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(JEMA/JSA)

**AC load break switches for rated voltages
above 1 kV up to and including 52 kV**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Electrical Manufacturers' Association (JEMA)/Japanese Standards Association (JSA) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act. This edition replaces the previous edition (**JIS C 4605 : 1998**), which has been technically revised.

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AC load break switches for rated voltages above 1 kV up to and including 52 kV

Introduction

This Japanese Industrial Standard has been prepared based on **IEC 62271-103** : 2011, Edition 1, with some modifications of the technical contents in consideration of the power distribution system in Japan and the product form indigenous to Japan.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JI. Annex JA to Annex JH are unique to **JIS** and not given in the corresponding International Standard.

1 Scope and normative references

1.1 Scope

This Standard is applicable to three-phase, alternating current switches and switch-disconnectors (hereafter referred to as switches), for indoor and outdoor installations, for rated voltages above 1 kV up to and including 52 kV and for rated frequencies 50 Hz and/or 60 Hz, which are manually operated or electrically operated.

This Standard is also applicable to three-phase, alternating current switches used on single-phase electric circuit.

This standard is also applicable to the operating devices of these switches and to their control equipment.

Switch-disconnectors are also covered by **JIS C 4606** : 2011 and **IEC 62271-102** : 2001 for their disconnecting function.

This Standard establishes requirements for switches used in distribution systems.

This Standard is not applicable to switches for capacitor, electric furnace, motor, etc., which is frequently opened and closed. However, when the number of opening and closing operations is within the scope of this Standard, this Standard is applicable to those switches as agreed between the interested parties.

It is assumed that opening and closing operations are performed according to the manufacturer's instructions. A breaking operation should not immediately follow a making operation since the current may exceed the rated breaking current of the switch immediately after the making operation even though the current is within the rated breaking current.

Earthing switches are not covered by this Standard. Earthing switches shall be in accordance with **IEC 62271-102** : 2001.

NOTE 1 Except where special clarification is required, the term "switch" is used to refer to all kinds of switches and switch-disconnectors within the

scope of this Standard.

NOTE 2 Since NOTE 2 given in the International Standard is a normative content, it has been moved to the main body.

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

IEC 62271-103 : 2011 *High-voltage switchgear and controlgear — Part 103 : Switches for rated voltages above 1 kV up to and including 52 kV (MOD)*

In addition, symbols which denote the degree of correspondence 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**.

1.2 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 the revisions (including amendments) made thereafter shall not be applied. For those without the indication of the year, the most recent editions (including amendments) shall be applied.

JIS C 0445 : 1999 *Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

NOTE Corresponding International Standard : IEC 60445 *Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

JIS C 0920 : 2003 *Degrees of protection provided by enclosures (IP Code)*

NOTE Corresponding International Standard : IEC 60529 : 1989 *Degrees of protection provided by enclosures (IP Code)*

JIS C 3316 : 2008 *Polyvinyl chloride insulated wires for electrical apparatus*

JIS C 3611 : 1991 *Insulated wires for cubicle type unit substation for 6.6 kV receiving*

JIS C 3801-1 : 1999 *Testing method for insulators — Part 1 : Insulators for overhead line*

JIS C 3801-3 : 1999 *Testing method for insulators — Part 3 : Hollow insulators*

JIS C 3802 : 1964 *Permissible limits of visual defects for insulating porcelains*

JIS C 4003 : 2010 *Electrical insulation — Thermal evaluation and designation*

JIS C 4606 : 2011 *Indoor use disconnectors for 3.3 kV or 6.6 kV*

JIS C 4902-1 *High voltage power capacitors and attached apparatus — Part 1 : Capacitors*

JIS C 60068-2 (all parts) *Environmental testing — Part 2 : Tests*

- NOTE Corresponding International Standard : IEC 60068-2 (all parts) *Environmental testing — Part 2 : Tests*
- JIS C 60068-2-1 : 2010 *Environmental testing — Part 2-1 : Tests — Test A : Cold*
- NOTE Corresponding International Standard : IEC 60068-2-1 *Environmental testing — Part 2-1 : Tests — Test A : Cold*
- JIS C 60068-2-2 : 2010 *Environmental testing — Part 2-2 : Tests — Test B : Dry heat*
- NOTE Corresponding International Standard : IEC 60068-2-2 *Environmental testing — Part 2-2 : Tests — Test B : Dry heat*
- JIS C 60068-2-30 : 2011 *Environmental testing — Part 2-30 : Tests — Test Db : Damp heat, cyclic (12 h + 12 h cycle)*
- NOTE Corresponding International Standard : IEC 60068-2-30 *Environmental testing — Part 2-30 : Tests — Test Db : Damp heat, cyclic (12 h + 12 h cycle)*
- JIS C 60068-2-78 : 2015 *Environmental testing — Part 2-78 : Tests — Test Cab : Damp heat, steady state*
- NOTE Corresponding International Standard : IEC 60068-2-78 : 2012 *Environmental testing — Part 2-78 : Tests — Test Cab : Damp heat, steady state*
- JIS C 60664-1 : 2009 *Insulation coordination for equipment within low-voltage systems — Part 1 : Principles, requirements and tests*
- NOTE Corresponding International Standard : IEC 60664-1 *Insulation coordination for equipment within low-voltage systems — Part 1 : Principles, requirements and tests*
- JIS C 60695-1 (all parts) *Fire hazard testing — Part 1 : Guidance for assessing the fire hazard of electrotechnical products*
- NOTE Corresponding International Standard : IEC 60695-1 (all parts) *Fire hazard testing — Part 1 : Guidance for assessing the fire hazard of electrotechnical products*
- JIS C 60695-7-1 : 1997 *Fire hazard testing — Part 7 : Guidance on the minimization of toxic hazards due to fires involving electrotechnical products Section 1 : General*
- NOTE Corresponding International Standard : IEC 60695-7 (all parts) *Fire hazard testing — Part 7 : Toxicity of fire effluent*
- JIS C 60721 (all parts) *Classification of environmental conditions*
- NOTE Corresponding International Standard : IEC 60721 (all parts) *Classification of environmental conditions*
- JIS H 8641 : 2007 *Hot dip galvanized coatings*
- JIS R 5210 : 2009 *Portland cement*
- JIS Z 8601 : 1954 *Preferred numbers*

JIS Z 8721 : 1993 Colour specification — Specification according to their three attributes

IEC 60060-1 : 1989 High-voltage test techniques — Part 1 : General definitions and test requirements

IEC 60071-1 : 2006 Insulation co-ordination — Part 1 : Definitions, principles and rules

IEC 60071-2 : 1996 Insulation co-ordination — Part 2 : Application guide

IEC 60417 : 2002 Graphical symbols for use on equipment

IEC 61180-1 : 1992 High-voltage test techniques for low voltage equipment — Part 1 : Definitions, test and procedure requirements

IEC 62271-1 : 2007 High-voltage switchgear and controlgear — Part 1 : Common specifications

IEC 62271-102 : 2001 High-voltage switchgear and controlgear — Part 102 : Alternating current disconnectors and earthing switches

IEC TR 60815 : 1986 Guide for the selection of insulators in respect of polluted conditions

2 Normal and special service conditions

2.0A General

Unless otherwise specified, switches, including the operating devices and the control equipment which form an integral part of them, are intended to be used in accordance with their rated characteristics and the normal service conditions listed in **2.1**.

If the actual service conditions differ from these normal service conditions, switches and associated operating devices and control equipment shall be designed to comply with any special service conditions required by the user, or appropriate arrangements shall be made (refer to **2.2**).

NOTE Detailed information on the classification of environmental conditions is specified in **JIS C 60721-3-3 : 1997** (indoor) and **JIS C 60721-3-4 : 1997** (outdoor).

2.1 Normal service conditions

2.1.1 Indoor switches

The standard service conditions of indoor switches shall be as follows.

- a) The ambient air temperature does not exceed 40 °C and its average value, measured over a period of 24 h, does not exceed 35 °C.

The preferred values of minimum ambient air temperature are −5 °C and −15 °C.

- b) The influence of solar radiation may be neglected.
- c) The altitude does not exceed 1 000 m.

- d) The ambient air is not significantly polluted by dust, smoke, corrosive and/or flammable gases, vapours or salt. The manufacturer will assume that, in the absence of specific requirements from the user, there are none.
- e) The conditions of humidity are as follows. For these conditions, condensation shall not occur. To withstand the effects of high humidity and condensation, such as breakdown of insulation or corrosion of metallic parts, outdoor switches designed for such conditions should be used.
 - The average value of the relative humidity, measured over a period of 24 h, does not exceed 95 %.
 - The average value of the relative humidity, over a period of one month, does not exceed 90 %.

Condensation can be expected where sudden temperature changes occur in periods of high humidity.

Condensation may be prevented by special design of the building or housing, by suitable ventilation and heating of the station or by the use of dehumidifying equipment.

NOTE 1 Since NOTE 1 to NOTE 3 given in the International Standard are normative and permissible contents, they have been moved to the main body.

- f) Vibrations due to causes external to the switch or earth tremors are insignificant relative to the normal operating duties of the switch. The manufacturer will assume that, in absence of specific requirements from the user, there are none.

NOTE 2 The interpretation of the term “insignificant” is the responsibility of the user or specifier of the switch. The user has determined either that there are no effects of vibration and earthquake, or that these risks are insignificant.

2.1.2 Outdoor switches

The standard service conditions of outdoor switches shall be as follows.

- a) The ambient air temperature does not exceed 40 °C and its average value, measured over a period of 24 h, does not exceed 35 °C.

