

Australian Standard™

**Common specifications for high-voltage
switchgear and controlgear standards
(IEC 60694, Ed.2.2(2002) MOD)**



This Australian Standard was prepared by Committee EL-007, Power Switchgear. It was approved on behalf of the Council of Standards Australia on 16 March 2005. This Standard was published on 27 May 2005.

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Australian Standard™

Common specifications for high-voltage switchgear and controlgear standards (IEC 60694, Ed.2.2(2002) MOD)

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-007, Power Switchgear, to supersede AS/NZS 2650:2000.

The objective of this Standard is to state those specifications common to high-voltage switchgear and controlgear within the scope of the Standard.

This Standard is an adoption with national modifications and has been reproduced from IEC 60694, Ed.2.2(2002), *Common specifications for high-voltage switchgear and controlgear standards*, and has been varied as indicated to take account of Australian conditions.

Variations to IEC 60694, Ed.2.2(2002) are indicated at the appropriate places throughout this Standard. Strikethrough (~~example~~) identifies IEC text, tables and figures which, for the purposes of this Australian Standard, are deleted. Where text, tables or figures are added, each is set in its proper place and identified by shading (example). Added figures are not themselves shaded, but are identified by a shaded border.

This Standard differs from the Standard it supersedes in the following major areas:

- (a) Standard is now Australian only to reflect the withdrawal of New Zealand participation in Committee EL-007.
- (b) Definitions have been updated.
- (c) 'Rated supply voltage of closing and opening devices and of auxiliary and control circuits' (Subclause 4.8) has been replaced.
- (d) Tables 14 and 15 replace tables 4 and 5.
- (e) 'Auxiliary and control equipment' (Subclause 5.4) has been replaced.
- (f) New figures 4,5,6,7 and 8 have been added.
- (g) Electromagnetic compatibility (Subclause 5.18) has been replaced.
- (h) The title and text of Subclause 6.2.10 has been replaced.
- (i) The title and text of Subclause 6.4.2 has been replaced.
- (j) Subclauses 6.9.1 to 6.9.7 and table 13 have been replaced.
- (k) Additional tests on auxiliary and control circuits (Subclause 6.10) have been added.
- (l) New annex 'Electromagnetic compatibility site measurements' (Annex H) has been added.
- (m) Bibliography (Annex G) has been updated.
- (n) References have been updated.

As this Standard is reproduced from an International Standard, the following applies:

- (i) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (ii) In the source text 'this international standard' should read 'this Australian Standard'.
- (iii) A full point should be substituted for a comma when referring to a decimal marker.
- (iv) Any French text on figures should be ignored.

The terms 'normative' and 'informative' are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

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STANDARDS AUSTRALIA

Australian Standard

Common specifications for high-voltage switchgear and controlgear standards (IEC 60694, Ed.2.2(2002) MOD)

Any table, figure or text of the international standard that is struck through is not part of this standard. Any Australian table, figure or text that is added is part of this standard and is identified by shading.

1 General

1.1 Scope

This International Standard applies to a.c. switchgear and controlgear, designed for indoor and outdoor installation and for operation at service frequencies up to and including 60 Hz on systems having voltages above 1 000 V.

This standard applies to all high-voltage switchgear and controlgear except as otherwise specified in the relevant IEC standards for the particular type of switchgear and controlgear.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

References to international standards that are struck through in this clause are replaced by references to Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is identified as such.

~~IEC 60034-1:1996, Rotating electrical machines — Part 1: Rating and performance~~

AS 1359.101, Rotating electrical machines, Part 101: General requirements—Rating and performance (identical to IEC 60034-1)

IEC 60038:1983, IEC standard voltages

~~IEC 60050(131):1978, International Electrotechnical Vocabulary (IEV) — Chapter 131: Electric and magnetic circuits~~

AS 1852.131, International Electrotechnology Vocabulary, Part 131: Electric and magnetic circuits

~~IEC 60050(151):1978, International Electrotechnical Vocabulary (IEV) — Chapter 151: Electrical and magnetic devices~~

AS 1852.151, International Electrotechnology Vocabulary, Part 151: Electric and magnetic devices

IEC 60050(191):1990, International Electrotechnical Vocabulary (IEV) – Chapter 191: Dependability and quality of service

~~IEC 60050(301):1983, International Electrotechnical Vocabulary (IEV) — Chapter 301: General terms on measurements in electricity~~

AS 1852.301, *International Electrotechnology Vocabulary, Part 301: General terms on measurements in electricity*

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

~~IEC 60050(441):1984, International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear and fuses~~

AS 1852.441, *International Electrotechnology Vocabulary, Part 441: Switchgear, controlgear and fuses*

~~IEC 60050(446):1983, International Electrotechnical Vocabulary (IEV) — Chapter 446: Electrical relays~~

AS 1852.446, *International Electrotechnology Vocabulary, Part 446: Electrical relays*

~~IEC 60050(581):1978, International Electrotechnical Vocabulary (IEV) — Chapter 581: Electro-mechanical components for electronic equipment~~

AS 1852.581, *International Electrotechnology Vocabulary, Part 581: Electromechanical components for electronic equipment*

~~IEC 60050(604):1987, International Electrotechnical Vocabulary (IEV) — Chapter 604: Generation, transmission and distribution of electricity—Operation~~

AS 1852.604, *International Electrotechnology Vocabulary, Part 604: Generation, transmission and distribution of electricity—Operation*

IEC 60050(811):1991, *International Electrotechnical Vocabulary (IEV) – Chapter 811: Electric traction*

~~IEC 60050(826):1982, International Electrotechnical Vocabulary (IEV) — Chapter 826: Electrical installations of buildings~~

AS 1852.826, *International Electrotechnology Vocabulary, Part 826: Electrical installations of buildings*

IEC 60051-2:1984, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 2: Special requirements for ammeters and voltmeters*

IEC 60051-4:1984, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 4: Special requirements for frequency meters*

IEC 60051-5:1985, *Direct acting indicating analogue electrical measuring instruments and their accessories – Part 5: Special requirements for phase meters, power factor meters and synchroscopes*

IEC 60059:1938, *IEC standard current ratings*

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

AS 1931.1, *High-voltage test techniques, Part 1: General definitions and test requirements (identical to IEC 60060-1)*

~~IEC 60064:1993, Tungsten filament lamps for domestic and similar general lighting purposes—Performance requirements~~

