

Low-voltage switchgear and controlgear

Part 1. General rules

The European Standard EN 60947-1 : 1997, with the incorporation of its amendment A1 : 1998, has the status of a British Standard

ICS 29.130.20

National foreword

This British Standard is the English language version of EN 60947-1 : 1997, including amendment A1 : 1998. It was derived by CENELEC from IEC 60947-1 : 1996, including amendment 1 : 1997. It supersedes BS EN 60947-1 : 1992, which is withdrawn.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a single sideline.

The UK participation in its preparation was entrusted by Technical Committee PEL/17, High-voltage switchgear and controlgear, to Subcommittee PEL/17/2, Low-voltage switchgear and controlgear, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change-over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement these international or European publications may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or by using the 'Find' facility of the BSI Standards Electronic Catalogue.

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Board, was published under the authority of the Standards Board and comes into effect on 15 March 1998

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ISBN 0 580 29154 5

Amendments issued since publication

Amd. No.	Date	Text affected
10271	March 1999	Annex N added. Other changes indicated by a double sideline



Documents

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Summary of pages

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Descriptors: low-voltage switchgear and controlgear, characteristics, specification, test

English version

Low-voltage switchgear and controlgear

Part 1: General rules

(includes amendment A1 : 1998)

(IEC 60947-1 : 1996 + A1 : 1997, modified)

Appareillage à basse tension

Partie 1: Règles générales

(inclut l'amendement A1 : 1998)

(CEI 60947-1 : 1996 + A1 : 1997, modifiée)

Niederspannungsschaltgeräte

Teil 1: Allgemeine Festlegungen

(enthält Änderung A1 : 1998)

(IEC 60947-1 : 1996 + A1 : 1997, modifiziert)

This European Standard was approved by CENELEC on 1997-10-01; amendment A1 was approved by CENELEC on 1998-01-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 60947-1:1996, prepared by SC 17B, Low-voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, together with common modifications prepared by the Technical Committee CENELEC TC 17B, Low-voltage switchgear and controlgear including dimensional standardization, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 60947-1 on 1997-10-01.

This European Standard supersedes EN 60947-1:1991 and its amendments A11:1994, A2:1995 and A1:1996.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-06-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-06-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes C, K, L, M and ZA are normative and annexes A, B, D, E, F, G, H and J are informative.

Annex ZA has been added by CENELEC.

Foreword to amendment A1

The text of document 17B/855/FDIS, future amendment 1 to IEC 60947-1 : 1996, prepared by SC 17B, Low-voltage switchgear and controlgear, of IEC TC 17, Switchgear and controlgear, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as amendment A1 to EN 60947-1 : 1997 on 1998-01-01.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-10-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1998-10-01

Annexes designated 'normative' are part of the body of the standard.

In this standard, annexes N and ZA are normative.

Annex ZA has been added by CENELEC.

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 1: General rules

1 General

The purpose of this standard is to harmonize as far as practicable all rules and requirements of a general nature applicable to low-voltage switchgear and controlgear in order to obtain uniformity of requirements and tests throughout the corresponding range of equipment and to avoid the need for testing to different standards.

All those parts of the various equipment standards which can be considered as general have therefore been gathered in this standard together with specific subjects of wide interest and application, e.g. temperature-rise, dielectric properties, etc.

For each type of low-voltage switchgear and controlgear, only two main documents are necessary to determine all requirements and tests:

- 1) this basic standard, referred to as "Part 1" in the specific standards covering the various types of low-voltage switchgear and controlgear;
- 2) the relevant equipment standard hereinafter referred to as the "relevant product standard" or "product standard".

For a general rule to apply to a specific product standard, it shall be explicitly referred to by the latter, by quoting the relevant clause or subclause number of this standard followed by "Part 1" e.g. "7.2.3 of Part 1".

A specific product standard may not require, and hence may omit, a general rule (as being not applicable), or it may add to it (if deemed inadequate in the particular case), but it may not deviate from it, unless there is a substantial technical justification.

