.

JIS B 9706-1 *Safety of machinery — Indication, marking and actuation — Part 1 : Requirements for visual, acoustic and tactile signals*

NOTE : Corresponding International Standard : **IEC 61310-1** *Safety of machinery — Indication, marking and actuation — Part 1 : Requirements for visual, acoustic and tactile signals* (IDT)

JIS C 0920 *Degrees of protection provided by enclosures (IP Code)*

NOTE : Corresponding International Standard : **IEC 60529** *Degrees of protection provided by enclosures (IP Code)* (IDT)

JIS C 60364-4-41 : 2006 *Electrical installations of buildings — Part 4-41 : Protection for safety — Protection against electric shock*

NOTE : Corresponding International Standard : **IEC 60364-4-41** : 2001 *Electrical installations of buildings — Part 4-41 : Protection for safety — Protection against electric shock* (IDT)

JIS E 4001 *Railway rolling stock — Vocabulary*

JIS E 5004-1 : 2006 *Electric equipment for rolling stock — Part 1 : General service conditions and general rules*

NOTE : Corresponding International Standard : **IEC 60077-1** : 1999 *Railway applications — Electric equipment for rolling stock — Part 1 : General service conditions and general rules* (MOD)

IEC 60364 (all parts) *Electrical installations of buildings*

IEC 60439 (all parts) *Low-voltage switchgear and controlgear assemblies*

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

IEC 61140 *Protection against electric shock — Common aspects for installation and equipment*

IEC 62128-1 *Railway applications — Fixed installations — Part 1 : Protective provisions relating to electrical safety and earthing*

IEC 62128-2 *Railway applications — Fixed installations — Part 2 : Protective provisions against the effects of stray currents caused by d.c. traction systems*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions in JIS E 4001 and the following apply. For more information relating to definitions of parts of the fixed installations, refer to IEC 62128-1 and IEC 62128-2 from which these definitions are derived.

3.1 Terms and definitions concerning persons involved

3.1.1 skilled person

person who can judge the work assigned to him and recognize possible dangers on the basis of his professional training, knowledge and experience and of his knowledge of the relevant requirements

Generally, a person with reasonable experience, familiarity with electrical safety and ability to predict dangers.

3.1.2 instructed person

person informed about the tasks assigned to him and about possible dangers involved in neglectful behaviour and who, if necessary, has been given a degree of training

Generally, a person who has been given a degree of safety training and work instructions.

NOTE : The divisions as defined in 3.1.1 and in 3.1.2 are for sorting out the railway authorities, manufacturers and those who are engaged in maintenance work from the aspects of knowledge and ability concerning electrical hazards — they do not represent actual roles that are certified by specific official qualification procedures.

3.1.3 ordinary person

any person who cannot be defined either as a in 3.1.1 or as in 3.1.2

3.2 Other terms and definitions

3.2.1 closed electrical operating area

any 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 Access to such areas is permitted only to skilled persons and instructed

persons.

NOTE 2 The definition of closed electrical operating area can be suitable for underfloor or upper roof cabinets. Generally speaking it is any location (inside or outside the car body) which is kept secure because of the voltage that can assume the equipment inside it. Access to such areas is not allowed to ordinary persons.

3.2.2 contact line

conductor system for supplying electrical energy to vehicles through current-collecting equipment

3.2.3 contact wire

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

3.2.4 direct contact

contact of persons or livestock with live parts

3.2.5 earth

conductive mass of the earth, or the state in which electrical equipment is being connected to it

Its electrical potential at any point is conventionally taken as equal to zero.

3.2.6 electrical operating area

any room or location which serves primarily for the operation of electrical equipment and is normally entered only by skilled persons or instructed persons

NOTE : The electrical operating area can be any operator's room, machine and/or equipment room not specially closed which is kept secure because of the voltage that can assume the equipment inside the cabinet. Access to such areas is not allowed to ordinary persons.

3.2.7 electric shock

dangerous physiological effect resulting from the passing of an electric current through a human or animal body

3.2.8 exposed conductive part

any metallic or other form of conductive material which is not energized except in case of failure, and which may be accessible to touch by persons or livestock

3.2.9 failure

termination of the ability of an item to perform a required function

3.2.10 electrical hazard

condition that can lead to a potential accident or an actual accident

3.2.11 indirect contact

contact of persons or livestock with exposed conductive parts which have become live under fault conditions

3.2.12 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

3.2.13 live part

conductor or conductive part intended to be energized in normal use, including a neutral conductor

3.2.14 nominal voltage

voltage by which an installation or part of an installation is designated

NOTE 1 The voltages are expressed by the value between poles, ripple-free for d.c., and by the r.m.s. value between phases for a.c.