AS 2325, Tungsten filament lamps for general service—Performance requirements (identical to IEC 60064)

~~IEC 60068-2 (all parts), Environmental testing—Part 2: Tests~~

AS 60068.2 (all parts), Environmental testing, Part 2: Tests (identical to IEC 60068.2 (all parts))

~~IEC 60068-2-1:1990, Environmental testing—Part 2: Tests. Tests A: Cold~~

~~IEC 60068-2-2:1974, Environmental testing—Part 2: Tests. Tests B: Dry heat~~

~~IEC 60068-2-17:1994, Environmental testing—Part 2: Tests—Test Q: Sealing~~

~~IEC 60068-2-30:1980, Environmental testing—Part 2: Tests. Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle)~~

~~IEC 60068-2-75, Environmental testing—Part 2: Tests—Test Eg: Impact, spring hammer~~

~~IEC 60068-2-78, Environmental testing—Part 2-78: Tests—Test Cab: Damp heat, steady state~~

~~IEC 60071-1:1993, Insulation co-ordination—Part 1: Definitions, principles and rules~~

AS 1824.1, Insulation co-ordination, Part 1: Definitions, principles and rules

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

IEC 60073:1996, Basic and safety principles for man-machine interface, marking and identification – Coding principles for indication devices and actuators

IEC 60081:1997, Double-capped fluorescent lamps – Performance specifications

IEC 60083:1997, Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC

IEC 60085:1984, Thermal evaluation and classification of electrical insulation

IEC 60115-4:1982, Fixed resistors for use in electronic equipment – Part 4: Sectional specification: Fixed power resistors

IEC 60130 (all parts), Connectors for frequencies below 3 MHz

IEC 60227 (all parts), Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V

AS/NZS 60227.5, Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V, Part 5: Flexible cables (cords) (identical to IEC 60227-5)

IEC 60228:1978, Conductors of insulated cables

IEC 60245 (all parts), Rubber insulated cables – Rated voltages up to and including 450/750 V

AS/NZS 60245, *Rubber insulated cables—Rated voltages up to and including 450/750 V, Part 4: Cords and flexible cables* (identical to IEC 60245-4)

IEC 60255-5:1977, *Electrical relays – Part 5: Insulation tests for electrical relays*

IEC 60255-8:1990, *Electrical relays – Part 8: Thermal electrical relays*

IEC 60255-21-1:1988, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section One: Vibration tests (sinusoidal)*

IEC 60255-21-3:1993, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section 3: Seismic tests*

IEC 60255-23:1994, *Electrical relays – Part 23: Contact performance*

~~IEC 60269-1:1998, *Low-voltage fuses – Part 1: General requirements*~~

AS 60269.1, *Low-voltage fuses, Part 1: General requirements* (identical to IEC 60269-1)

~~IEC 60269-2:1986, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)*~~

AS 60269.2.0, *Low-voltage fuses, Part 2.0: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)* (identical to IEC 60269-2)

~~IEC 60269-2-1:2004, *Low-voltage fuses – Part 2-1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) – Sections I to VI: Examples of types of standardized fuses*~~

AS 60269.2.1, *Low-voltage fuses, Part 2.1: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)—Sections I to VI: Examples of types of standardized fuses* (identical to IEC 60269-2-1)

~~IEC 60270:1981, *Partial discharge measurements*~~

AS 60270, *High-voltage test techniques—Partial discharge measurements*

IEC 60296:1982, *Specification for unused mineral insulating oils for transformers and switchgear*

IEC 60309-1:1999, *Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements*

IEC 60309-2:1999, *Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories*

IEC 60326 (all parts), *Printed boards*

IEC 60376:1971, *Specification and acceptance of new sulphur hexafluoride*

IEC 60393-1:1989, *Potentiometers for use in electronic equipment – Part 1: Generic specification*

~~IEC 60417 (all parts), *Graphical symbols for use on equipment*~~

AS 60417 (all parts), *Graphical symbols for use on equipment* (identical to IEC 60417)

IEC 60445:1999, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

IEC 60480:1974, *Guide to the checking of sulphur hexafluoride (SF₆) taken from electrical equipment*

IEC 60485:1974, *Digital electronic d.c. voltmeters and d.c. electronic analogue-to-digital converters*

IEC 60502-1:1997, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) – Part 1: Cables for rated voltages of 1 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)*

IEC 60507:1991, *Artificial pollution tests on high-voltage insulators to be used on a.c. systems*

~~IEC 60512-2:1985, Electromechanical components for electronic equipment; basic testing procedures and measuring methods – Part 2: General examination, electrical continuity and contact resistance tests, insulation tests and voltage stress tests~~

AS 3726.2, *Electromechanical components for electronic equipment—Basic testing procedures and measuring methods, Part 2: General examination, electrical continuity and contact resistance tests, insulation tests and voltage stress tests (identical to IEC 60512-2)*

~~IEC 60529:1989, Degrees of protection provided by enclosures (IP code)~~

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

IEC 60617, *Graphical symbols for diagrams*

IEC 60669-1:1998, *Switches for household and similar fixed-electrical installations – Part 1: General requirements*

IEC 60721, *Classification of environmental conditions*

IEC 60730-2-9:1992, *Automatic electrical controls for household and similar use – Part 2: Particular requirements for temperature sensing controls*

IEC 60730-2-13:1995, *Automatic electrical controls for household and similar use – Part 2: Particular requirements for humidity sensing controls*

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

AS 4436, *Guide for the selection of insulators in respect of polluted conditions (identical to IEC 60815)*

IEC 60816:1984, *Guide on methods of measurement of short-duration transients on low-voltage power and signal lines*

~~IEC 60947-2:1995, Low-voltage switchgear and controlgear – Part 2: Circuit-breakers~~

AS/NZS 3947.2, *Low-voltage switchgear and controlgear, Part 2: Circuit-breakers (identical to IEC 60947.2)*

~~IEC 60947-3:1999, Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units~~

AS/NZS 3947.3, *Low-voltage switchgear and controlgear, Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units* (identical to IEC 60947-3)

~~IEC 60947-4-1:1990, *Low-voltage switchgear and controlgear – Part 4: Contactors and motor-starters – Section One: Electromechanical contactors and motor-starters*~~

AS 60947.4.1, *Low-voltage switchgear and controlgears, Part 4.1: Contactors and motor-starters—Electromechanical contactors and motor-starters* (identical to IEC 60947-4-1)