NOTE – The product standards due to be part of the series of IEC standards covering low-voltage switchgear and controlgear are:

- 947-2: Part 2: Circuit-breakers
- 947-3: Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units
- 947-4: Part 4: Contactors and motor-starters
- 947-5: Part 5: Control-circuit devices and switching elements
- 947-6: Part 6: Multiple function equipment
- 947-7: Part 7: Ancillary equipment

1.1 Scope and object

This standard applies, when required by the relevant product standard, to switchgear and controlgear hereinafter referred to as "equipment" and intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c. or 1 500 V d.c.

It does not apply to low-voltage switchgear and controlgear assemblies which are dealt with in IEC 439.

NOTE – In certain clauses or subclauses of this standard, the equipment covered by this standard is also referred to as "device", to be consistent with the text of such clauses or subclauses.

The object of this standard is to state those general rules and requirements which are common to low-voltage equipment as defined in 1.1, including for example:

- definitions;
- characteristics;
- information supplied with the equipment;
- normal service, mounting and transport conditions;
- constructional and performance requirements;
- verification of characteristics and performance.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 947. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 947 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.

IEC 50(151): 1978, *International Electrotechnical Vocabulary (IEV) – Chapter 151: Electrical and magnetic devices*

IEC 50(441): 1984, *International Electrotechnical Vocabulary (IEV) – Chapter 441: Switchgear, controlgear and fuses*

IEC 50(604): 1987, *International Electrotechnical Vocabulary (IEV) – Chapter 604: Generation, transmission and distribution of electricity – Operation*

IEC 50(826): 1982, *International Electrotechnical Vocabulary (IEV) – Chapter 826: Electrical installations of buildings*

IEC 60, *High-voltage test techniques*

IEC 68-2-3: 1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 71-1: 1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 73: 1991, *Coding of indicating devices and actuators by colours and supplementary means*

IEC 85: 1984, *Thermal evaluation and classification of electrical insulation*

IEC 99-1: 1991, *Surge arresters – Part 1: Non-linear resistor type gapped surge arresters for a.c. systems*

IEC 112: 1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 216, *Guide for the determination of thermal endurance properties of electrical insulating materials*

- IEC 269-1: 1986, *Low-voltage fuses – Part 1: General requirements*
- IEC 269-2: 1986, *Low-voltage fuses – Part 2: Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)*
- IEC 364-4-443: 1990, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 44: Protection against overvoltages – Section 443: Protection against overvoltages of atmospheric origin or due to switching*
- IEC 417: 1973, *Graphical symbols for use on equipment – Index, survey and compilation of the single sheets*
- IEC 439-1: 1992, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*
- IEC 445: 1988, *Identification of equipment terminals and of terminations of certain designated conductors, including general rules of an alphanumeric system*
- IEC 447: 1993, *Man-machine interface (MM) – Actuating principles*
- IEC 529: 1989, *Degrees of protection provided by enclosures (IP code)*
- IEC 617-7: 1983, *Graphical symbols for diagrams – Part 7: Switchgear, controlgear and protective devices*
- IEC 664-1: 1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests – Basic safety publication*
- IEC 695-2-1/0: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 0: Glow-wire test methods – General*
- IEC 695-2-1/1: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 1: Glow-wire end-product test and guidance*
- IEC 695-2-1/2: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 2: Glow-wire flammability test on materials*
- IEC 695-2-1/3: 1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 3: Glow-wire ignitability test on materials*
- IEC 695-2-2: 1991, *Fire hazard testing – Part 2: Test methods – Section 2: Needle-flame test*
- IEC 707: 1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source*
- IEC 981: 1989, *Extra-heavy duty rigid steel conduits for electrical installations*
- IEC 998-1: 1990, *Connecting devices for low-voltage circuits for household and similar purposes – Part 1: General requirements*

IEC 1000-4-2: 1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test – Basic EMC publication*

IEC 1000-4-3: 1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test*

IEC 1000-4-4: 1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 4: Electrical test transient/burst immunity test – Basic EMC publication*

IEC 1000-4-5: 1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

IEC 60536-2 : 1992, *Classification of electrical and electronic equipment with regard to protection against electric shock — Part 2: Guidelines to requirements for protection against electric shock*

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

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

CISPR 22: 1993, *Limits and methods of measurement of radio disturbance characteristics of information technology equipment*

2 Definitions

NOTE – Most of the definitions listed in this clause are taken unchanged from the IEV (IEC 50). When this is the case, the IEV reference is given in brackets with the title (the first group of 3 figures indicates the IEV chapter reference).