NOTE 2 The actual voltage may differ from the nominal voltage by a quantity within permitted tolerances. For further information about traction systems supply voltages, see table 0A of JIS E 5004-1 or IEC 60850.

3.2.15 obstacle

part preventing unintentional direct contact of persons or livestock to any live parts or exposed conductive parts, but not preventing direct contact by deliberate action

3.2.16 power circuit

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

3.2.17 protective bonding

equipotential connection for protective purposes

3.2.18 protective conductor

conductor used for some protective measures for protection against electric shock for electrically connecting any of the following parts :

- exposed conductive parts ;
- main earthing terminal ;
- earth electrode ;
- earthed point of the source or artificial neutral.

NOTE : In Japanese railway electrification systems using iron wheels and iron rails, the running rails are the basic protective conductors. In the case of rubber tyre railways and levitated railways having no protective conductor, parts of their vehicle body that are securely earthed while the passengers are getting on and getting off the train are regarded as the protective conductors.

4 Classification of voltage bands

4.1 General principles

This Standard is based on the maximum supply voltages at which the equipment or electrical circuits are subjected.

The voltages are classified into bands according to the nominal value as shown in

table 1. Different installation rules apply to each of these bands.

NOTE : For the voltage bands applied in France, Italy, etc., see table 2 and table 3 of IEC 61991.

The power supply of the various circuits installed in railway rolling stock are of different types such as

- batteries ;
- transformers ;
- voltage dividers ;
- rotating machines ;
- static converters ;
- capacitors ;
- special sources.

Table 1 Nominal voltage of each

Unit : V

Band	Nominal voltage U	
	AC	DC
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	$1\,000 < U$	$1\,500 < U$

4.2 Connections between circuits

Circuits operating at different nominal voltages connected by power conversion equipment which does not provide a conducting path between them, or circuits which are linked only by a connection direct to the vehicle body external to the power conversion circuitry, shall be individually classified at the nominal voltage of each circuit.

NOTE 1 A circuit insulated with a transformer, etc. is included in such circuits.

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 shall be classified at the nominal voltage of the highest voltage circuit.

NOTE 2 The condition in NOTE 1 can apply to circuits connected, for example, by means of a chopper convertor with impedance coupling.

Where circuits are linked conductively to a higher voltage source other than simply by circuit bonds connected to the vehicle body (for example by an auto-transformer or potential divider), all circuits in the group shall be 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 shall be classified according to the highest voltage at which the detection equipment will operate.

NOTE : The integrity of the detection equipment should be taken into account.

Circuits not connected to the vehicle body, for example floating supplies, shall be classified as appropriate in order to ensure that the requirements of this Standard are met, taking due account of the potentials possible in such circuits under normal or fault conditions.

5 Protective provisions against direct contact

5.0A General principles

Live parts capable of causing an electric shock shall be protected against direct contact. All types of equipment shall be capable of being operated without loss of protection against direct contact. Protection against direct contact shall be provided by at least one of the means described in 5.1 to 5.3, supplemented as necessary by warning labels as described in 5.4.

5.1 Protection by insulation

In addition to the requirements of JIS E 5004-1, the insulating materials used to cover live parts shall be appropriate to the nominal equipment operating voltage and the conditions of use. Further provisions should be considered in order to minimize the consequences of damage and to reinforce the insulation.

5.2 Protection by prevention of access

Access to live parts shall be prevented by placing them within closed electrical operating areas or by placing them out of reach. The rest of this Standard explains the measures required.

5.2.1 Voltages in bands I to III

NOTE : See 5.3 for the protection when only voltage band I is employed.

5.2.1.1 Protection by the use of closed electrical operating areas

Live parts within the vehicle, energized with voltages in bands I to III, shall be contained within closed electrical operating areas.

Access to closed electrical operating areas containing energized live parts is permitted as follows :

- band I and II : access is permitted to instructed persons and skilled persons ;
- band III : access is only permitted to instructed persons and skilled persons pro-