~~IEC 60947-4-2:1995, *Low-voltage switchgear and controlgear – Part 4: Contactors and motor-starters – Section 2: AC semiconductor motor controllers and starters*~~

AS 60947.4.2, *Low-voltage switchgear and controlgear, Part 4.2: Contactors and motor-starters—AC semiconductor motor controllers and starters* (identical to IEC 60947-4-2)

~~IEC 60947-5-1:1997, *Low-voltage switchgear and controlgear – Part 5: Control circuit devices and switching elements – Section One: Electromechanical control circuit devices*~~

AS 60947.5.1, *Low-voltage switchgear and controlgear, Part 5.1: Control circuit devices and switching elements—Electromechanical control circuit devices* (identical to IEC 60947-5-1)

~~IEC 60947-7-1:1989, *Low-voltage switchgear and controlgear – Part 7: Ancillary equipment – Section One: Terminal blocks for copper conductors*~~

AS 60947.7.1, *Low-voltage switchgear and controlgear, Part 7: Ancillary equipment—Terminal blocks for copper conductors* (identical to IEC 60947-7-1)

~~IEC 60947-7-2:1995, *Low-voltage switchgear and controlgear – Part 7: Ancillary equipment – Section 2: Protective conductor terminal blocks for copper conductors*~~

AS 60947.7.2, *Low-voltage switchgear and controlgear, Part 7.2: Ancillary equipment—Protective conductor terminal blocks for copper conductors*

~~IEC 61000-4-1:1992, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 1: Overview of immunity tests – Basic EMC publication*~~

AS/NZS 61000.4.1, *Electromagnetic compatibility (EMC), Part 4.1: Testing and measurement techniques—Overview of immunity tests*

IEC 61000-4-4:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical fast transient/burst immunity test – Basic EMC Publication*

IEC 61000-4-12:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 12: Oscillatory waves immunity test – Basic EMC Publication*

IEC 61000-4-17:1999, *Electromagnetic compatibility (EMC) – Part 4-17: Testing and measurement techniques – Ripple on d.c. input power port immunity test*

IEC 61000-4-29:2000, *Electromagnetic compatibility (EMC) – Part 4-29: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations on d.c. input power ports, immunity tests*

IEC 61000-5 (all parts), *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines*

IEC 61000-5-1:1996, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 1: General considerations – Basic EMC publication*

IEC 61000-5-2:1997, *Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling*

IEC 61000-6-5:2001, *Electromagnetic compatibility (EMC) – Part 6-5: Generic standards – Immunity for power station and substation environments*

IEC 61020-4:1991, *Electromechanical switches for use in electronic equipment – Part 4: Sectional specification for lever (toggle) switches*

IEC 61166:1993, *High-voltage alternating current circuit-breakers – Guide for seismic qualification of high-voltage alternating current circuit-breakers*

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

AS 4362.1, *High-voltage test techniques for low-voltage equipment, Part 1: Definitions, test and procedure requirements* (identical to IEC 61180-1)

~~IEC 61634:1995, High-voltage switchgear and controlgear—Use and handling of sulphur hexafluoride (SF₆) in high-voltage switchgear and controlgear~~

AS 2791, *High-voltage switchgear and controlgear—Use and handling of sulphur hexafluoride (SF₆) in high-voltage switchgear and controlgear* (identical to IEC 61634)

IEC 61810 (all parts), *Electromechanical non-specified time all-or-nothing relays*

IEC 61810-1:1998, *Electromechanical non-specified time all-or-nothing relays – Part 1: General requirements*

IEC 61810-7:1997, *Electromechanical all-or-nothing relays – Part 7: Tests and measurement procedures*

IEC 62271-100, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers*

~~CISPR 11:1990, Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment~~

AS/NZS CISPR 11, *Industrial, scientific and medical (ISM) radio-frequency equipment—Electromagnetic disturbance characteristics—Limits and methods of measurement*

CISPR 16-1:1993, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1: Radio disturbance and immunity measuring apparatus*

CISPR 18-2:1986, *Radio interference characteristics of overhead power lines and high-voltage equipment – Part 2: Methods of measurement and procedure for determining limits* Amendment 1 (1993)

Other International Standards are referred to for information in this standard. They are listed in annex G.

2 Normal and special service conditions

Unless otherwise specified, high-voltage switchgear and controlgear, including the operating devices and the auxiliary 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, high-voltage switchgear and controlgear and associated operating devices and auxiliary equipment shall be designed to comply with any special service conditions required by the user, or appropriate arrangements shall be made (see 2.2).

NOTE 1 Appropriate action should also be taken to ensure proper operation under such conditions of other components, such as relays.

NOTE 2 Detailed information concerning classification of environmental conditions is given in IEC 60721-3-3 (indoor) and IEC 60721-3-4 (outdoor).

2.1 Normal service conditions

2.1.1 Indoor switchgear and controlgear

- 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 minimum ambient air temperature is –5 °C for class "minus 5 indoor", –15 °C for class "minus 15 indoor" and –25 °C for class "minus 25 indoor".

- 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.
- e) The conditions of humidity are as follows:
- the average value of the relative humidity, measured over a period of 24 h, does not exceed 95 %;
 - the average value of the water vapour pressure, over a period of 24 h, does not exceed 2,2 kPa;
 - the average value of the relative humidity, over a period of one month, does not exceed 90 %;
 - the average value of the water vapour pressure, over a period of one month, does not exceed 1,8 kPa.

For these conditions, condensation may occasionally occur.

NOTE 1 Condensation can be expected where sudden temperature changes occur in periods of high humidity.

NOTE 2 To withstand the effects of high humidity and condensation, such as breakdown of insulation or corrosion of metallic parts, switchgear designed for such conditions and tested accordingly should be used.

NOTE 3 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.

- f) Vibration due to causes external to the switchgear and controlgear or earth tremors are negligible.
- g) Induced electromagnetic disturbances at interfaces of the secondary system, as a result of switching in the high-voltage system, do not exceed 1,6 kV common mode for normal EMC severity class, and 0,8 kV common mode for reduced EMC severity class.

NOTE 4 The maximum induced voltage values may be exceeded at interfaces to instrument transformers. Refer to instrument transformer standards for adequate performances of these devices.

2.1.2 Outdoor switchgear and controlgear

- 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 minimum ambient air temperature is –10 °C for class "minus 10 outdoor", –25 °C for class "minus 25 outdoor" and –40 °C for class "minus 40 outdoor".