When an IEV definition is amended, the IEV reference is not indicated with the title, but in an explanatory note.

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2.1 General terms

2.1.1 switchgear and controlgear: A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures. [441-11-01]

2.1.2 switchgear: A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for use in connection with generation, transmission, distribution and conversion of electric energy. [441-11-02]

2.1.3 controlgear: A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for the control of electric energy consuming equipment. [441-11-03]

2.1.4 over-current: A current exceeding the rated current. [441-11-06]

2.1.5 short circuit: The accidental or intentional connection, by a relatively low resistance or impedance, of two or more points in a circuit which are normally at different voltages. [151-03-41]

2.1.6 short-circuit current: An over-current resulting from a short circuit due to a fault or an incorrect connection in an electric circuit. [441-11-07]

2.1.7 overload: Operating conditions in an electrically undamaged circuit which cause an over-current. [441-11-08]

2.1.8 overload current: An over-current occurring in an electrically undamaged circuit.

2.1.9 ambient air temperature: The temperature, determined under prescribed conditions, of the air surrounding the complete switching device or fuse. [441-11-13]

NOTE – For switching devices or fuses installed inside an enclosure, it is the temperature of the air outside the enclosure.

2.1.10 conductive part: A part which is capable of conducting current although it may not necessarily be used for carrying service current. [441-11-09]

2.1.11 exposed conductive part: A conductive part which can readily be touched and which is not normally alive, but which may become alive under fault conditions. [441-11-10]

NOTE – Typical exposed conductive parts are walls of enclosures, operating handles, etc.

2.1.12 extraneous conductive part: A conductive part not forming part of the electrical installation and liable to introduce a potential, generally the earth potential. [826-03-03]

2.1.13 live part: A conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor. [826-03-01]

NOTE – This term does not necessarily imply a risk of electric shock.

2.1.14 protective conductor (symbol PE): A 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.

[826-04-05]

2.1.15 neutral conductor (symbol N): A conductor connected to the neutral point of a system and capable of contributing to the transmission of electrical energy. [826-01-03]

NOTE – In some cases, the functions of the neutral conductor and the protective conductor may be combined under specified conditions in one and the same conductor referred to as the PEN conductor [Symbol PEN].

2.1.16 enclosure: A part providing a specified degree of protection of equipment against certain external influences and a specified degree of protection against approach to or contact with live parts and moving parts.

NOTE – This definition is similar to IEC 441-13-01, which applies to assemblies.

2.1.17 integral enclosure: An enclosure which forms an integral part of the equipment.

2.1.18 utilization category (for a switching device or a fuse): A combination of specified requirements related to the conditions in which the switching device or the fuse fulfils its purpose, selected to represent a characteristic group of practical applications. [441-17-19]

NOTE – The specified requirements may concern e.g. the values of making capacities (if applicable), breaking capacities and other characteristics, the associated circuits and the relevant conditions of use and behaviour.

2.1.19 isolation (isolating function): Function intended to cut off the supply from all or a discrete section of the installation by separating the installation or section from every source of electrical energy for reasons of safety.

2.1.20 electric shock: Pathophysiological effect resulting from an electric current passing through a human or animal body. [826-03-04]

2.2 Switching devices

2.2.1 switching device: A device designed to make or break the current in one or more electric circuits. [441-14-01]

NOTE – A switching device may perform one or both of these operations.

2.2.2 mechanical switching device: A switching device designed to close and open one or more electric circuits by means of separable contacts. [441-14-02]

NOTE – Any mechanical switching device may be designated according to the medium in which its contacts open and close, e.g.: air, SF₆, oil.

2.2.3 semiconductor switching device: A switching device designed to make and/or break the current in an electric circuit by means of the controlled conductivity of a semiconductor.

NOTE – This definition differs from IEC 441-14-03 since a semiconductor switching device is also designed for breaking the current.