The preferred values of minimum ambient air temperature are –10 °C and –20 °C.

Rapid temperature changes should be taken into account.

- b) Solar radiation up to a level of 1 000 W/m² (on a clear day at noon) should be considered. Under certain levels of solar radiation, appropriate measures, for example roofing, forced ventilation, etc., may be necessary, or derating may be used, in order not to exceed the specified temperature rises.

NOTE 1 Since NOTE 1 given in the International Standard is a permissible content, it has been moved to the main body.

NOTE 2 Details of global solar radiation are given in **JIS C 60721-2-4 : 1999**.

- c) The altitude does not exceed 1 000 m.
- d) The ambient air may be polluted by dust, smoke, corrosive gas, vapours or salt. The pollution does not exceed Pollution level II (medium) according to Table 1 of **IEC TR 60815** : 1986. For salt pollution, refer to “General service” in Table 0A.
- e) The ice coating shall be considered in the range from 1 mm up to, but not exceeding, 20 mm.
- f) The wind speed does not exceed 34 m/s (corresponding to 700 Pa on cylindrical surfaces).

NOTE 3 Characteristics of wind are described in **JIS C 60721-2-2** : 1996.

- g) Consideration should be given to condensation or precipitations that may occur.

NOTE 4 Characteristics of precipitation are defined in **JIS C 60721-2-2** : 1996.

- h) Vibrations due to causes external to the switch or earth tremors are insignificant relative to the normal operating duties of the switch. The manufacturer will assume that, in absence of specific requirements from the user, there are none.

NOTE 5 The interpretation of the term “insignificant” is the responsibility of the user or specifier of the equipment. Either the user is not concerned with seismic events, or his analysis shows that the risk is “insignificant”.

2.2 Special service conditions

When the switch is used under conditions different from the normal service conditions given in 2.1, the user's requirements should refer to standardized steps as follows. If the switch is used under special service conditions, the manufacturer shall respond by fulfilling the requirements prescribed by the user.

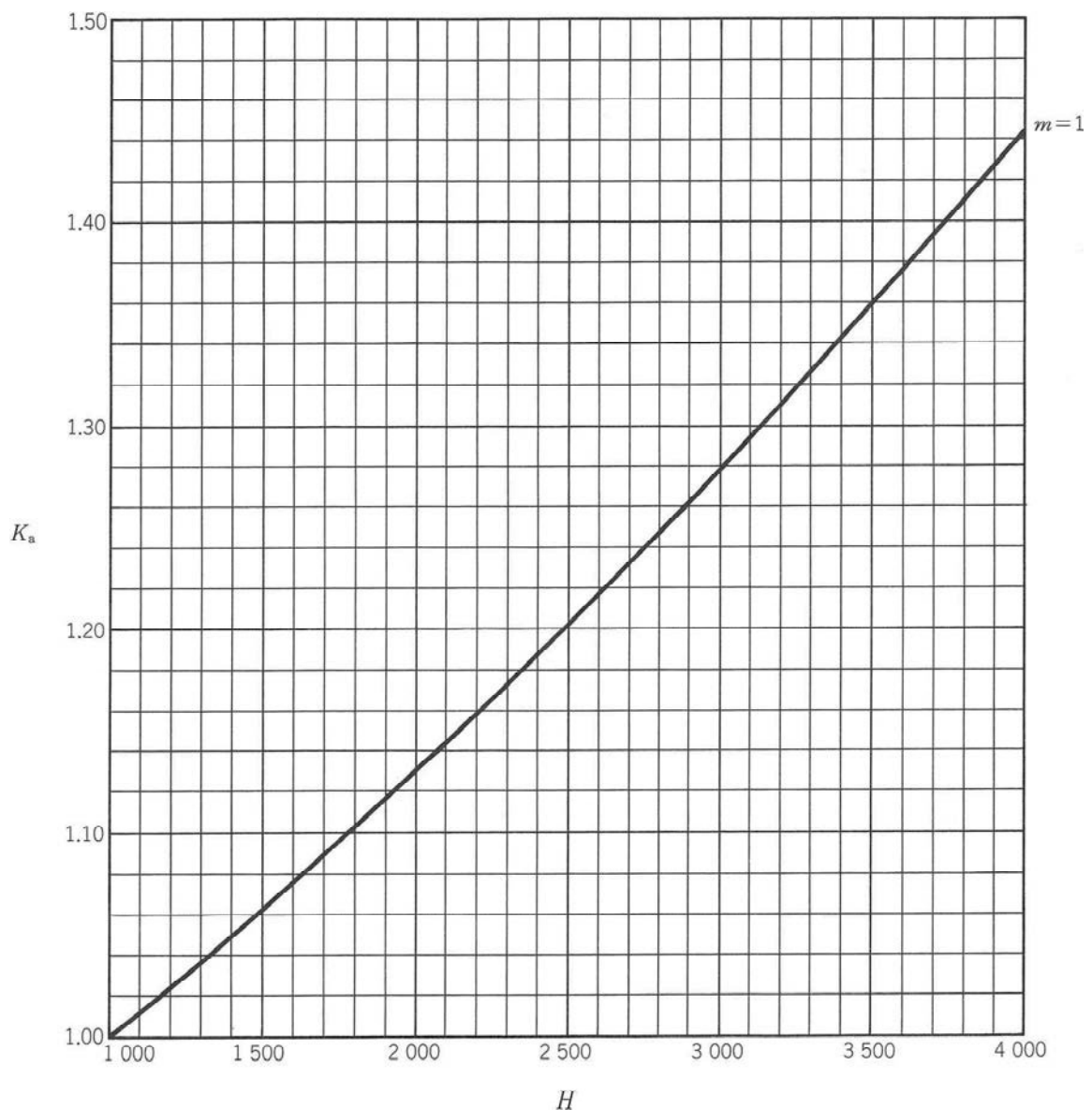
2.2.1 Altitude

For installations at an altitude higher than 1 000 m, the insulation withstand level of external insulation under standard atmospheric conditions shall be determined by multiplying the rated insulation levels at the service location by a factor K_a in accordance with Figure 0A.

For internal insulation, the dielectric characteristics are identical at any altitude and no special precautions need to be taken. For external and internal insulation, refer to **IEC 60071-2** : 1996.

For the control circuit, no special precautions need to be taken if the altitude is lower than 2 000 m. For higher altitudes, refer to **JIS C 60664-1** : 2009.

NOTE Since NOTE 1 and NOTE 2 given in the International Standard are normative contents, they have been moved to the main body.



The altitude correction factor can be calculated from 4.2.2 of IEC 60071-2 : 1996 with the following equation, which is modified to reflect that no correction is required for altitude 1 000 m or below :

$$K_a = e^{m(H-1\,000)/8\,150}$$

where, H : altitude (m)

m : $m = 1$ for power-frequency and lightning impulse withstand voltage tests

Figure 0A Altitude correction factor (corresponding to IEC 62271-1 : 2007, Figure 1)

2.2.2 Pollution

For the type of resistance to salt pollution and pollution level (equivalent salt deposit of polluted liquid), Table 0A should be applied.

Since the relationship between the pollution level and the approximate distance from

the shore depends on the topography and other factors, and there are large regional differences, installation should be performed with full consideration of these.

Table 0A Pollution level according to resistance to salt pollution

Classification	Pollution level (equivalent salt deposit) mg/cm ²		Approximate distance from the shore km	
	Switch external surface (incl. bushing)	Lead-wire type hollow porcelain	Against typhoon	Against seasonal wind
General service	0.03	0.03	—	—
Light salt pollution service	0.06	0.03	10 to 50	3 to 10
Medium salt pollution service	0.12	0.06	3 to 10	1 to 3
Heavy salt pollution service	0.35	0.12 ^{a)}	0 to 3	0 to 1
Note ^{a)} If the lead wire is reinforced with e.g. a mould cone, 0.06 mg/cm ² is acceptable.				

2.2.3 Temperature and humidity

For installation in a place where the ambient temperature can be outside the normal service condition range stated in 2.1, the preferred ranges of minimum and maximum ambient air temperature to be specified should be

- a) -35°C and $+40^{\circ}\text{C}$ for very cold climates;
- b) -5°C and $+50^{\circ}\text{C}$ for very hot climates.

In certain regions with frequent occurrence of warm humid winds, sudden changes of temperature may occur resulting in condensation even indoors.

2.2.4 Vibrations, shock and tilting

The standard switch is designed for mounting on substantially level or vertical structures, free from excessive vibration, shock, and tilting. Where any of these abnormal conditions exists, requirements for the particular application should be specified by the user.

Installations where the effects of strong earthquakes are considered, in particular, shall be as agreed between the interested parties.

2.2.5 Wind speed

(Requirements for wind speed are not specified in this Standard.)

2.2.6 Other special service conditions

When special environmental conditions prevail at the location where the switch is to be put in service, they should be specified by the user by reference to **JIS C 60721** (all parts).

3 Terms and definitions

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

3.1 General terms

For the purposes of this Standard, the general terms and definitions given in **IEC 62271-1 : 2007, 3.1**, and the following apply.

3.1.101

effectively earthed neutral system

(The term is not defined in this Standard.)

3.1.102

non-effectively earthed neutral system

(The term is not defined in this Standard.)

3.2 Assemblies of switchgear and controlgear

The terms and definitions for assemblies of switchgear and controlgear given in **IEC 62271-1 : 2007, 3.2** shall apply.

3.3 Parts of assemblies

The terms and definitions for parts of assemblies given in **IEC 62271-1 : 2007, 3.3** shall apply.

3.4 Switching devices

The terms and definitions for switching devices given in **IEC 62271-1 : 2007, 3.4**, and the following apply.