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.~~

- b) Maximum solar radiation does not exceed 1.1 kW/m^2 (equivalent to a black body temperature of 80°C).

NOTE 1 Under certain conditions of solar radiation appropriate measures, e.g. roofing, forced ventilation, etc. may be necessary, or derating may be used, in order not to exceed the specified temperature rises.

NOTE 2 Details of global solar radiation are given in IEC 60721-2-4.

- 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 the pollution level II – Medium according to table 1 of IEC 60815.
- e) The ice coating does not exceed 1 mm for class 1, 10 mm for class 10 and 20 mm for class 20.
- 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 IEC 60721-2-2.

- g) Account should be taken of the presence of condensation or precipitations.

NOTE 4 Characteristics of precipitation are defined in IEC 60721-2-2.

- h) Vibration due to causes external to the switchgear and controlgear or to earth tremors are negligible.
- i) Induced electromagnetic disturbances at interfaces of the secondary system, as a result of switching in the high-voltage system, do not exceed 1,6 kV common mode for normal EMC severity class, and 0,8 kV common mode for reduced EMC severity class.

NOTE 5 The maximum induced voltage values may be exceeded at interfaces to instrument transformers. Refer to instrument transformer standards for adequate performances of these devices.

- j) Sudden drops of temperature of up to 20°C in a period of 20 min should be taken into account.

2.2 Special service conditions

When high-voltage switchgear and controlgear may be used under conditions different from the normal service conditions given in 2.1, the user's requirements should refer to standardized steps as follows.

2.2.1 Altitude

For installation at an altitude higher than 1 000 m, the insulation level of external insulation under the standardized reference atmospheric conditions shall be determined by multiplying the insulation withstand voltages required at the service location by a factor K_a in accordance with figure 1.

NOTE 1 For internal insulation, the dielectric characteristics are identical at any altitude and no special precautions need to be taken. For external and internal insulation, see IEC 60071-2.

NOTE 2 For low-voltage auxiliary and control equipment, no special precautions need to be taken if the altitude is lower than 2 000 m. For higher altitude, see IEC 60664-1.

2.2.2 Pollution

For installation in polluted ambient air, a pollution level III – Heavy, or IV – Very heavy of IEC 60815 should be specified.

2.2.3 Temperature and humidity

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

– 50°C and $+40^\circ\text{C}$ for very cold climates;

– 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.

In tropical indoor conditions, the average value of relative humidity measured during a period of 24 h can be 98 %.

2.2.4 Vibrations

For installations where earthquakes are likely to occur, severity level in accordance with IEC 61166 should be specified by the user.

2.2.5 Other parameters

When special environmental conditions prevail at the location where switchgear and controlgear is to be put in service, they should be specified by the user by reference to IEC 60721.

3 Definitions

For the purpose of this International Standard, the definitions in IEC 60050(151); IEC 60050(191); IEC 60050(441); IEC 60050(604) and IEC 60050(826) apply.

Some of them are recalled hereunder for easier use.

The definitions given below are also applicable. They are classified in accordance with IEC 60050(441). The definitions of IEC 60050(441) are not repeated but reference is made to their specific sub-clause number. References from other than IEC 60050(441) are classified so as to be aligned with the classification used in International Electrotechnical Vocabulary IEC 60050(441).

3.1 General terms

3.1.1

switchgear and controlgear

[IEV 441-11-01]

3.1.2

external insulation

the distances in atmosphere and the surfaces in contact with open air of solid insulation of the equipment which are subject to dielectric stresses and to the effects of atmospheric and other external conditions such as pollution, humidity, vermin etc.

[IEV 604-03-02]

3.1.3

IP code

a coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects, ingress of water and to give additional information in connection with such protection [3.4 of IEC 60529]

3.1.4

protection provided by an enclosure against access to hazardous parts

the protection of persons against:

- contact with hazardous mechanical parts;
- contact with hazardous low-voltage live parts;
- approach to hazardous high-voltage live parts below adequate clearance inside an enclosure [3.6 of IEC 60529]

3.1.5 maintenance

the combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function
[IEV 191-07-01]

3.1.6 scheduled maintenance

the preventive maintenance carried out in accordance with an established time schedule
[IEV 191-07-10]

3.1.7 inspection

periodic visual investigation of the principal features of the switchgear and controlgear in service without dismantling. This investigation is generally directed toward pressures and/or levels of fluids, tightness, position of relays, pollution of insulating parts, but actions such as lubricating, cleaning, washing, etc. which can be carried out with the switchgear and controlgear in service are also included

NOTE Observations resulting from inspection can lead to the decision to carry out overhaul.

3.1.8 diagnostic tests

comparative tests of the characteristic parameters of switchgear and controlgear to verify that it performs its functions, by measuring one or more of these parameters

NOTE The result from diagnostic tests can lead to the decision to carry out overhaul.

3.1.9 examination

inspection with the addition of partial dismantling, as required, supplemented by means such as measurements and non-destructive tests in order to reliably evaluate the condition of the switchgear and controlgear

3.1.10 overhaul

work done with the objective of repairing or replacing parts which are found to be out of tolerance by inspection, test, examination, or as required by manufacturer's maintenance manual, in order to restore the component and/or the switchgear and controlgear to an acceptable condition

3.1.11 down time

the time interval during which an item is in a down state
[IEV 191-09-08]

3.1.12 failure

the termination of the ability of an item to perform a required function
[IEV 191-04-01]

NOTE 1 After failure the item has a fault.

NOTE 2 "Failure" is an event, as distinguished from "fault", which is a state.

NOTE 3 This concept as defined does not apply to items consisting of software only.

3.1.13 major failure (of switchgear and controlgear)

failure of a switchgear and controlgear which causes the cessation of one or more of its fundamental functions

A major failure will result in an immediate change in the system operating conditions, e.g. the backup protective equipment will be required to remove the fault, or will result in mandatory removal from service within 30 min for unscheduled maintenance

3.1.14

minor failure (of switchgear and controlgear)

any failure of a constructional element or a sub-assembly which does not cause a major failure of the switchgear and controlgear

3.1.15

defect

an imperfection in the state of an item (or inherent weakness) which can result in one or more failures of the item itself, or of another item under the specific service or environmental or maintenance conditions, for a stated period of time

3.1.16

ambient air temperature

[IEV 441-11-13]

3.1.17

servicing level

ground level or fixed permanent floor level from which an authorized person can operate a device

3.1.18

non-exposed type

type of component of which no live part can readily be touched

3.1.19

monitoring

observation of the operation of a system or part of a system to verify correct functioning by detecting incorrect functioning; this being done by measuring one or more variables of the system and comparing the measured values with the specified values

[IEV 351-18-24, modified]

NOTE Several definitions are given for this term in the IEV. They are related to different cases of application. The reference given above is to be applied in the present case.

