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**Railway applications—Fixed
installations—DC switchgear—
Part 1: General**

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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 submitted by Railway Electrical Engineering Association of Japan (REEAJ)/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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JIS E 2501 series consists of the following two parts under the general title “*Railway applications—Fixed installations—DC switchgear*”:

Part 1: General

Part 2: DC circuit-breakers

Railway applications— Fixed installations—DC switchgear— Part 1: General

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **IEC 61992-1** published in 2006 with some modifications of the technical contents to include the specifications of standards used in Japan.

The portions given continuous sidelines or dotted underlines in this Standard are the matters in which the contents of the original International Standard have been modified. A list of modifications with explanations is given in Annex JA.

1 Scope

This Standard specifies general requirements for d.c. switchgear and controlgear (hereafter referred to as “switchgear”) which supply electrical power to railway rolling stocks and are intended to be used in fixed electrical installations with nominal voltage not exceeding 3 000 V d.c.

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

IEC 61992-1:2006 *Railway applications—Fixed installations—DC switchgear—Part 1: General* (MOD)

The symbols which denote the degree of correspondence (MOD) in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified) and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 4003 *Electrical insulation—Thermal evaluation and designation*

NOTE : Corresponding International Standard: IEC 60085 *Electrical insulation—Thermal evaluation and designation* (IDT)

JIS C 8269-1 *Low-voltage fuses—Part 1: General requirements*

NOTE : Corresponding International Standard: IEC 60269-1 *Low-voltage fuses—Part 1: General requirements* (IDT)

JIS E 2501-2 *Railway applications—Fixed installations—DC switchgear—Part 2: DC circuit-breakers*

NOTE : Corresponding International Standard: IEC 61992-2 *Railway applications—Fixed installations—DC switchgear—Part 2: DC circuit-breakers* (MOD)

- IEC 60850 Railway applications—Supply voltage of traction systems
- IEC 61992-3 *Railway applications—Fixed installations—DC switchgear—Part 3: Indoor d.c. disconnectors, switch-disconnectors and earthing switches*
- IEC 61992-4 *Railway applications—Fixed installations—DC switchgear—Part 4: Outdoor d.c. disconnectors, switch-disconnectors and earthing switches*
- IEC 61992-5 *Railway applications—Fixed installations—DC switchgear—Part 5: Surge arresters and low-voltage limiters for specific use in d.c. systems*
- IEC 61992-6 *Railway applications—Fixed installations—DC switchgear—Part 6: DC switchgear assemblies*
- EN 50124-1 *Railway applications—Insulation coordination—Part 1: Basic requirements—Clearances and creepage distances for all electrical and electronic equipment*

3 Terms and definitions

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

NOTE : The definitions cited from **IEC 60050-441** (IEV) and **IEC 60050-811** (IEV) without modification are included. In this case, the referenced **IEV** number is given in parentheses after the term (first three digits indicate the chapter number of **IEV**). When the definitions are modified from the definition of **IEV**, the word “modified” is attached after the referenced **IEV** number.

3.1 General terms

3.1.1 switchgear

general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment; it covers also assemblies of such devices and equipment with associated interconnections, accessories, enclosures (see **3.3.13**) and supporting structures

3.1.2 d.c. switchgear and controlgear assembly

combination of one or more d.c. switching devices together with associated control, measuring, signalling, protective, regulating equipment, etc. completely assembled under the responsibility of the supplier, with all the internal electrical and mechanical interconnections and structural parts

NOTE 1 Throughout **JIS E 2501** series, the abbreviation “switchgear assembly” is used for a d.c. switchgear and controlgear assembly.

NOTE 2 An enclosure, but not an integral enclosure, when housing a switching device (see **3.1.3**) and some associated controlgear, may be considered a switchgear assembly.