3.4.101

switch

switching device capable of making, carrying and breaking currents under normal circuit conditions, which may include carrying currents for a specified time under abnormal circuit conditions such as an overcurrent and a short circuit.

(**IEC 60050-441 : 1984, 441-14-10** is modified)

3.4.102

switch-disconnector

switch which, in the open position, satisfies the isolating requirements specified for a disconnector

(**IEC 60050-441 : 1984, 441-14-12**)

3.4.103

general purpose switch

(The term is not defined in this Standard.)

3.4.103.1

class E1 general purpose switch

(The term is not defined in this Standard.)

3.4.103.2

class E2 general purpose switch

(The term is not defined in this Standard.)

3.4.103.3

class E3 general purpose switch

(The term is not defined in this Standard.)

3.4.103.4

class M1 switch

(The term is not defined in this Standard.)

3.4.103.5

class M2 switch

(The term is not defined in this Standard.)

3.4.103.6

class C1 switch

(The term is not defined in this Standard.)

3.4.103.7

class C2 switch

(The term is not defined in this Standard.)

3.4.104

limited purpose switch

(The term is not defined in this Standard.)

3.4.105

special purpose switch

(The term is not defined in this Standard.)

3.4.105.1

single capacitor bank switch

(The term is not defined in this Standard.)

3.4.105.2

back-to-back capacitor bank switch

(The term is not defined in this Standard.)

3.4.105.3

motor switch

(The term is not defined in this Standard.)

3.4.105.4

parallel power transformer closed-loop switch

(The term is not defined in this Standard.)

3.5 Parts of switch

The terms and definitions for parts of switch given in **IEC 62271-1 : 2007, 3.5** shall apply.

3.6 Operation

The terms and definitions for operation given in **IEC 62271-1 : 2007, 3.6** shall apply.

3.7 Characteristic quantities

The terms and definitions for characteristic quantities given in **IEC 62271-1 : 2007, 3.7**, and the following apply.

3.7.4

non-sustained disruptive discharge, NSDD

disruptive discharge associated with current interruption, that does not result in the resumption of power-frequency current or, in the case of capacitive current interruption, does not result in current in the main load circuit

3.7.101

breaking capacity

current which can be made and broken under the circuit condition specified in this Standard

3.7.102

mainly active load-breaking capacity

current which flows through each pole when opening or closing a load circuit in which the load can be represented by resistors and reactors connected in parallel

3.7.103

no-load transformer breaking capacity

current which flows through each pole of a switch when opening or closing a circuit

where the load is no-load transformer(s)

3.7.104

closed-loop breaking capacity

current which flows through each pole when opening or closing a closed-loop circuit (in which both sides of the switch remain energized after breaking, and the voltage between terminals is substantially lower than a system voltage)

3.7.105

cable-charging breaking capacity

(The term is not defined in this Standard.)

3.7.106

line-charging breaking capacity

(The term is not defined in this Standard.)

3.7.106A

charging breaking capacity

current which flows through each pole of a switch when opening or closing a circuit where the load is no-load electric circuit(s)

3.7.106B

capacitor breaking capacity

current which flows through each pole of a switch when opening or closing a circuit where the load is a capacitor bank for power factor improvement

3.7.107

single capacitor bank breaking capacity

(The term is not defined in this Standard.)

3.7.108

back-to-back capacitor bank breaking capacity

(The term is not defined in this Standard.)

3.7.109

back-to-back capacitor bank inrush making current

(The term is not defined in this Standard.)

3.7.110

motor breaking capacity

(The term is not defined in this Standard.)

3.7.111

earth fault breaking capacity

(The term is not defined in this Standard.)

3.7.112

cable and line-charging breaking capacity under earth fault conditions

(The term is not defined in this Standard.)

3.7.113

breaking current

current which flows through each pole of a switch during a breaking process which is expressed by an alternating r.m.s. value at the instant of initiation of the arc during a breaking process of mainly active load current and closed-loop current, and by the quotient of a peak value of current wave immediately before initiation of the arc and $\sqrt{2}$ during a breaking process of exciting current, charging current and capacitor current

In the case of three-phase test, it means the average value of the three-phase currents.

3.7.114

(peak) making current

current which flows through each pole of a switch during the transient period following the initiation of current during a making operation, which is expressed by the maximum value of the first major loop of the current (see Figure 0B). In the case of three-phase test, it is the highest value in any phase.

NOTE Peak value may differ from one pole to another and from one operation to another as it depends on the instant of current initiation relative to the wave of the applied voltage.

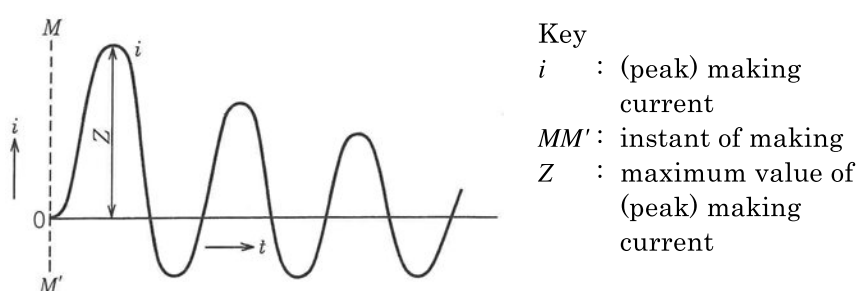


Figure 0B (Peak) making current

3.7.115

short-circuit making capacity

(The term is not defined in this Standard.)

3.7.116

restrike performance

(The term is not defined in this Standard.)

3.7.117

re-ignition (of an a.c. mechanical switching device)

(The term is not defined in this Standard.)

3.7.118

restrike (of an a.c. mechanical switching device)

resumption of power frequency current between the contacts of a switch during a breaking operation with an interval of zero current of a quarter cycle of power frequency or longer

(IEC 60050-441 : 1984, 441-17-46 is modified)

3.7A General terms

3.7A.1

operating mechanism

mechanism part for driving the contact of a switch inside the switch and inside the operating device

3.7A.2

control equipment

equipment which receives and selects signals from outside the switch, to control the operating mechanism of the switch.

3.7A.3

operating device

device which is installed separately from the switch body and opens or closes a switch by mechanically connecting to the switch body

3.7A.4

control circuit

generic term of circuit which controls the operating mechanism of a switch, auxiliary contact and measuring circuit

It is incorporated inside the switch, control equipment and operating device.

3.7A.5

resistance to salt pollution

performance which is used as the reference in the design of a switch so that the dielectric strength will not decrease to a hazardous extent even though the surface of insulation is polluted by adhesion of dust containing salt. It is classified into four types i.e. general service, light salt pollution service, medium salt pollution service and heavy

salt pollution service, according to forecasted quantity of salt adhesion.

3.7B Terms relative to classification

3.7B.1

air switch

switch in which opening and closing of the circuit are carried out in the open air

3.7B.2

vacuum switch

switch in which opening and closing of the circuit are carried out in vacuum

3.7B.3

gas switch

switch in which opening and closing of the circuit are carried out in an inert gas such as sulfur hexafluoride

3.7B.4

open type switch

switch with an enclosure of such construction that no particular means is provided to protect the switch from contact with and/or ingress of foreign substances

3.7B.5

enclosed type switch

switch with an enclosure of such construction that ingress of small solid foreign substances (excluding dusts) as well as erroneous contact of tools, wires, etc. with the current carrying parts and/or operating parts are prevented

3.7C Terms relative to ratings

3.7C.1

rated control voltage

voltage to be employed as the reference in designing an electric control equipment of switch

This is expressed by the input side terminals voltage of the control equipment during operation.

3.7D Terms relative to construction

3.7D.1

lead-wire type terminals

terminals of such a system that insulated wires are directly drawn out from inside of the bushing of a switch and the ends of the lead-wires are connected with external wires

3.7D.2

terminal plate system or wire clamping system terminals

terminals of such a system that external wires are, directly or by the aid of crimp-style terminals or the like, are screwed in and clamped by metal fittings at the end of bushings or the end of supporting insulation

It is called terminal plate system or wire clamping system according to shapes of metal fittings at the end of bushings or the end of supporting insulation.

3.7D.3

crossbar

insulating support which mechanically connects the live parts of every phase in a switch

3.7E Terms relative to tests

3.7E.1

opening time

time from the instant when a circuit opening command is given to the switch in a closed state until contacts of all poles separate (see Figure 0C)

3.7E.2

arcing time

time from the instant when a first arcing pole arcs until the principal current of all poles is broken

When it comes to a certain pole, it is time from the instant when the pole arcs until the instant when principal current of the pole is broken (see Figure 0C).