3.1.20

supervision

activity, performed either manually or automatically, intended to observe the state of an item

[IEV 191-07-26]

NOTE Several definitions are given for this term in the IEV. They are related to different cases of application. The reference given above is to be applied in the present case.

3.2 Assemblies of switchgear and controlgear

3.2.1

self-protected switchgear

switchgear and controlgear incorporating integral voltage-limiting devices

3.2.2

test specimen

a test specimen is a complete switchgear and controlgear when the poles are mechanically linked (i.e. one operating mechanism) or when the type tests are mainly three-pole type tests. If this is not the case, a test specimen is one pole of the complete switchgear and controlgear. Where permitted in the relevant IEC standard, a test specimen may be a representative sub-assembly

3.3 Parts of assemblies

3.3.1

transport unit

a part of switchgear and controlgear suitable for transportation without being dismantled

3.4 Switching devices

No particular definitions.

3.5 Parts of switchgear and controlgear

3.5.1

enclosure

a part providing protection of equipment against certain external influences and, in any direction, protection against direct contact

[IEV 826-03-12]

NOTES This definition taken from IEC 60050(826) needs the following explanations under the scope of this standard:

- 1 Enclosures provide protection of persons or livestock against access to hazardous parts.
- 2 Barriers, shapes of openings or any other means – whether attached to the enclosure or formed by the enclosed equipment suitable to prevent or limit the penetration of the specified test probes are considered as a part of the enclosure, except when they can be removed without the use of a key or tool. [3.1 of IEC 60529]

3.5.2

hazardous part

a part that is hazardous to approach or touch [3.5 of IEC 60529]

3.5.3

contact

[IEV 441-15-05]

3.5.4

auxiliary circuit

[IEV 441-15-04]

3.5.5

control circuit

[IEV 441-15-03]

3.5.6

auxiliary switch

[IEV 441-15-11]

3.5.7

control switch

[IEV 441-14-46]

3.5.8

auxiliary contact

[IEV 441-15-10]

3.5.9

control contact

[IEV 441-15-09]

3.5.10**connection (bolted or the equivalent)**

two or more conductors designed to ensure permanent circuit continuity when forced together by means of screws, bolts or the equivalent

3.5.11**position indicating device**

[IEV 441-15-25]

3.5.12**monitoring device**

device intended to observe automatically the state of an item
[from IEV 191-07-26]

3.5.13**pilot switch**

[IEV 441-14-48]

3.5.14**low energy contact**

contact designed to be used in very low energy circuits, e.g. for monitoring or information technology

NOTE Typical applications are contacts inserted into a load circuit through which flows a current of some milliamperes at a voltage not exceeding 10 V at the terminals.

3.5.15**cable entry**

part with openings, which permit the passage of cables into the enclosure

3.5.16**cover plate**

part of an enclosure which is used for closing an opening and designed to be held in place by screws or similar means. It is not normally removed after the equipment is put in service

3.5.17**partition**

part of an assembly separating one compartment from other compartments
[IEV 441-13-06]

3.5.18**actuator**

part of the actuating system to which an external actuating force is applied

NOTE The actuator may take the form of a handle, knob, push-button, roller, plunger, etc.
[IEV 441-15-22]

3.5.19**indicating device (of a measuring instrument)**

ensemble of components of a measuring instrument intended to indicate the value of the measured quantity

NOTE By extension, the indicating means or setting device of any instrument such as a material measure or a signal generator.
[IEV 301-07-01]

3.5.20**splice**

connecting device with barrel(s) accommodating electrical conductor(s) with or without additional provision to accommodate and secure the insulation
[IEV 581-05-11]

3.5.21**terminal**

point of an electric circuit, intended for making a connection
[IEV 131-01-02]

3.5.22**terminal block**

assembly of terminals in a housing or body of insulating material to facilitate interconnection between multiple conductors
[IEV 581-06-36]

3.5.23**neutral conductor (symbol N)**

conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy
[IEV 826-01-03]

3.5.24**protective conductor (symbol PE)**

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

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

[IEV 826-04-05]

3.5.25**PEN conductor**

earthed conductor combining the functions of both protective conductor and neutral conductor

NOTE The acronym PEN results of the combination of both symbols PE for the protective conductor and N for the neutral conductor.

[IEV 826-04-06]

3.5.26**all-or-nothing relay**

electrical relay which is intended to be energized by a quantity whose value is either within its operative range or effectively zero

[IEV 446-11-02]

3.5.27**thermal electrical relay**

dependant-time measuring relay which is intended to protect an equipment from electrical thermal damage by measurement of the current flowing in the protected equipment and by a characteristic curve simulating its thermal behaviour

[IEV 446-15-16]

3.5.28**(mechanical) contactor**

mechanical switching device having only one position of rest, operated otherwise than by hand, capable of making, carrying and breaking currents under normal circuit conditions including operating overload conditions

NOTE Contactors may be designated according to the method by which the force for closing the main contacts is provided.

[IEV 441-14-33]

3.5.29 starter

combination of all the switching means necessary to start and stop a motor in combination with suitable overload protection

NOTE Starters may be designated according to the method by which the force for closing the main contacts is provided.

[IEV 441-14-38]

3.5.30 shunt release

release energized by a source of voltage

NOTE The source of voltage may be independent of the voltage of the main circuit.

[IEV 441-16-41]

3.5.31 switch

component fitted with an actuator and contacts to make and break a connection

[IEV 581-10-01]

3.5.32 distribution circuit (of buildings)

circuit supplying a distribution board

[IEV 826-05-02]

3.5.33 final circuit (of buildings)

circuit connected directly to current using equipment or to socket-outlets

[IEV 826-05-03]

3.5.34 toggle switch

switch having a lever (toggle), the movement of which results either directly or indirectly in the connection or disconnection of the switch terminations in a specified manner. Any indirect action through an actuating mechanism shall be such that the speed of connection and/or disconnection is independent of the speed of lever movement

[IEV 581-10-11]

3.5.35 disconnecter

mechanical switching device which provides, in the open position, an isolating distance in accordance with specified requirements

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

[IEV 441-14-05]

3.5.36 counter

device indicating the number of operating cycles a mechanical switching device has accomplished

3.5.37 indicator light

lamp used as an indicator

[IEV 811-31-06]

3.5.38**plug and socket-outlet**

means enabling the connection at will of a flexible cable to fixed wiring

NOTE The application of the means is shown in figure 1 of IEC 60309-1.