2.2.4 fuse: A device that, by the fusing of one or more of its specifically designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device. [441-18-01]

2.2.5 fuse-link: The part of a fuse (including the fuse-element(s)) intended to be replaced after the fuse has operated. [441-18-09]

2.2.6 fuse-element: A part of the fuse-link designed to melt under the action of current exceeding some definite value for a definite period of time. [441-18-08]

2.2.7 fuse-combination unit: A combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions. [441-14-04]

2.2.8 disconnecter: A mechanical switching device which, in the open position, complies with the requirements specified for the isolating function.

NOTE – This definition differs from IEC 441-14-05 because the requirements for the isolating function are not based only on an isolating distance.

2.2.9 switch (mechanical): A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions which may include specified operating overload conditions and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short circuit. [441-14-10]

NOTE – A switch may be capable of making but not breaking short-circuit currents.

2.2.10 switch-disconnector: A switch which, in the open position, satisfies the isolating requirements specified for a disconnecter. [441-14-12]

2.2.11 circuit-breaker: A mechanical switching device, capable of making, carrying and breaking currents under normal circuit conditions and also making, carrying for a specified time and breaking currents under specified abnormal circuit conditions such as those of short circuit. [441-14-20]

2.2.12 contactor (mechanical): A 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. [441-14-33]

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

2.2.13 semiconductor contactor (solid-state contactor): A device which performs the function of a contactor by utilizing a semiconductor switching device.

NOTE – A semiconductor contactor may also contain mechanical switching devices.

2.2.14 contactor relay: A contactor used as a control switch. [441-14-35]

2.2.15 starter: The combination of all the switching means necessary to start and stop a motor, in combination with suitable overload protection. [441-14-38]

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

2.2.16 control circuit device: An electrical device, intended for the controlling, signalling, interlocking, etc. of switchgear and controlgear.

NOTE – Control circuit devices may include associated devices dealt with in other standards, such as instruments, potentiometers, relays, in so far as such associated devices are used for the purposes specified.

2.2.17 control switch (for control and auxiliary circuits): A mechanical switching device which serves the purpose of controlling the operation of switchgear or controlgear, including signalling, electrical interlocking, etc. [441-14-46]

NOTE – A control switch consists of one or more contact elements with a common actuating system.

2.2.18 pilot switch: A non-manual control switch actuated in response to specified conditions of an actuating quantity. [441-14-48]

NOTE – The actuating quantity may be pressure, temperature, velocity, liquid level, elapsed time, etc.

2.2.19 push-button: A control switch having an actuator intended to be operated by force exerted by a part of the human body, usually the finger or palm of the hand, and having stored energy (spring) return. [441-14-53]

2.2.20 terminal block: An insulating part carrying one or more mutually insulated terminal assemblies and intended to be fixed to a support.

2.2.21 short-circuit protective device (SCPD): A device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them.

2.2.22 surge arrester: A device designed to protect the electrical apparatus from high transient overvoltages and to limit the duration and frequently the amplitude of the follow-on current. [604-03-51]

2.3 *Parts of switching devices*

2.3.1 pole of a switching device: The portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together. [441-15-01]

NOTE – A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

2.3.2 main circuit (of a switching device): All the conductive parts of a switching device included in the circuit which it is designed to close or open. [441-15-02]

2.3.3 control circuit (of a switching device): All the conductive parts (other than the main circuit) of a switching device which are included in a circuit used for the closing operation or opening operation, or both, of the device. [441-15-03]

2.3.4 auxiliary circuit (of a switching device): All the conductive parts of a switching device which are intended to be included in a circuit other than the main circuit and the control circuits of the device. [441-15-04]

NOTE – Some auxiliary circuits fulfil supplementary functions such as signalling, interlocking, etc., and, as such, they may be part of the control circuit of another switching device.