3.7E.3

breaking time

time from the instant when a circuit opening command is given to the switch in a closed state to the instant when the principal current of all poles is broken (see Figure 0C)

3.7E.4

closing time

time from the instant when a circuit closing command is given to the switch in an opened state until contacts of all poles come into contact (see Figure 0C)

3.7E.5

making time

time from the instant when a circuit closing command is given to the switch in an opened state until current begins to flow in a main circuit (see Figure 0C)

3.7E.6

pre-arcing time

time from the first phase energization start point in the closing operation to the point in which the contact of all phases is completed (see Figure 0C)

3.7E.7

full opening time

time from the instant when a circuit opening command is given to the switch in a closed state until contacts of all poles reach the opening position (see Figure 0C)

3.7E.8

full closing time

time from the instant when a circuit closing command is given to the switch in an opened state until contacts of all poles reach the closing position (see Figure 0C)

3.7E.9

power-frequency recovery voltage

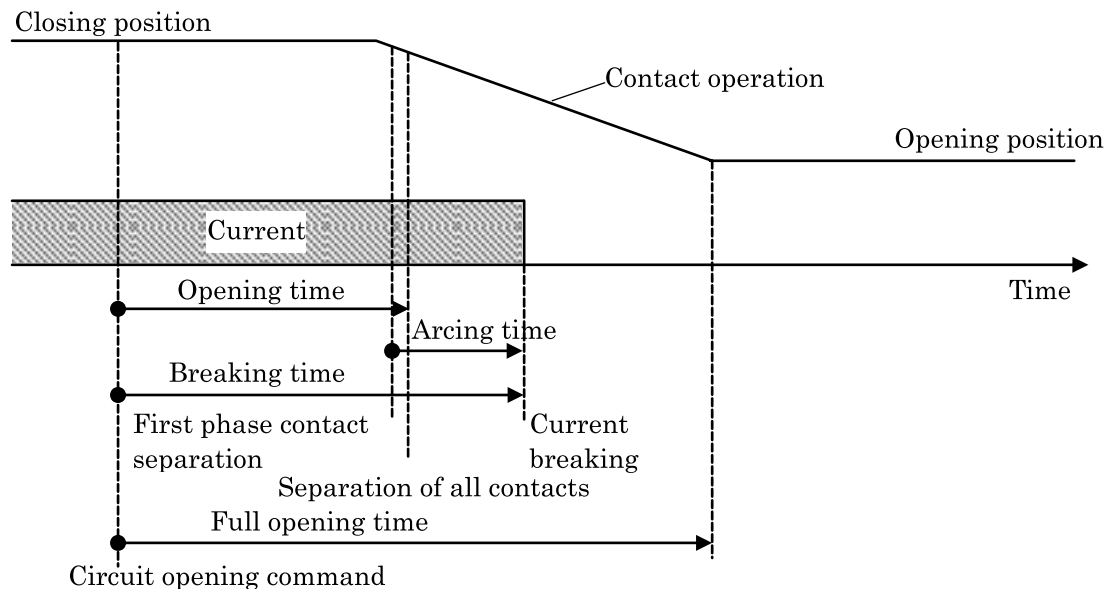
voltage of power-frequency that appears, immediately after current breaking in one pole of a switch, across both terminals of that pole or across respective breaking points of that pole

Unless otherwise specified, it is expressed in r.m.s. value. In some cases, it is expressed in the value converted to the line voltage.

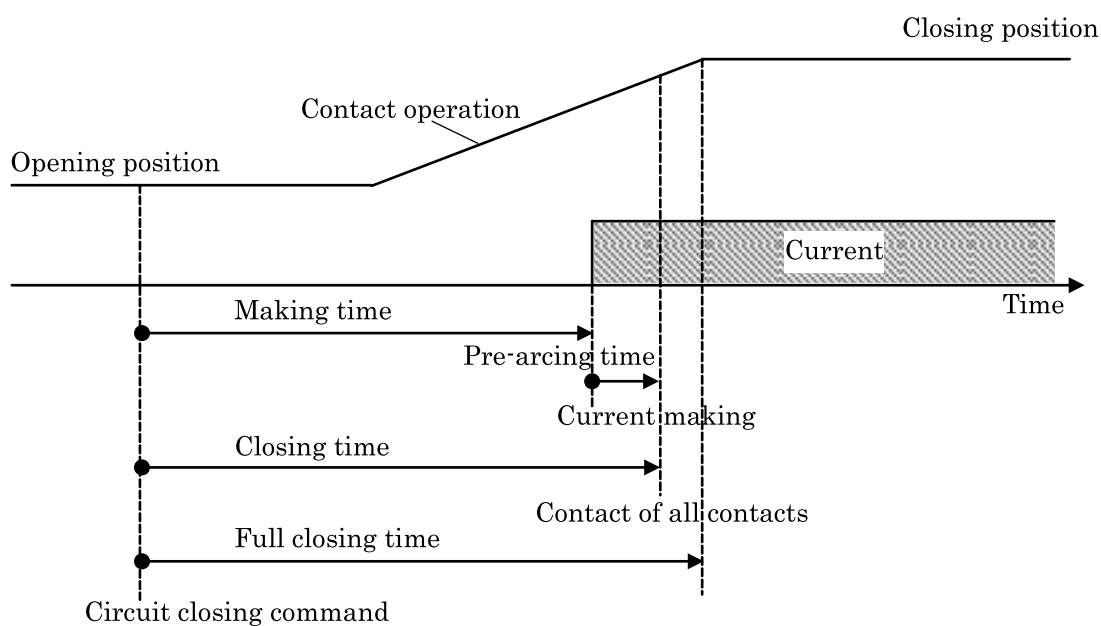
3.7E.10

transient recovery voltage

transient voltage that appears, immediately after current breaking in one pole of a switch, across both terminals of that pole or across respective breaking points of that pole



a) Circuit opening operation



b) Circuit closing operation

Figure 0C Time and terms related to opening/closing

3A Classification of switch

3A.1 Classification according to installation site

The classification according to installation site shall be as follows :

- a) indoor service;
- b) outdoor service.

3A.2 Classification according to energy for switching operation

The classification according to energy for switching operation shall be as follows :

- a) manual operation;
- b) electric power operation;
 - 1) solenoid operation;
 - 2) motor operation;
 - 3) motor energy storage.

3A.3 Classification according to arc suppressing media (symbol)

The classification according to arc suppressing media (symbol) shall be as follows :

- a) air (A);
- b) vacuum (V);
- c) gas (G).

3A.4 Classification according to enclosure structure

The classification according to enclosure structure shall be as follows :

- a) open type : IP0X specified in **JIS C 0920** : 2003 or superior to this;
- b) enclosed type : IP4X specified in **JIS C 0920** : 2003 or superior to this.

3A.5 Classification according to resistance to salt pollution of outdoor switch

The classification according to resistance to salt pollution of outdoor switch shall be as follows :

- a) general service;
- b) light salt pollution service;
- c) medium salt pollution service;
- d) heavy salt pollution service.

4 Ratings

4.0 Ratings of switch

The common rating of switch, including its operating device and control equipment, as specified by the manufacturer should be as follows. In some cases, other rated characteristics may be required. In that case, the rated characteristics shall be as agreed between the interested parties.

- a) Rated voltage (U_r)
- b) Rated withstand voltage (U_p)
- c) Rated frequency (f_r)
- d) Rated current (I_r)
- e) Rated short-time withstand current (I_k)

- f) Rated duration of short-circuit (t_k)
- g) Rated control voltage (U_a)
- h) Rated frequency of control circuit
- i) Rated filling levels for insulation (P_{re})
- j) Rated short-circuit making current (I_{ma})

4.1 Rated voltage (U_r)

The rated voltage refers to a limit of the working voltage which can be applied to the switch, and is expressed by line voltage.

4.1.1 Range I for rated voltages of 52 kV and below

The standard values in the range for rated voltages of 52 kV and below shall be as follows.

3.6 kV, 7.2 kV, 12 kV, 24 kV and 36 kV

4.1.2 Range II for rated voltages of exceeding 52 kV

Requirements for range II for rated voltages of exceeding 52 kV are not specified in this Standard.

4.2 Rated withstand voltage

The rated withstand voltage of switch shall be selected from the values given in Table 0B.

In this table, the rated withstand voltage applies at the standardized reference atmosphere [temperature (20 °C), pressure (1 013 kPa) and humidity (11 g/m³)] specified in IEC 60071-1 : 2006.

These withstand voltages include the altitude correction to a maximum altitude of 1 000 m specified for the normal operating conditions (see 2.1). For special service conditions, refer to 2.2.

The rated withstand voltage values for lightning impulse voltage (U_p) and power-frequency voltage (U_d) should be selected without crossing the horizontal marked lines. The rated withstand voltage shall be expressed by the withstand voltage value between the main circuit terminals of the rated lightning impulse withstand voltage and the earth.

For most of the rated voltages, several rated withstand voltages exist to allow for application of different performance criteria or overvoltage patterns. The choice should be made considering the frequency of lightning strikes, the effect of earthing resistance, and the limiting voltage of the lightning arrester.

The rated withstand voltage of the control circuit shall be the value given in Table 0C.

Table 0B Rated withstand voltages for rated voltages of range I [corresponding to IEC 62271-1 : 2007, Table 1 a)]

Rated voltage U_r kV (r.m.s. value)	Rated power-frequency withstand voltage Dry (1 min) Watering (10 sec) U_d kV (r.m.s. value)		Rated lightning impulse withstand voltage Dry U_p kV (peak value)	
	Between the main circuit terminals and the earth and between different phase main circuit terminals	Between main circuit terminals of the same phase	Between the main circuit terminals and the earth and between different phase main circuit terminals	Between main circuit terminals of the same phase
3.6	10	19	30	35
	16	19	45	52
7.2	16	25	45	52
	22	25	60	70
12	28	32	75	85
			90	105
24	38 50	44 60	75	85
			100	115
			125	145
			150	175
36	70	80	150	175
			170	195
			200	230

The withstand voltage value between the same phase main circuit terminals of a switch which is installed directly below the disconnecter and is not used as a disconnecter may be the same as the value specified between the main circuit terminals and the earth and between the main circuit terminals of the different phase.

Drying test shall be applied to indoor switch, and drying and watering tests shall be applied to outdoor switch.

Lead-wire type outdoor switch shall be applied with the lead wire insulation coating removed from the end of the hollow porcelain to expose the conductor, except for those with a moulded cone.

The outdoor switch of terminal plate system or wire clamping system shall be applied with the terminal insulation cover removed.