3.1.3 switching device (441-14-01)

device designed to make or break the current in one or more electric circuits

3.1.4 d.c. circuit-breaker

switching device capable of making, carrying and breaking direct currents under normal circuit conditions and also making, carrying (up to a specified limit and for a specified time) and breaking currents under specified abnormal conditions, such as those of short-circuit

3.1.5 d.c. disconnecter

mechanical switching device, which provides, in the open position, for safety reasons, an isolating distance (see 3.3.6) in accordance with specified requirements

A disconnecter is only able to make or break current of very limited magnitude such as those arising from electrostatic charging or discharge across undamaged insulation. The ability to make or break minimum currents due to eventual marginal transient conditions of the network is subject to agreement between purchaser and supplier.

NOTE 1 The disconnecter is capable of opening and closing a circuit when either negligible d.c. current is broken or made, or when no significant change in the voltage across the terminals of the disconnecter occurs. It is also capable of carrying d.c. currents under normal circuit conditions and carrying, for a specified time, currents under abnormal conditions such as those of short-circuit.

NOTE 2 A disconnecter is not suitable for making or breaking load current, fault current or other current arising from the effects of lightning or transient phenomena.

3.1.6 switch-disconnector

mechanical switching device capable of making, carrying and breaking currents in normal circuit conditions and, when specified, in given operating overload conditions

In addition, it is able to carry, for a specified time, currents under specified abnormal circuit conditions, such as short-circuit conditions. Moreover, it complies with the requirements for a disconnecter.

NOTE 1 When specified, a switch-disconnector may be designed for making short-circuit currents, but not for breaking the same.

NOTE 2 Outdoor switch-disconnectors, in given special conditions, may be required to be suitable for breaking overload currents of specified amplitude.

3.1.7 earthing switch (441-14-11)

mechanical switching device for earthing parts of the circuit, capable of withstanding for a specified time, currents under abnormal conditions such as those of short circuit, but not required to carry current under normal conditions of the circuit

NOTE : An earthing switch may have a short-circuit making capacity (see 3.2.30).

3.1.8 low-voltage limiter

device intended to be in parallel in those parts of a traction system where overvoltages are expected having the function of limiting the voltage to predetermined values

3.1.9 d.c. sensor

device used for detecting a current or a voltage in a d.c. main circuit, which produces an output signal, proportional to and linear (over a range) with the primary input, for connection to a secondary device which acts on the signal

3.1.10 d.c. shunt

device connected in the primary circuit, usually composed of metal grids, that provides a millivolt output proportional to the current following in the primary circuit

3.1.11 isolating transducer

device which is interposed between the output of a sensor in the main circuit and the input of a secondary device used for measurement or protection, and used to provide an output isolated from the main circuit and, usually, at lower voltage

3.1.12 operation

motion of the moving contact(s) from one position to another position, for example open to close or open to earth

NOTE 1 This may be a closing operation or an opening operation.

NOTE 2 If a distinction is necessary, the terms “electrical operation” (for example make and break) and “mechanical operation” (for example closing and opening) should be used.

NOTE 3 The position of a switching device where the continuity of the main circuit is assured is indicated as “close” position.

NOTE 4 The position of a switching device where the prescribed distance between the contacts of the switching device is assured is indicated as “open” position.

3.1.13 operating cycle (of a mechanical switching device) (441-16-02)

succession of operations from one position to another and back to the first position through all other positions, if any

3.1.14 dependent manual operation (of a mechanical switching device) (441-16-13)

operation solely by means of directly applied manual energy, such that the speed and force of the operation are dependent upon the action of the operator

3.1.15 stored energy operation (of a mechanical switching device) (441-16-15)

operation by means of energy stored in the device itself prior to the completion of the operation and sufficient to complete it under predetermined conditions

NOTE : This kind of operation may be subdivided according to

- the energy storage mode (spring, weight, etc.);
- the origin of the energy (manual, electric, etc.);
- the energy releasing mode (manual, electric, etc.).

3.1.16 independent manual operation (of a mechanical switching device) (441-16-16)

stored-energy operation where the energy originates from manual power, stored and released in one continuous operation, in such a way that the speed and force of the operation are independent from the action of the operator

3.1.17 independent power operation

operation by means of energy where the energy originates from an external power source and is released in a single continuous operation, in such a way that the speed and force of the operation are independent from the action of the operator

3.1.18 utilisation category (of a switching device) (441-17-19, modified)

combination of specified requirements related to the condition in which the switching device fulfils its purpose, selected to represent a characteristic group of practical applications

NOTE : The specified requirements may concern, for example the values of the making capacities, if applicable, breaking capacities and other characteristics, the associated circuits and the relevant conditions of use and behaviour. The term “duty” used elsewhere in the standard corresponds to a particular aspect of the utilisation category.