3.5.39**cable coupler**

means enabling the connection at will of two flexible cables

NOTE The application of the means is shown in figure 1 of IEC 60309-1.

3.5.40**appliance coupler**

means enabling the connection at will of a flexible cable to the equipment

NOTE The application of the means is shown in figure 1 of IEC 60309-1.

3.5.41**connector**

component which terminates conductors for the purpose of providing connection and disconnection to a suitable mating component
[IEV 581-06-01]

3.5.42**coil**

set of series-connected turns, usually coaxial

[IEV 151-01-21]

3.5.43**static switching component**

device in which the switching action is developed by electronic, magnetic, optical or other components without mechanical motion

3.5.44**secondary system**

entity of

- control and auxiliary circuits, mounted on or adjacent to the switchgear or controlgear, including circuits in central control cubicles;
- equipment for monitoring, diagnostics, etc., that is part of the auxiliary circuits of the switchgear or controlgear;
- circuits connected to the secondary terminals of instrument transformers, that are part of the switchgear or controlgear

3.5.45**subassembly (of a secondary system)**

part of a secondary system, with regard to function or position. A subassembly is normally placed in a separate enclosure, and shall have its own interface

3.5.46**interchangeable subassembly (of a secondary system)**

subassembly which is intended to be placed in various positions within a secondary system, or intended to be replaced by other similar subassemblies. An interchangeable subassembly has an accessible interface

3.6 Operation**3.6.1****dependent power operation**

[IEV 441-16-14]

3.6.2 stored energy operation [IEV 441-16-15]

3.6.3 positively driven operation

operation which, in accordance with specified requirements, is designed to ensure that auxiliary contacts of a mechanical switching device are in the respective positions corresponding to the open or closed position of the main contacts
[IEV 441-16-12, modified]

NOTE A positively driven operating device is made by the association of a moving part, linked mechanically to the main contact of the primary circuit, without the use of springs, and a sensing element. In the case of mechanical auxiliary contacts, this sensing element can be simply the fixed contact, directly connected to the secondary terminal. In the case where the function is achieved electronically, the sensing element can be a static transducer (optical, magnetic, etc.) associated with a static switch, or associated with an electronic or electro-optic transmitting element.

3.6.4 Definitions relative to pressure (or density)

3.6.4.1 rated filling pressure for insulation p_{re} (or density ρ_{re})

the pressure in Pascals (Pa), for insulation and/or for switching, referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, to which the assembly is filled before being put into service, or automatically replenished

3.6.4.2 rated filling pressure for operation p_{rm} (or density ρ_{rm})

the pressure (Pa), referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, to which the control device is filled before being put into service or automatically replenished

3.6.4.3 alarm pressure for insulation p_{ae} (or density ρ_{ae})

the pressure (Pa), for insulation and/or for switching, referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, at which a monitoring signal may be provided to indicate that replenishment is necessary in a relatively short time

3.6.4.4 alarm pressure for operation p_{am} (or density ρ_{am})

the pressure (Pa), referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, at which a monitoring signal may be provided to indicate that replenishment of the control device is necessary in a relatively short time

3.6.4.5 minimum functional pressure for insulation p_{me} (or density ρ_{me})

the pressure (Pa), for insulation and/or for switching, referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, at which and above which rated characteristics of switchgear and controlgear are maintained and at which a replenishment becomes necessary

3.6.4.6 minimum functional pressure for operation p_{mm} (or density ρ_{mm})

the pressure (Pa), referred to the standard atmospheric air conditions of +20 °C and 101,3 kPa (or density), which may be expressed in relative or absolute terms, at which and above which rated characteristics of switchgear and controlgear are maintained and at which a replenishment of the control device becomes necessary. This pressure is often designated as interlocking pressure

3.6.5 Definitions relating to gas and vacuum tightness

These definitions apply to all switchgear and controlgear which use vacuum or gas, other than air at atmospheric pressure, as insulating or combined insulating and interrupting or operating medium.

3.6.5.1

gas-filled compartment

a compartment of switchgear and controlgear in which the gas pressure is maintained by one of the following systems:

- a) controlled pressure system;
- b) closed pressure system;
- c) sealed pressure system.

NOTE Several gas-filled compartments may be permanently interconnected to form a common gas-system (gas-tight assembly).

3.6.5.2

controlled pressure system for gas

a volume which is automatically replenished from an external or internal gas source

NOTE 1 Examples of controlled pressure systems are air-blast circuit-breakers or pneumatic operating mechanisms.

NOTE 2 A volume may consist of several permanently connected gas-filled compartments.

3.6.5.3

closed pressure system for gas

a volume which is replenished only periodically by manual connection to an external gas source

NOTE Example of closed pressure systems are SF₆ single pressure circuit-breakers.

3.6.5.4

sealed pressure system

a volume for which no further gas or vacuum processing is required during its expected operating life

NOTE 1 Examples of sealed pressure systems are tubes of vacuum circuit-breakers or some SF₆ circuit-breakers.

NOTE 2 Sealed pressure systems are completely assembled and tested in the factory.

3.6.5.5

absolute leakage rate, F

the amount of gas escaped by time unit, expressed in Pa.m³/s

3.6.5.6

permissible leakage rate, F_p

the maximum permissible absolute leakage rate of gas specified by the manufacturer for a part, a component or a sub-assembly, or by using the tightness coordination chart (TC), for an arrangement of parts, components or sub-assemblies connected together in one pressure system

3.6.5.7

relative leakage rate, F_{rel}

the absolute leakage rate related to the total amount of gas in the system at rated filling pressure (or density). It is expressed in percentage per year or per day

3.6.5.8

time between replenishments, T

the time elapsed between two replenishments performed either manually or automatically when the pressure (density) reaches the alarm level, to compensate the leakage rate F

3.6.5.9**number of replenishments per day, N**

the number of replenishments to compensate the leakage rate F . This value is applicable to controlled pressure systems

3.6.5.10**pressure drop, Δp**

the drop of pressure in a given time caused by the leakage rate F , without replenishment

3.6.5.11**tightness coordination chart, TC**

a survey document supplied by the manufacturer, used when testing parts, components or sub-assemblies, to demonstrate the relationship between the tightness of a complete system and that of the parts, components and/or sub-assemblies

3.6.5.12**cumulative leakage measurement**

a measurement which takes into account all the leaks from a given assembly to determine the leakage rate

3.6.5.13**sniffing**

the action of slowly moving a leak meter sensing probe around an assembly to locate a gas leak

3.6.6 Definitions relating to liquid tightness

These definitions apply to all switchgear and controlgear which use liquids as insulating, combined insulating and interrupting, or control medium with or without permanent pressure.