When a lower value of the rated lightning impulse withstand voltage U_p specified in this table is adopted, it is recommended that one of the following conditions be satisfied.

- When installed in a location where lightning strikes are infrequent and direct or proximity lightning does not need to be considered (e.g. cable systems).
- When equipment to prevent damage by direct or proximity lightning is installed, and the effect of earthing resistance is reduced by connecting earthing, etc.
- When the limiting voltage of the lightning arrester is low and there is a considerable margin between it and the withstand voltage value even during high current discharge.
- When the distance to the lightning arrester is very close, such as in a closed distribution panel, and the margin against internal vibration of ingress lightning can be reduced.

Table 0C Rated withstand voltage value between the charging section of the control circuit and the earth

Withstand voltage value between the charging section of the control circuit and the earth	
Rated power-frequency withstand voltage Dry (1 min) kV (r.m.s. value)	Rated lightning impulse withstand voltage Dry kV (peak value)
2.0	7.0 ^{a)}
Note ^{a)} The rated lightning impulse withstand voltage value specified in this table is the value when the control circuit is not equipped with a surge absorber or other protective device against abnormal voltage. If the rated value cannot be applied due to the installation of protective devices, etc., it shall be in accordance with the agreement between the interested parties.	

4.3 Rated frequency (f_r)

The rated frequency shall be 50 Hz and/or 60 Hz.

4.4 Rated normal current and temperature rise

4.4.1 Rated normal current (I_r)

The rated normal current of switch shall be the limit of the current which the switch shall be able to carry continuously without exceeding the specified temperature rise under specified conditions of use and behaviour.

The values of rated normal currents should be selected according to Table 0D or from the R 10 series specified in **JIS Z 8601 : 1954**.

NOTE The R 10 series comprises the numbers 1 – 1.25 – 1.6 – 2 – 2.5 – 3.15 – 4 – 5 – 6.3 – 8 and their products by 10ⁿ.

Table 0D Rated normal current

Unit: A	
Rated (normal) current	100, 200, 300, 400, 600, 800, 1 200, 1 500, 2 000, 3 000 and 4 000

4.4.2 Temperature rise

The temperature rise of any part of the switch at an ambient air temperature not exceeding 40 °C shall not exceed the temperature-rise limits specified in Table 0E when the tests specified in 6.5 are carried out.

Table 0E Limits of temperature and temperature rise for various parts, materials and dielectrics of switch (corresponding to IEC 62271-1 : 2007, Table 3)

Nature of the part, of the material and of the dielectric ^{a) b) c)}	Maximum allowable temperature °C	Temperature rise limit at ambient air temperature not exceeding 40 °C K
1 Contacts ^{d)} Bare copper or bare copper alloy – in air – in SF ₆ (sulphur hexafluoride) ^{e)} Silver-coated or nickel-coated ^{f)} – in air – in SF ₆ ^{e)} Tin-coated ^{f)} – in air – in SF ₆ ^{e)}	 75 105 105 105 90 90	 35 65 65 65 50 50
2 Connection, bolted or the equivalent ^{d)} Bare-copper, bare-copper alloy or bare-aluminium alloy – in air – in SF ₆ ^{e)} Silver-coated or nickel-coated – in air – in SF ₆ ^{e)} Tin-coated – in air – in SF ₆ ^{e)}	 90 115 115 115 105 105	 50 75 75 75 65 65
3 All other contacts or connections made of bare metals or coated with other materials than those in 1 and 2 above	^{g)}	^{g)}
4 Terminals for the connection to external conductors by screws or bolts ^{h)} – bare metal – silver, nickel or tin-coated – other coatings	 90 105 ^{g)}	 50 65 ^{g)}
5 Metal parts acting as springs	ⁱ⁾	ⁱ⁾
6 Materials used as insulation and metal parts in contact with insulation of the following thermal classes ^{j) k)} – Y and cemented parts of porcelain insulators, hollow porcelain, etc. – A – E – B – F – enamel : oil base synthetic – H – other insulating material	 90 105 120 130 155 100 120 180 ^{l)}	 50 65 80 90 115 60 80 140 ^{l)}
7 Accessible parts – expected to be touched in normal operation – which need not to be touched in normal operation	 70 80	 30 40
Notes ^{a)} According to its function, the same part may belong to several categories as listed in this table. In this case, the permissible maximum values of temperature and temperature rise to be considered are the lowest among the relevant categories. ^{b)} For vacuum switches, the values of temperature and temperature rise limits are not applicable for parts in vacuum. The remaining parts shall not exceed the values of temperature and temperature rise limits given in this table.		

Table 0E (concluded) (corresponding to IEC 62271-1 : 2007, Table 3)

Notes	c) Care shall be taken to ensure that no damage is caused to the surrounding insulating materials. d) When engaging parts have different coatings or one part is of bare material, the permissible temperatures and temperature rises shall be : – for contacts, those of the surface material having the lowest value permitted in this table; – for connections, those of the surface material having the highest value permitted in this table. e) SF₆ means pure SF₆ or a mixture of SF₆ and other oxygen-free gases. Due to the absence of oxygen, a harmonization of the limits of temperature rise for different contact and connection parts in the case of gas switch appears appropriate. The permissible temperature limits for bare copper and bare copper alloy parts can be equalized to the values for silver-coated or nickel-coated parts in the case of SF₆ atmospheres (refer to IEC TR 60943 : 2009). In the particular case of tin-coated parts, due to fretting corrosion effects (refer to IEC TR 60943 : 2009), an increase of the permissible temperatures is not applicable, even under the oxygen-free conditions of SF₆. f) The quality of the coated contacts shall be such that a continuous layer of coating material remains on the surface of the contact area after the tests are performed according to the relevant specifications for each equipment. The tests to be performed are : – current making and breaking test and short-circuit making test; – short-time withstand current test; – no-voltage continuous making and breaking test. When no layer of coating material remains, the contacts shall be regarded as “bare”. g) When materials other than those given in this table are used, their properties shall be considered, notably in order to determine the maximum permissible temperature. h) The values in this table shall be the limits regardless of the type of material and surface treatment of the external conductor connected to the terminals of the main circuit and control circuit. i) The temperature shall not reach a value where the elasticity of the material is impaired. j) <u>The temperature rise limit of insulators and hollow porcelain made of organic insulators such as epoxy resin shall be as agreed between the interested parties.</u> k) <u>Thermal classes of insulating materials shall be as given in JIS C 4003 : 2010.</u> l) Limited only by the requirement to cause any damage to surrounding parts.
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4.5 Rated short-time withstand current (I_k)

The rated short-time withstand current shall be the limit of current at which no abnormality is observed when the switch carries current during a rated duration of short-circuit under the circuit conditions specified in this Standard.

The rated short-time withstand current shall be as given in Table 0F.

Table 0F Rated short-time withstand current and rated short-circuit making current

Rated current (I_r) A	Rated short-time withstand current (r.m.s.) (I_k) kA	Rated short-circuit making current (peak value) (I_{ma}) kA	Number of times of making rated short-circuit current (I_{ma})	
100, 200	4	10	Class A : once Class B : twice Class C : three times	
	8	20		
	12.5	31.5		
300	8	20		
	10 a)	25		
	12.5	31.5		
400	8	20		
	10 a)	25		
	12.5	31.5		
	16	40		
	20	50		
	25	63		
	31.5	80		
	40	100		
	80	200		
600, 800, 1 200, 1 500, 2 000, 3 000, 4 000	8	20		
	12.5	31.5		
	16	40		
	20	50		
	25	63		
	31.5	80		
	40	100		
	80	200		
The short-time withstand current shall be expressed in the symmetric r.m.s. value at the rated duration of short-circuit, and among each phase at the first frequency of current initiation, the largest one shall have a peak value (including the d.c. portion) equal to or greater than the rated short-circuit making current.				
Note a) The rated voltage is limited to 3.6 kV.				

4.6 Rated peak withstand current (I_p)

Requirements for rated peak withstand current are not specified in this Standard.

4.7 Rated duration of short-circuit (t_k)

The rated duration of short-circuit is the interval of time for which a switch can carry, in the closed position, a current equal to its rated short-time withstand current.

The standard value of rated duration of short-circuit is 1 s.

If it is necessary, a value lower or higher than 1 s may be chosen. When other values than 1 s is chosen, the recommended values are 0.5 s, 2 s and 3 s.

4.8 Rated control voltage (U_a)

The values given in Table 0G are standard rated control voltages. In the case of a.c.,

it shall be expressed in r.m.s.

The control circuit shall be capable of carrying and breaking the current of the switch at any control voltage value in the range of 85 % to 110 % of the rated value.

Table 0G Standard value of rated control voltage (corresponding to IEC 62271-1 : 2007, Table 4 and Table 5)

Unit: V	
a.c. voltage or d.c. voltage	Rated control voltage
a.c. voltage	100 and 200
d.c. voltage	24, 48 and 100

4.9 Rated frequency of control circuit

The standard value of the rated frequency shall be 50 Hz and/or 60 Hz.

4.10 Rated pressure of compressed gas supply for controlled pressure systems

Requirements for rated pressure of compressed gas supply for controlled pressure systems are not specified in this Standard.

4.11 Rated filling levels for insulation

The pressure (or density) of gas switch shall be assigned by the manufacturer referred to atmospheric air conditions of 20 °C.

4.11.101 Rated filling levels for insulation and/or switching

These ratings shall apply to all types of gases used for insulation or making/breaking.

4.11.102 Rated filling levels for operation

Requirements for rated filling levels for operation are not specified in this Standard.