3.1.19 unidirectional switching device

switching device (for example a circuit-breaker), the purpose of which is to interrupt d.c. current which is flowing in a prescribed direction through that device, and which is identified accordingly

3.1.20 bidirectional switching device

switching device (for example a circuit-breaker), the purpose of which is to interrupt d.c. current which flows in either direction through that device, and which is identified accordingly

NOTE : Proof of bidirectional ability is included in the interrupting type tests.

3.2 Performance characteristics

3.2.1 nominal voltage, U_n

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

3.2.2 highest system voltage, U_{max}

highest value given for the voltage in the continuous operating conditions U_{max1} specified in **IEC 60850**

3.2.3 rated insulation voltage, U_{Nm}

maximum value of the d.c. voltage for which the equipment is designed in respect to its insulation

3.2.4 rated voltage, U_{Ne}

voltage value, given by the manufacturer, which, combined with rated service current, determines the utilisation of the equipment and to which the corresponding tests and utilisation categories, if any, relate

NOTE : The rated voltage may differ from the nominal voltage by a quantity within permitted tolerances in accordance with **IEC 60850**.

3.2.5 rated auxiliary and control supply voltage

voltage measured at the circuit terminals of the apparatus during its operation, including, if necessary, the auxiliary resistors or accessories supplied or required by the manufacturer to be installed in series with it, but not including the conductors to the electrical supply

3.2.6 rated impulse withstand voltage, U_{Ni}

peak value of an impulse voltage of prescribed form and polarity which the equipment is capable of withstanding to, without failure, under the specified test conditions

3.2.7 power-frequency withstand voltage, U_a

power-frequency test voltage level which, when withstood by the equipment, proves the integrity of its insulation in operating conditions

3.2.8 recovery voltage, U_r (441-17-25, modified)

voltage which appears across the terminals of a switching device after the breaking of the current

3.2.9 maximum arc voltage, $\hat{U}_{arc}$

maximum voltage appearing across the switching device during arcing

3.2.10 prospective current (441-17-01, modified)

current that would flow in the circuit if the device was replaced by a conductor of negligible impedance

NOTE : The prospective current may be qualified in the same way as a real current: prospective broken current, peak value of the prospective current, etc.

3.2.11 conventional free-air thermal current, I_{th}

current which may be used for the temperature-rise test of an equipment in free-air

This value is equal to or greater than the maximum value of the rated service current I_{Ne} of the equipment.

NOTE 1 Free-air is the indoor air existing in normal conditions, reasonably free from dust and external radiations.

NOTE 2 A free-air device is a device supplied by the manufacturer without an enclosure (see **3.3.13**) or a device supplied by the manufacturer with an integral enclosure (see **3.3.14**).

3.2.12 conventional enclosed thermal current, I_{the}

current which may be used for the temperature-rise tests of the equipment when mounted in a specified enclosure

This value is equal to or greater than the maximum value of the rated service current I_{Ne} of the enclosed equipment.

3.2.13 rated service current, I_{Ne}

value of current stated by the manufacturer taking into account the rated voltage (see 3.2.4), the continuous duty and the utilisation category (see 3.1.18) and the protective enclosure type, if any

NOTE 1 Any current exceeding I_{Ne} is an overload condition.

NOTE 2 If a load cycle is specified by the purchaser, it should define the steady-state currents before and after the load cycle. If the temperature-rises resulting from the load cycle exceed the temperature-rise limits, then a higher rated service current needs to be used.