3.6.6.1**controlled pressure system for liquid**

a volume which is automatically replenished with liquid

3.6.6.2**closed pressure system for liquid**

a volume which is manually replenished only periodically with liquid

3.6.6.3**absolute leakage rate, F_{liq}**

the amount of liquid escaped by time unit, expressed in cm^3/s

3.6.6.4**permissible leakage rate, $F_{p(liq)}$**

the maximum permissible leakage rate specified by the manufacturer for a liquid pressure system

3.6.6.5**number of replenishments per day, N_{liq}**

the number of replenishments to compensate the leakage rate F_{liq} . This value is applicable to controlled pressure systems

3.6.6.6**pressure drop, ΔP_{liq}**

the drop in pressure in a given time caused by the leakage rate F_{liq} without replenishment

3.7 Characteristic quantities

3.7.1

isolating distance

[IEV 441-17-35]

3.7.2

degree of protection

the extent of protection provided by an enclosure against access to hazardous parts, against ingress of solid foreign objects and/or ingress of water and verified by standardized test methods [3.3 of IEC 60529]

3.7.3

rated value

a quantity value assigned, generally by a manufacturer, for a specified operating condition of a component device or equipment
[IEV 151-04-03]

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4 Ratings

The common ratings of switchgear and controlgear, including their operating devices and auxiliary equipment, should be selected from the following:

- rated voltage (U_r)
- rated insulation level
- rated frequency (f_r)

- d) rated normal current (I_r)
- e) rated short-time withstand current (I_k)
- f) rated peak withstand current (I_p)
- g) rated duration of short circuit (t_k)
- h) rated supply voltage of closing and opening devices and of auxiliary circuits (U_a)
- i) rated supply frequency of closing and opening devices and of auxiliary circuits
- j) rated pressure of compressed gas supply for insulation or operation.

NOTE Other rated characteristics may be necessary and will be specified in the relevant IEC standards.

4.1 Rated voltage (U_r)

The rated voltage indicates the upper limit of the highest voltage of systems for which the switchgear and controlgear is intended. Standard values of rated voltages are given below:

NOTE For editorial reasons, mainly due to the characteristics of the transient recovery voltages, the subdivision in voltage ranges differs from that in IEC 60038.

4.1.1 Range I for rated voltages of 245 kV and below

Series I 3,6 kV – 7,2 kV – 12 kV – 17,5 kV – 24 kV – 36 kV – 52 kV – 72,5 kV – 100 kV – 123 kV – 145 kV – 170 kV – 245 kV.

Series II (based on the current practice in North America): 4,76 kV – 8,25 kV – 15 kV – 25,8 kV – 38 kV – 48,3 kV – 72,5 kV.

4.1.2 Range II for rated voltages above 245 kV

300 kV – 362 kV – 420 kV – 550 kV – 800 kV.

4.2 Rated insulation level

The rated insulation level of switchgear and controlgear shall be selected from the values given in tables 1 and 2.

In these tables, the withstand voltage applies at the standardized reference atmosphere (temperature, pressure and humidity) specified in IEC 60071-1. For special service conditions, see 2.2.

The rated withstand voltage values for lightning impulse voltage (U_p), switching impulse voltage (U_s) (when applicable), and power-frequency voltage (U_d) shall be selected without crossing the horizontal marked lines. The rated insulation level is specified by the rated lightning impulse withstand voltage phase to earth.

For most of the rated voltages, several rated insulation levels exist to allow for application of different performance criteria or overvoltage patterns. The choice should be made considering the degree of exposure to fast-front and slow-front overvoltages, the type of neutral earthing of the system and the type of overvoltage limiting devices (see IEC 60071-2).

The "common values" as used in tables 1a and 1b apply to phase-to-earth, between phases and across the open switching device, if not otherwise specified in this standard. The withstand voltage values "across the isolating distance" are valid only for the switching devices where the clearance between open contacts is designed to meet the safety requirements specified for disconnectors.

For further information about insulation levels, see annex D.

**Table 1a – Rated insulation levels for rated voltages
of range I, series I**

Rated voltage U_r kV (r.m.s. value)	Rated short-duration power-frequency withstand voltage U_d kV (r.m.s. value)		Rated lightning impulse withstand voltage U_p kV (peak value)	
	Common value	Across the isolating distance	Common value	Across the isolating distance
(1)	(2)	(3)	(4)	(5)
3,6	10	12	20	23
			40	46
7,2	20	23	40	46
			60	70
12	28	32	60	70
			75	85
			95	110
17,5	38	45	75	85
			95	110
24	50	60	95	110
			125	145
36	70	80	145	165
			170	195
			200	230
52	95	110	250	290
72,5	140	160	325	375
100	150	175	380	440
	185	210	450	520
123	185	210	450	520
	230	265	550	630
145	230	265	550	630
	275	315	650	750
170	275	315	650	750
	325	375	750	860
245	360	415	850	950
	395	460	950	1 050
	460	530	1 050	1 200

**Table 1b – Rated insulation levels for rated voltages of range I, series II
(used in North America)***

Rated voltage U_r kV (r.m.s. value)	Rated short-duration power-frequency withstand voltage U_d kV (r.m.s. value)				Rated lightning impulse withstand voltage U_p kV (peak value)	
	Common value		Across the isolating distance		Common value	Across isolating distance
	Dry	Wet**	Dry	Wet**		
(1)	(2)	(2 a)	(3)	(3 a)	(4)	(5)
4,76	19	–	21	–	60	70
8,25	26	24	29	27	75	80
	35	30	39	33	95	105
15	35	30	39	33	95	105
	50	45	55	50	110	125
25,8	50	45	55	50	125	140
	70	60	77	66	150	165
38	70	60	77	66	150	165
	95	80	105	88	200	220
48,3	120	100	132	110	250	275
72,5	160	140	176	154	350	385
* For rated voltages higher than 72,5 kV up to and including 245 kV, the values of table 1a are applicable.						
** Wet values are a 10 s withstand for equipment used outdoors. See 9.2 of IEC 60060-1.						