4.101 Rated mainly active load-breaking capacity (I_{load})

The rated mainly active load-breaking capacity is the maximum mainly active load breaking current that the switch shall be capable of making/breaking at its rated voltage. Its value shall be equal to the rated normal current if no other value is indicated on the nameplate or in the instruction manual.

The rated mainly active load-breaking capacity should be as given in Table 0H or Table 0I.

Table 0H Rated breaking capacity

Unit: A

Type of rated breaking capacity	Rated current (I_r)				
	100	200	300	400	600
Rated mainly active load-breaking capacity (I_{load})	100	200	300	400	600
Rated closed-loop breaking capacity (I_{loop})	100	200	300	400	600
Rated no-load transformer breaking capacity	5	10	15	20	30
Rated charging breaking capacity	10				

Table 0I Rated breaking capacity

Unit: A

Type of rated breaking capacity	Rated value
Rated mainly active load-breaking capacity (I_{load})	800, 1 200, 1 500, 2 000, 3 000, 4 000
Rated closed-loop breaking capacity (I_{loop})	800, 1 200, 1 500, 2 000, 3 000, 4 000
Rated no-load transformer breaking capacity	1, 3, 5, 10, 20, 30, 50
Rated charging breaking capacity	3, 5, 10, 20, 30

4.102 Rated closed-loop breaking capacity (I_{loop})

The rated closed-loop breaking capacity is the maximum closed-loop current that the switch shall be capable of making/breaking at its rated voltage.

For the rated closed-loop breaking capacity of switch that is capable of making/breaking closed-loop breaking current, values given in Table 0H or Table 0I are recommended.

4.102A Rated no-load transformer breaking capacity

The rated no-load transformer breaking capacity is the maximum no-load transformer current that the switch shall be capable of making/breaking at its rated voltage.

For the rated no-load transformer breaking capacity, values given in Table 0H or Table 0I are recommended.

4.103 Rated charging breaking capacity

The rated charging breaking capacity is the maximum charging current that the switch shall be capable of making/breaking at its rated voltage.

For the rated charging breaking capacity, values given in Table 0H or Table 0I are recommended.

4.103A Rated capacitor breaking capacity

The rated capacitor breaking capacity of switch which is capable of making/breaking the capacitor current is the maximum capacitor current that the switch shall be capable of making/breaking at its rated voltage.

The rated capacitor breaking capacity shall be as given in Table 0J. The combinations with the rated current values shall be designated by the manufacturer.

Table 0J Rated capacitor breaking capacity

Unit: A	
Rated capacitor breaking capacity	
10, 15, 30, 40, 50, 75 and 100	

4.104 Rated line-charging breaking current (I_{lc})

Requirements for rated line-charging breaking current are not specified in this Standard.

4.105 Rated single capacitor bank breaking current for special purpose switches (I_{sb})

Requirements for rated single capacitor bank breaking current for special purpose switches are not specified in this Standard.

4.106 Rated back-to-back capacitor bank breaking current for special purpose switches (I_{bb})

Requirements for rated back-to-back capacitor bank breaking current for special purpose switches are not specified in this Standard.

4.107 Rated back-to-back capacitor bank inrush making current for special purpose switches (I_{in})

Requirements for rated back-to-back capacitor bank inrush making current for special purpose switches are not specified in this Standard.

4.108 Rated earth fault breaking current (I_{ef1})

Requirements for rated earth fault breaking current are not specified in this Standard.

4.109 Rated cable and line-charging breaking current under earth fault conditions (I_{ef2})

Requirements for rated cable and line-charging breaking current under earth fault conditions are not specified in this Standard.

4.110 Rated motor breaking current for special purpose switches (I_{mot})

Requirements for rated motor breaking current for special purpose switches are not specified in this Standard.

4.111 Rated short-circuit making current (peak value) (I_{ma})

The rated short-circuit making current is the maximum peak value of the current

that the switch shall be capable of making at its rated voltage.

The rated short-circuit making current shall be as given in Table 0F.

4.112 Rated breaking and making currents for a general purpose switch

Requirements for rated breaking and making currents for a general purpose switch are not specified in this Standard.

4.113 Ratings for limited purpose switches

Requirements for ratings for limited purpose switches are not specified in this Standard.

4.114 Ratings for special purpose switches

Requirements for ratings for special purpose switches are not specified in this Standard.

4.115 Ratings for switches backed by fuses

Requirements for ratings for switches backed by fuses are not specified in this Standard.

4.116 Type and classes for general purpose, limited purpose and special purpose switches

Requirements for type and classes for general purpose, limited purpose and special purpose switches are not specified in this Standard.

5 Design and construction

5.1 Requirements for liquids in the switch

Requirements for liquids in the switch are not specified in this Standard.

5.2 Requirements for gases in the switch

Requirements for gases in the switch are not specified in this Standard.

5.3 Earthing of switch

The switch shall be provided with a reliable earthing terminal having a clamping screw or bolt for connection of an earthing conductor suitable for specified fault conditions. The earthing terminal should be marked with the “protective earth” symbol, as indicated by Symbol 5019 of **IEC 60417**. Parts of metallic enclosures connected to the earthing system may be considered as an earthing conductor.

All metallic components and enclosures that may be touched during normal operating conditions and are intended to be earthed shall be connected to an earthing terminal.

The earthing terminal shall be as follows, based on the actual usage of switch in Japan.

- a) An earthing terminal capable of connecting an earthing wire with a conductor diameter not less than 2.6 mm and a nominal sectional area not exceeding 22 mm²

shall be provided on the body of a switch.

- b) An earthing terminal capable of connecting an earthing wire with a conductor diameter not less than 1.6 mm and a nominal sectional area not exceeding 5.5 mm² shall be provided on the metallic enclosure for control circuit not built in the switch body.
- c) Bolts or nuts which can mount the earthing wire firmly shall be appended to the earthing terminal. In this case, the bolts and nuts of the earthing terminal of outdoor switch shall be made of stainless steel or have corrosion resistance at least equivalent to that of stainless steel. When the switch mounting bolt is also used as an earthing terminal in the indoor switch, it is not necessary to install the earthing terminal separately.

5.4 Control circuit

5.4.1 Enclosures of control circuit

5.4.1.1 General

The enclosures for control circuits should be constructed of materials capable of withstanding the mechanical, electrical and thermal stresses, as well as the effects of humidity which are likely to be encountered in normal service.

5.4.1.2 Protection against corrosion

Protection against corrosion shall be ensured by the use of suitable materials or by the application of suitable protective coatings to the enclosures for control circuits, taking into account the intended conditions of use in accordance with the service conditions stated in Clause 2 (refer to Annex JA).

5.4.1.3 Degrees of protection

The degree of protection provided by an enclosure for control circuits shall be in accordance with **5.13**.

Openings in cable entries, cover plates, etc. shall be so designed that, when the cables are properly installed, the stated degree of protection of an enclosure for control circuits, as defined in **5.13**, shall be obtained.

Any ventilation openings shall be shielded or arranged so that the same degree of protection as that specified for the enclosure for control circuits is obtained.

5.4.2 Protection against electric shock

5.4.2.1 Protection by segregation of control circuits from the main circuit

The control circuit which is installed on the frame of switches shall be suitably protected against disruptive discharge from the main circuit.

5.4.2.2 Accessibility

The control circuit to which access is required during service shall be accessible without the need to compromise clearances to hazardous parts, except for the control circuit inside the switch.

Where clearances to the charging section may be compromised by environmental related changes in the service access level (for example accumulation of snow, sand, etc.), the use of increased clearances should be considered, except for the control circuit inside the switch.

When a capacitor is used in the control circuit having a structure that allows an operational check, a protective device shall be installed in order to ensure the safety of a checker.

5.4.3 Fire hazard

5.4.3.1 General

As the risk of fire is present in control circuits, the likelihood of fire shall be reduced under conditions of normal use and even in the event of malfunction or failure.

The first objective is to prevent ignition due to an electrically energized part of control circuits. The second objective is to limit the fire impact, if fire or ignition occurs inside the enclosure of control circuits.

5.4.3.2 Components and circuit design

In normal operation, heat dissipation of components is generally small. However, a component may, when faulty or in an overload condition resulting from an external fault, generate excess heat such that fire may be initiated.

The manufacturer should design or choose components taking into account normal conditions and self-ignition characteristics due to the effects of the maximum fault power. Special attention should be given to resistors.

Consideration should be given to the assembly of components and the relative arrangement of those that may dissipate excessive heat by providing around them sufficient space and/or ventilation.

5.4.3.3 Managing fire impact

Provisions should be taken in order to manage fire impact. Enclosures for control circuits should be constructed, insulated, made watertight, etc. with materials sufficiently resistant to probable ignition and heat sources situated within. The manufacturer should consider that, if it ignites, a component may emit melted flaming material and/or glowing particles.

5.4.4 Components installed in control circuit

5.4.4.1 Selection of components

All components used in the control circuits should be designed or selected to be operational with their rated characteristics over the whole actual service conditions inside control circuits enclosures. These internal conditions can differ from service conditions of outdoor switches specified in Clause 2.

5.4.4.2 Installation of components

Components shall be installed in accordance with the instructions of their manufac-

turer.

5.4.4.3 Accessibility

Closing and opening actuators should be located between 0.4 m and 2 m above servicing level of switch. Other actuators should be located at such a height that they can be easily operated, and indicating devices should be located at such a height that they can be easily readable.

Structure-mounted or floor-mounted enclosures for control circuits should be installed at such a height, with respect to the servicing level, that the above requirements for accessibility, operating and reading heights are met.