3.2.14 rated short-time withstand current, I_{Ncw}

current that a circuit or a switching device in the closed position can carry, during a specified short time under prescribed conditions of use and behaviour

3.2.15 rated earth fault current (of a switchgear assembly), I_{Ncwe}

maximum short-time withstand current which can be carried in the earthing circuit

3.2.16 short-circuit current, I_{ss}

prospective sustained current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit

3.2.17 rated short-circuit current, I_{Nss}

maximum value of the prospective sustained short-circuit current that the device will carry

3.2.18 peak of the short-circuit current, $\hat{I}_{ss}$

peak prospective value of the short-circuit current under transient conditions

3.2.19 cut-off current (441-17-12, modified)

maximum instantaneous value of current attained during the breaking operation of a switching device

3.2.20 circuit time constant, t_c

value of the ratio of inductance over resistance of the circuit

3.2.21 track time constant (of a line), T_c

time constant of the track itself plus all parts on the load side of a switching device, including the contact line (overhead contact line or third rail), the return circuit and any low-frequency or high-frequency impedance bonds

3.2.22 rated track time constant (of a switching device), T_{Nc}

conventional value assigned to a switching device describing the capability of the device to break inductive short-circuit currents under specified conditions

3.2.23 source time constant, T_s

time constant of the d.c. source on the incoming supply side of a switching device, including the a.c. supply network, the rectifier conversion equipment, smoothing reactors, the d.c. connections in the substation and the feeder and return connections between substation and track

3.2.24 breaking current

current of a switching device at the instant of initiation of the contact separation during a breaking process

3.2.25 breaking capacity (441-17-08, modified)

value of the prospective breaking current that a switching device is capable of breaking at a stated voltage and under prescribed conditions of use and behaviour

NOTE : For short-circuit breaking capacity, see **3.2.26**.

3.2.26 rated short-circuit breaking capacity

breaking capacity for which prescribed conditions include a short circuit at the load terminals of the switching device

3.2.27 critical current, I_c

value of breaking current, less than the rated short-circuit breaking current, at which the arcing time is a maximum and is significantly longer than at the rated short-circuit breaking current

It can be a current or a range of currents which produce this effect, see Annex C.

3.2.28 maximum circuit-energy short-circuit current, $I_{\max E}$

rated short-circuit current of a short-circuit having the maximum possible value of circuit energy, which normally occurs at a short distance along the track from the substation

3.2.29 making capacity (441-17-09)

value of the prospective making current that a switching device is capable of making at a stated voltage, under prescribed conditions of use and behaviour

NOTE : For short-circuit making capacity, see **3.2.30**.

3.2.30 rated short-circuit making capacity

making capacity for which the prescribed conditions include a short circuit at the load side terminals of the switching device

3.2.31 distant fault short-circuit

short circuit at a position remote from the switching device interrupting the fault

3.2.32 ambient air temperature (of a switchgear)

temperature, determined under prescribed conditions, of the air surrounding the enclosure or switchgear

3.3 Components

3.3.1 component

essential part of the switchgear which serves a specific function (for example, circuit-breaker, disconnecter, switch, fuse, shunt, voltage and current transducers, bushing, busbar, etc.)

3.3.2 conductive part (441-11-09)

part which is capable of conducting current, although it may not necessarily be used for carrying service current

3.3.3 live part

conductor or conductive part intended to be energised in normal use, including, if applicable, the return conductor

NOTE : The return circuit of the switchgear may be considered as either a live or an earthed part. The rated insulation voltage of the return circuit is stated by the purchaser.

3.3.4 clearance

distance between two conductive parts along a string stretched along the shortest distance between these conductive parts

3.3.5 clearance between open contacts

distance between the contacts, or any conductive part connected to the contacts, of a mechanical switching device in the open position

3.3.6 isolating distance

clearance between open contacts satisfying the safety requirements specified for switching devices

3.3.7 creepage distance

shortest distance along the surface of the insulating material between two conductive parts

NOTE : A seal between two portions of insulating material is considered to be a part of the surface.

3.3.8 main circuit (of a switching device)

all conductive parts of a switching device included in the circuit which is designed to close and open

3.3.9 main contact (of a mechanical switching device)

contact included in the main circuit of a mechanical switching device, intended to carry, in the close position, the current of the main circuit

3.3.10 arcing contact

contact on which the arc (if any) is intended to be established

NOTE : An arcing contact may serve as a main contact: it may be a separate contact so designed that it opens after, and closes before, another contact which it is intended to protect from damage.