Table 2a – Rated insulation levels for rated voltages of range II

Rated voltage U_r kV (r.m.s. value)	Rated short-duration power-frequency withstand voltage U_d kV (r.m.s. value)		Rated switching impulse withstand voltage U_s kV (peak value)			Rated lightning impulse withstand voltage U_p kV (peak value)	
	Phase-to-earth and between phases (note 3)	Across open switching device and/or isolating distance (note 3)	Phase-to-earth and across open switching device	Between phases (notes 3 and 4)	Across isolating distance (notes 1, 2 and 3)	Phase-to-earth and between phases	Across open switching device and/or isolating distance (notes 2 and 3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
300	380	435	750	1 125	700 (+ 245)	950	950 (+ 170)
			850	1 275		1 050	1 050 (+ 170)
362	450	520	850	1 275	800 (+ 295)	1 050	1 050 (+ 205)
			950	1 425		1 175	1 175 (+ 205)
420	520	610	950	1 425	900 (+ 345)	1 300	1 300 (+ 240)
			1 050	1 575		1 425	1 425 (+ 240)
550	620	800	1 050	1 680	900 (+ 450)	1 425	1 425 (+ 315)
			1 175	1 760		1 550	1 550 (+ 315)
800	830	1 150	1 300	2 210	1 100 (+ 650)	1 800	1 800 (+ 455)
			1 425	2 420		2 100	2 100 (+ 455)

NOTE 1 Column (6) is also applicable to some circuit-breakers, see IEC 62271-100.

NOTE 2 In column (6), values in brackets are the peak values of the power-frequency voltage $U_r \sqrt{2}/\sqrt{3}$ applied to the opposite terminal (combined voltage).

In column (8), values in brackets are the peak values of the power-frequency voltage $0,7 U_r \sqrt{2}/\sqrt{3}$ applied to the opposite terminal (combined voltage).

See annex D.

NOTE 3 Values of column (2) are applicable:

- for type tests, phase-to-earth,
- for routine tests, phase-to-earth, phase-to-phase, and across the open switching device.

Values of columns (3), (5), (6) and (8) are applicable for type tests only.

NOTE 4 These values are derived using the multiplying factors stated in table 3 of IEC 60071-1.

Table 2b – Additional rated insulation levels in North America for range II

Rated voltage U_r kV (r.m.s. value)	Rated short-duration power-frequency withstand voltage U_d kV (r.m.s. value)		Rated switching impulse withstand voltage U_s kV (peak value)			Rated lightning impulse withstand voltage U_p kV (peak value)	
	Phase-to-earth and between phases (note 3)	Across open switching device and/or isolating distance (note 3)	Phase-to-earth and across open switching device	Between phases (notes 3 and 4)	Across isolating distance (notes 1, 2 and 3)	Phase-to-earth and between phases	Across open switching device and/or isolating distance (notes 2 and 3)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
362	520	610	950	1 425	800 (+ 295)	1300	1 300 (+ 205)
550	710	890	1 175	2 210	900 (+ 450)	1800	1 800 (+ 315)
The notes are the same as those to table 2a.							

4.3 Rated frequency (f_r)

The standard values of the rated frequency are 16 2/3 Hz, 25 Hz, 50 Hz and 60 Hz.

4.4 Rated normal current and temperature rise

4.4.1 Rated normal current (I_r)

The rated normal current of switchgear and controlgear is the r.m.s. value of the current which switchgear and controlgear shall be able to carry continuously under specified conditions of use and behaviour.

The values of rated normal currents should be selected from the R 10 series, specified in IEC 60059.

NOTE 1 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 10^n .

NOTE 2 Rated currents for temporary or for intermittent duty are subject to agreement between manufacturer and user.

4.4.2 Temperature rise

The temperature rise of any part of switchgear and controlgear at an ambient air temperature not exceeding 40 °C shall not exceed the temperature-rise limits specified in table 3 under the conditions specified in the test clauses.

Table 3 – Limits of temperature and temperature rise for various parts, materials and dielectrics of high-voltage switchgear and controlgear

Nature of the part, of the material and of the dielectric (See points 1, 2 and 3) (See note)	Maximum value	
	Temperature °C	Temperature rise at ambient air temperature not exceeding 40 °C K
1 Contacts (see point 4) Bare-copper or bare-copper alloy – in air 75 35 – in SF ₆ (sulphur hexafluoride) (see point 5) 105 65 – in oil 80 40 Silver-coated or nickel-coated (see point 6) – in air 105 65 – in SF ₆ (see point 5) 105 65 – in oil 90 50 Tin-coated (see point 6) – in air 90 50 – in SF ₆ (see point 5) 90 50 – in oil 90 50		
2 Connection, bolted or the equivalent (see point 4) Bare-copper, bare-copper alloy or bare-aluminium alloy – in air 90 50 – in SF ₆ (see point 5) 115 75 – in oil 100 60 Silver-coated or nickel-coated see point 6) – in air 115 75 – in SF ₆ (see point 5) 115 75 – in oil 100 60 Tin-coated in air 105 65 – in SF ₆ (see point 5) 105 65 – in oil 100 60		
3 All other contacts or connections made of bare metals or coated with other materials (see point 7) (see point 7)		
4 Terminals for the connection to external conductors by screws or bolts (see point 8) – bare 90 50 – silver, nickel or tin-coated 105 65 – other coatings (see point 7) (see point 7)		
5 Oil for oil switching devices (see points 9 and 10) 90 50		
6 Metal parts acting as springs (see point 11) (see point 11)		
7 Materials used as insulation and metal parts in contact with insulation of the following classes (see point 12) – Y 90 50 – A 105 65 – E 120 80 – B 130 90 – F 155 115 – Enamel: oil base 100 60 synthetic 120 80 – H 180 140 – C other insulating material (see point 13) (see point 13)		
8 Any part of metal or of insulating material in contact with oil, except contacts 100 60		
9 Accessible parts – expected to be touched in normal operation 70 30 – which need not to be touched in normal operation 80 40		
NOTE The points referred to in this table are those of 4.4.3.		