Components in control circuits should be so arranged as to be accessible for mounting, wiring, maintenance and replacement. Where a component may need adjustment during its service life, easy access should be considered without danger of electrical shock, except for the control circuit inside the switch.

5.4.4.4 Identification

Identification of components installed in control circuits is the responsibility of the manufacturer and it shall be in agreement with the indication and arrangement on the wiring diagrams and drawings. If a component is of the plug-in type, an identifying mark should be placed on the component and on the fixed part where the component plugs in.

Where mixing of components or voltages could cause confusion, consideration should be given to more explicit marking.

5.4.4.5 Requirements for control circuit components

The control circuit components shall comply with applicable JISs if one exists.

5.4.4.5.1 Cables and wiring

The specification of cables to connect control circuits of the switch is the responsibility of the manufacturer. The choice is governed by the current that must be carried, by the voltage drop and the current transformer burden, by the mechanical stresses to which the cable is subjected and by the type of insulation. The choice of conductors in control circuits is also the responsibility of the manufacturer.

Where a facility for external wiring is required, an appropriate connecting device shall be provided for example terminal blocks, plug-in terminations, etc.

Cables shall be adequately supported. The insulating covering shall be constructed so as to be protected by a tube, etc. and to be free from damage caused by sharp edges.

Wire routing should take into account the proximity of heating elements.

The available wiring space shall permit spreading of the cores of multi-core cables and the proper termination of the conductors. The conductors shall not be subjected to stresses that reduce their normal life.

Conductors connected to apparatus and indicating devices in covers or doors shall be

so installed that no mechanical damage can occur to the conductors as a result of movement of these covers or doors.

The number of connections made to a terminal shall not exceed its designed maximum.

The method and extent of identification of conductors, for example by numbers, colours or symbols, is the responsibility of the manufacturer. Identification of conductors shall be in agreement with the wiring diagrams and drawings, and the specification of the user, if applicable. This identification may be limited to the ends of the conductors. Where appropriate, identification of wiring according to **JIS C 0445** : 1999 may be applied.

5.4.4.5.2 Terminals

Terminals shall maintain the necessary contact pressure, corresponding to the current rating and the short-circuit current of circuits.

Terminal blocks for wiring components inside the control circuit shall be chosen according to the cross-section of the conductors used.

5.4.4.5.3 Auxiliary switches

Requirements for auxiliary switches are not specified in this Standard.

5.4.4.5.4 Auxiliary and control contacts

Auxiliary and control contacts shall be suitable for their intended duty in terms of making and breaking capacity and timing of the operation of the auxiliary and control contacts.

Auxiliary and control contacts shall be suitable for the number of electrical and mechanical operating cycles specified for the switch by the manufacturer.

Where an auxiliary contact is made available to the user, the technical documents provided by the manufacturer should contain information regarding this contact.

5.4.4.5.5 Contacts other than auxiliary and control contacts

A contact other than an auxiliary or control contact is a contact driven by a component (relay, contactor, low-voltage switch, etc.) used in the control circuits.

Where a contact other than an auxiliary or control contact is made available to the user, the technical documents provided by the manufacturer shall include information about this contact.

5.4.4.5.6 Relays

Where a relay is chosen and used at a voltage different from the rated voltage of control circuits, an appropriate device shall be provided to allow it to operate correctly under the conditions specified in **4.8** (for example, provision of a series resistor).

5.4.4.5.7 Shunt releases

Requirements for shunt releases are not specified in this Standard.

5.4.4.5.8 Heating elements

Requirements for heating elements are not specified in this Standard.

5.4.4.5.9 Operation counters

Operation counters shall be suitable for their intended duty in terms of environmental conditions and for the number of electrical and mechanical operating cycles specified for the switch by the manufacturer.

5.4.4.5.10 Illumination

Requirements for illumination are not specified in this Standard.

5.4.4.5.11 Operating coils

Operating coils of switch shall be suitable for their intended duty (for example, with respect to temperature rise, dielectric withstand, etc.).

5.5 Direct operation (solenoid operation or motor operation)

A switch operated by a solenoid or motor actuated by (external) control supply shall operate satisfactorily at any voltage between 85 % to 110 % of the rated control voltage, and shall be capable of making the rated short-circuit making current. For a.c. operated switches, the frequency of control supply shall be the rated frequency. If the maximum closing time is stated by the manufacturer, it shall not be exceeded.

5.6 Stored energy operation

5.6.0A General

A switch arranged for stored energy operation shall be capable of making and breaking all currents up to its rated values when the energy storage device is suitably charged. If maximum closing and opening times are stated by the manufacturer, these shall not be exceeded.

In the case of reapplication of the energy supply after a loss of energy, the specified behaviour is not necessarily required.

5.6.1 Energy storage in gas receivers or hydraulic accumulators

Requirements for energy storage in gas receivers or hydraulic accumulators are not specified in this Standard.

5.6.2 Energy storage in springs

When the energy storage device is a spring, the requirements of 5.6.0A apply when the spring is charged.

5.6.3 Manual charging

If a spring is charged by hand, the direction of motion of the handle shall be marked, except for cases where the direction of motion of the handle is clearly known.

The maximum actuating force required for manually charging a spring shall not exceed 300 N. When the switch is used on an outdoor pole, the force shall be 100 N to 300 N.

5.6.4 Motor charging

Motors, and their electrically operated control circuit for charging a spring, shall operate satisfactorily between 85 % and 110 % of the rated control voltage (refer to 4.8), the control supply frequency of control circuit, in the case of a.c., being the rated supply frequency (refer to 4.9).

5.6.5 Energy storage in capacitors

When the energy store is a charged capacitor, the requirements of 5.6.0A apply when the capacitor is charged.

5.7 Independent manual or power operation (independent unlatched operation)

Requirements for independent manual or power operation are not specified in this Standard.

5.8 Operation of releases

Requirements for operation of releases are not specified in this Standard.

5.9 Low- and high-pressure interlocking and monitoring devices

Requirements for low- and high-pressure interlocking and monitoring devices are not specified in this Standard.

5.10 Nameplates and instruction manuals

The switches and their operating devices or control equipment used in combination shall be provided with nameplates and/or manufacturer's instruction manuals which contain the product information given in Table 2.

It should be stated whether pressures (or densities) are absolute or relative values.

For outdoor switch (including operating devices and control equipment), the nameplates and their methods of attachment shall be weather-proof and corrosion-proof.

For the switch combined with an operating device or control equipment, when the nameplate of switch includes the contents of the nameplate of operating device or the nameplate of control equipment, the nameplate of operating device or the nameplate of control equipment may be omitted.

Technical characteristics on nameplates and/or in instruction manuals which are common to several kinds of switch shall be represented by the same symbols.

Table 2 Product information

Term		Ab- brevi- ation	Unit	Switch	Operat- ing device or control equip- ment	Conditions re- quiring indica- tion	Example
(1)		(2)	(3)	(4)	(5)	(6)	
Information stated on nameplate							
Name including class of arc suppressing media and other classification a)		---	---	X	---	---	Outdoor switch in air (heavy salt pol- lution proof)
Classi- fication	Service area	---	---	Y	---	Different from that stated above or outdoor switch marked with "resistance to salt pollution"	Outdoor service
	Operation system	---	---	(X)	---	---	Auto- matic
	Pollution proofness of outdoor switch	---	---	Y	---	Different from general service, light salt pollu- tion service and medium salt pollution service	Heavy salt pol- lution service
Manufacturer or its ab- breviation		—	—	X	X	—	—
Type designation (name of type assigned by manufacturer)		—	—	X	X	—	—
Year (western year)		—	—	X	X	—	—
Serial number		—	—	X	X	—	—

Table 2 (continued)

Term (1)	Ab- brevi- ation (2)	Unit (3)	Switch (4)	Operat- ing device or control equip- ment (5)	Conditions re- quiring indica- tion (6)	Example
Rated voltage	U_r	kV	X	—	—	7.2 kV
Rated withstand voltage b)	U_p	kV	X	—	—	60 kV
Rated frequency	f_r	Hz	Y	—	Different from 50/60 Hz for common use	60 Hz
Rated (normal) current	I_r	A	X	—	—	200 A
Rated short-time with- stand current	I_k	kA	X	—	—	8 kA
Rated duration of short-circuit	t_k	s or second	Y	—	Different from 1 s	2 s 2 sec- onds
Rated short-circuit making current and identification of Class A, B or C	I_{ma}	kA	X	—	—	B 20 kA
Temperature class	—	—	(X)	—	—	-35 °C
Connection diagram	—	—	Y	Y	Complex wiring	—
Total mass	—	kg	X	—	—	—
Information stated on nameplate or instruction manual						
Rated mainly active load-breaking capacity	I_{load}	A	Y	—	Different from cases the same as Table 0H or Table 0I	500 A
Number of mak- ing/breaking operations	—	—	Y	—	Different from 200 times	100 times
Rated closed-loop breaking capacity	I_{loop}	A	Y	—	Different from cases the same as Table 0H	500 A
Rated no-load trans- former breaking capaci- ty	—	A	Y	—	Different from cases the same as Table 0H	25 A
Rated charging break- ing capacity	—	A	Y	—	Different from cases the same as Table 0H	20 A
Rated capacitor break- ing capacity	—	A	X	—	—	30 A
Rated filling levels for insulation	P_{re}	kPa	Y	—	—	—
Rated control voltage and identification of d.c. voltage and/or a.c. volt- age	U_a	V	—	X	—	AC100 V

Table 2 (concluded)

X : indication is mandatory. Y : indication is required when conditions in column (6) are met. (X) : indication is arbitrary.
Abbreviations in column (2) may be used instead of terms in column (1). When terms in column (1) is used, the word “rated” may be omitted. When figures are the same, abbreviations may be combined. Example: I_r , I_{load} , $I_{loop} = 400\text{ A}$
Notes a) It may be described in the item “Classification” directly below. b) The indicated value shall be the lightning impulse withstand voltage value between the main circuit terminals and the earth.