3.3.11 control circuit (of a switching device)

conductive parts of a switching device, other than those parts forming the main circuit, forming a circuit used to control and actuate the making and breaking operations of the switching device

3.3.12 auxiliary circuit (of a switching device)

conductive parts of a switching device forming a circuit differing from the main circuit and the control circuit

3.3.13 enclosure

part providing a specified degree of protection of the equipment against certain external influences specified and a specified degree of protection against approach to or contact with live parts and against contact with moving parts

NOTE : For degrees of protection, see **JIS C 0920**.

3.3.14 integral enclosure

enclosure which forms an integral part of the equipment

3.4 Terms relating to d.c. circuit-breakers, switch-disconnectors and associated relays

3.4.1 air d.c. circuit-breaker

d.c. circuit-breaker which exclusively operates by means of contacts which open and close in air at atmospheric pressure

3.4.2 semiconductor circuit-breaker

circuit-breaker designed to make and/or break the current in an electric circuit by means of the controlled conductivity of a semiconductor

NOTE : There may be mechanical contacts associated with these semiconductor devices.

3.4.3 vacuum d.c. circuit-breaker

circuit breaker which is designed to make and/or break the current in a d.c. circuit in vacuum in combination with commutation device (see **3.4** of **JIS E 2501-2**)

3.4.4 line circuit-breaker, type L

circuit-breaker used to connect or disconnect a power line circuit to a d.c. source of supply

The power line circuit is that circuit which transmits the electrical energy to the electrical machines and traction equipment on the vehicles. These circuit-breakers are fitted with electrical protection and tripping devices. Line circuit-breakers are used to disconnect the track line from the energised busbar.

NOTE : Line circuit-breakers are always trip-free circuit-breakers (see **3.4.11**).

3.4.5 rectifier circuit-breaker, type R

circuit-breaker that connects the output of the rectifier to the energised busbar of the switchboard

NOTE 1 Rectifier circuit-breakers are fitted with a reverse series trip device to disconnect the rectifier from the d.c. busbar in the event of a rectifier fault.

NOTE 2 The terms “forward” and “reverse” relate to the normal flow of energy.

3.4.6 interconnecting circuit-breaker, type I

circuit-breaker used to couple or uncouple different portions of the contact line network

NOTE : These circuit-breakers are sometimes called bus-section or section circuit-breakers.

3.4.7 high speed current limiting circuit-breaker, type H

circuit-breaker with a break time sufficiently short to prevent the short-circuit current reaching the peak value it would have attained without interruption

3.4.8 very high-speed current-limiting circuit-breaker, type V

circuit-breaker in which the opening time is shorter than that of type H (For its characteristics, see 5.2 of JIS E 2501-2.)

3.4.9 semi-high speed circuit-breaker, type S

circuit-breaker in which interruption of the current is ensured, but no current limitation may take place

3.4.10 tripping (operation)

opening operation of a switching device initiated by a relay or release

3.4.11 trip-free circuit-breaker

circuit-breaker in which the moving contacts return to and remain in the open position when the tripping operation is initiated after the initiation of the closing operation, even if the closing command is maintained

NOTE : To ensure proper breaking of the current which may have been established, it may be necessary that the contacts momentarily reach the closed position.

3.4.12 release (of a mechanical switching device)

device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or closing of the switching device

NOTE 1 The term “release” refers here to any device, with mechanical action, used for a tripping operation, when the specified conditions are met in the input electrical circuits of the device.

NOTE 2 A circuit-breaker can have several releases, each becoming operational according to specified conditions.

NOTE 3 A release can be made up of mechanical, electromagnetic or electronics parts.

3.4.13 relay (of a mechanical switching device)

device, electrically connected to a release fitted on the operating mechanism of a switching device, which permits the operation of the switching device

NOTE 1 The term “relay” refers here to any device, with electrical action, used for actuating a tripping operation, when the specified conditions are met in the input electrical circuits of the device.