5.11 Interlocking devices

Interlocking devices between different components of equipment may be required for reasons of safety and/or convenience of operation (for example between a switch and the associated earthing switch).

An interlocking device is a system made of multiple components (it may contain mechanical parts, cables, contactors, coils, etc.).

5.12 Position indication

A switch shall be so constructed that the open and closed position can be easily checked by either of the following:

- a) the gap between contacts is visible;
- b) the position of each movable contact is indicated by a reliable indicating device. In the case where all poles of a switch are so coupled as to be operated as a single unit, it is permissible to use a common indicating device.

Clear and reliable indication shall be provided of the position of the contacts of the main circuit in case of non-visible contacts.

5.13 Degrees of protection provided by enclosures

Degrees of protection according to **JIS C 0920 : 2003** shall be specified for all enclosures of switch and for enclosures for control equipment and operating device.

The degrees of protection apply to the service condition of the switch.

The degrees of protection may be temporarily different for other conditions such as maintenance, testing, etc.

5.13.1 Protection of persons against access to hazardous parts and protection of the equipment against ingress of solid foreign objects (IP coding)

For the classification of the protection of persons against access to hazardous parts and the protection of the equipment against ingress of solid foreign objects, the IP code of the open type shall be IP0X or superior to this and the IP code of the enclosed type shall be IP4X or superior to this, except for the drainage hole part and the external connection terminal part for a main circuit.

The degrees of protection provided by the enclosure of a ground-mounted switch

shall be as agreed between the interested parties.

5.13.2 Protection against ingress of moisture (IP coding)

For the indoor switch, control equipment and operating device, no degree of protection against harmful ingress of water as per the second characteristic numeral of the IP code is specified (second characteristic numeral X).

For the outdoor switch, control equipment and operating device provided with additional protection features against rain and other weather conditions, the degree of protection shall be either IPX3, IPX4, IPX5, IPX6 or IPX7.

The degrees of protection provided by the enclosure of a ground-mounted switch shall be as agreed between the interested parties.

5.13.3 Protection of switch against mechanical impact

The enclosed type switch shall be capable of opening and closing normally and shall not show any abnormality when subjected to the tests specified in 6.7.2.0B.

5.14 Creepage distances for outdoor insulators

The outdoor switch shall have creepage distances that satisfy the requirements of 6.2.8. No specific requirements for creepage distance are given for indoor switch.

IEC TR 60815 : 1986 gives general rules that assist in choosing insulators which should give satisfactory performance under polluted conditions.

NOTE For insulators other than outdoor external ceramic or glass insulator, specific requirements are under consideration.

5.15 Gas and vacuum tightness

The specifications of 5.15.3 apply to all switches which use vacuum or gas, other than ambient air, for insulation or combination of insulation and current breaking.

5.15.1 Controlled pressure systems for gas

Requirements for controlled pressure systems for gas are not specified in this Standard.

5.15.2 Closed pressure systems for gas

Requirements for closed pressure systems for gas are not specified in this Standard.

5.15.3 Sealed pressure systems

The tightness of sealed pressure systems is specified by their expected operating life.

The expected operating life with regard to leakage performance shall be considered.

5.16 Liquid tightness

Requirements for liquid tightness are not specified in this Standard.

5.17 Fire hazard (flammability)

The materials should be chosen and the parts designed in such a way that they retard the propagation of any flame resulting from accidental overheating in the switch

and reduce harmful effects on the local environment. In cases where product performance requires the use of flammable materials, product design should take flame retardation into account, if applicable.

JIS C 60695-1 (all parts) provides guidance for assessing the fire hazard of electro-technical products.

JIS C 60695-7-1 : 1997 on the minimization of toxic hazards due to fires involving electrotechnical products should be applied.

The information supplied by manufacturer should enable the user to evaluate fire hazards.

5.18 Electromagnetic compatibility (EMC)

The EMC is defined for interfaces or ports of control circuits or subassemblies. Immunity tests shall be in accordance with **6.9.2**.

NOTE General guidance regarding EMC and considerations to improve EMC are given in **IEC TR 61000-5-1** and **IEC TR 61000-5-2**. The magnitude of induced voltages in control circuits depends both on the control circuits themselves and on conditions such as the earthing and rated voltage of the main circuit.

5.19 X-ray emission

Requirements for X-ray emission are not specified in this Standard.

5.20 Corrosion

The switch shall be of a construction that takes corrosion into account. All bolted or screwed parts of the main circuit and of the enclosure should remain easy to disassemble, as applicable. In particular, galvanic corrosion of materials in contact shall be considered because, for example, it may lead to the loss of tightness or increased contact resistance, reference is made to Annex JA.

Corrosion stresses are strongly dependant on the environmental conditions at the installation site. The atmospheric conditions are important, but the installation should consider the solar and temperature variation, the air flow, etc.

5.101 Making and breaking operations

All switches shall be designed so as to be capable of making the circuits to which their rated making current apply.

All switches shall be designed so as to be capable of breaking at the assigned recovery voltage any current up to and including their rated breaking currents.

5.102 Requirements for switch-disconnectors

Switch-disconnectors shall, in addition, comply with the requirements specified for disconnectors in **IEC 62271-102** : 2001 or **JIS C 4606** : 2011 for their disconnecting function. For the withstand voltage test, however, this Standard applies.

5.103 Mechanical strength

Switches shall be capable of bearing mechanical terminal loads as specified by the manufacturer, when installed according to the manufacturer's instructions, as well as electromagnetic forces, without reduction of their reliability or current-carrying capacity.

5.104 Securing the making/breaking position

Switches shall be so constructed that they cannot come out of their open or closed positions by forces arising from gravity, vibration or reasonable shocks or by electromagnetic forces. If specifically required, switches or control equipment shall be designed to allow the application of means to prevent unauthorized operation.

5.105 Auxiliary contacts for signalling

Requirements for auxiliary contacts for signalling are not specified in this Standard.

5.106 No-load transformer breaking capacity

All switches shall be designed so as to be capable of making and breaking rated no-load transformer breaking capacity. Generally, the stress associated with this duty is negligible and is easily performed for a switch capable of switching active load.

Because of the variety of transformers and associated circuits and of the non-linearity of the transformer core, it is not possible to correctly model the switching of transformer magnetizing current using linear components in a test laboratory. Tests conducted using an available transformer will only be valid for the tested transformer and cannot be representative for other transformers. If a special test is necessary, test circuits and test procedures have to be agreed between customer and manufacturer.

5.106A Construction in general

The switch shall be a three-pole single throw switch. The live parts of outdoor switches shall be so constructed that they are not exposed to outside in any of open and closed positions.

5.106B Coating and plating

Any portion where rusting is anticipated shall be treated rustproof by coating or plating appropriate to the location.

The interior of outdoor switch and the parts made of steel or iron in indoor switches shall be electrically galvanized and then subjected to chromate treatment. All surfaces of outdoor steel or iron parts which are used being exposed to the outdoor such as hangers and tightening bolts shall be hot-dip galvanized as specified in **JIS H 8641** : 2007. In this procedure, the mass of plating shall be Class 2-45 or more for the parts made of steel or iron, Class 2-35 or more for bolts and washers, and Class 1A or more for thread parts of bolts and nuts, and shall be uniform.

5.106C Colour of coating

The colour of coating for a switch body and its control equipment shall, unless otherwise specified by the user, be as stated below according to the hue, lightness and chromaticness specified in **JIS Z 8721** : 1993.

- a) For outdoor switch : N5.5
- b) For indoor switch : 5Y7/1, or for the frame of relays or the like, N1.5.

5.106D Enclosure

The enclosure of enclosed outdoor switch body shall comply with the following requirements.

- a) The bottom surface of enclosure shall be so constructed that the surface is separated at least 20 mm even at the lowest point (at least 10 mm for the one made of stainless steel or light alloy) from the lower end face of leg, to prevent coming into contact with the earth or corroding easily.
- b) Where packings are used for the overlapping portions or the like of the enclosure, the enclosure shall be so constructed that the packings are not liable to be exposed to direct sunlight.

5.106E Operating mechanism

The operating mechanism shall comply with the following requirements.

- a) The operating mechanism shall be so constructed that it will cause neither semi-closed state nor semi-open state during normal closing and opening operations.
- b) The operating direction of operating handle shall, unless otherwise specified by the user, be as follows.
 - 1) **Pull string type** If the right string, viewed facing to the operating handle, is pulled downwards, the switch becomes “ON”, and if the left string is pulled downwards, the switch becomes “OFF”.
 - 2) **Rotary type** If the handle is rotated clockwise (right-handed), facing to the handle, the switch becomes “ON” and if it is rotated anticlockwise (left-handed), the switch becomes “OFF”.
 - 3) **UP and down type** If the handle is raised, the switch becomes “ON” and if it is lowered, the switch becomes “OFF”.
- c) When the position indicating device is a position indicator, the colour of position indicator shall be white (N9 or N9.3). In an enclosed outdoor switch equipped with an indicator, the left side, facing to the indicator, shall show “ON” and the right side shall show “OFF”. In such a case that an indicator is provided on the opposite side of the handle, the direction of indication is the same [see Figure 0Dc)].

When the indicator in “OFF” state is externally operated by hand, the contacts shall not become “ON”.