2.3.5 contact (of a mechanical switching device): Conductive parts designed to establish circuit continuity when they touch and which, due to their relative motion during an operation, open or close a circuit or, in the case of hinged or sliding contacts, maintain circuit continuity. [441-15-05]

2.3.6 contact piece: One of the conductive parts forming a contact. [441-15-06]

2.3.7 main contact: A contact included in the main circuit of a mechanical switching device, intended to carry, in the closed position, the current of the main circuit. [441-15-07]

2.3.8 arcing contact: Arc contact on which the arc is intended to be established. [441-15-08]

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

2.3.9 control contact: A contact included in a control circuit of a mechanical switching device and mechanically operated by this device. [441-15-09]

2.3.10 auxiliary contact: A contact included in an auxiliary circuit and mechanically operated by the switching device. [441-15-10]

2.3.11 auxiliary switch (of a mechanical switching device): A switch containing one or more control and/or auxiliary contacts mechanically operated by a switching device. [441-15-11]

2.3.12 "a" contact – make contact: A control or auxiliary contact which is closed when the main contacts of the mechanical switching device are closed and open when they are open. [441-15-12]

2.3.13 "b" contact – break contact: A control or auxiliary contact which is open when the main contacts of the mechanical switching device are closed and closed when they are open. [441-15-13]

2.3.14 relay (electrical): A device designed to produce sudden, predetermined changes in one or more electrical output circuits when certain conditions are fulfilled in the electrical input circuits controlling the device. [446-11-01]

2.3.15 release (of a mechanical switching device): A device, mechanically connected to a mechanical switching device, which releases the holding means and permits the opening or the closing of the switching device. [441-15-17]

NOTE – A release can have instantaneous, time-delay, etc., operation. The various types of releases are defined in 2.4.24 to 2.4.35.

2.3.16 actuating system (of a mechanical switching device): The whole of the operating means of a mechanical switching device which transmit the actuating force to the contact pieces.

NOTE – The operating means of an actuating system may be mechanical, electromagnetic, hydraulic, pneumatic, thermal, etc.

2.3.17 actuator: The part of the actuating system to which an external actuating force is applied. [441-15-22]

NOTE – The actuator may take the form of a handle, knob, push-button, roller, plunger, etc.

2.3.18 position indicating device: A part of a mechanical switching device which indicates whether it is in the open, closed, or, where appropriate, earthed position. [441-15-25]

2.3.19 indicator light: Light signal giving information either by lighting or extinguishing.

2.3.20 anti-pumping device: A device which prevents reclosing after a close-open operation as long as the device initiating closing is maintained in the position for closing. [441-16-48]

2.3.21 interlocking device: A device which makes the operation of a switching device dependent upon the position of operation of one or more other pieces of equipment. [441-16-49]

2.3.22 terminal: A conductive part of a device provided for electrical connection to external circuits.

2.3.23 screw-type terminal: A terminal intended for the connection and disconnection of conductors or for the inter-connection of two or more conductors, the connection being made, directly or indirectly, by means of screws or nuts of any kind.

NOTE – Examples are given in annex D.

2.3.24 screwless-type terminal: A terminal intended for the connection and disconnection of conductors or for the interconnection on two or more conductors, the connection being made, directly or indirectly, by means of springs, wedges, eccentrics or cones, etc.

NOTE – Examples are given in annex D.

2.3.25 clamping unit: The part(s) of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s).

2.3.26 unprepared conductor: A conductor which has been cut and the insulation of which has been removed for insertion into a terminal.

NOTE – A conductor the shape of which is arranged for introduction into a terminal or the strands of which are twisted to consolidate the end is considered to be an unprepared conductor.

2.3.27 prepared conductor: A conductor, the strands of which are soldered or the end of which is fitted with a cable lug, eyelet, etc.

2.4 Operation of switching devices

2.4.1 operation (of a mechanical switching device): The transfer of the moving contact(s) from one position to an adjacent position. [441-16-01]

NOTES

1 For example, for a circuit-breaker, this may be a closing operation or an opening operation.

2 If distinction is necessary, an operation in the electrical sense, e.g., make or break, is referred to as a switching operation, and an operation in the mechanical sense, e.g., close or open, is referred to as a mechanical operation.

2.4.2 operating cycle (of a mechanical switching device): A succession of operations from one position to another and back to the first position through all other positions, if any. [441-16-02]

2.4.3 operating sequence (of a mechanical switching device): A succession of specified operations with specified time intervals. [441-16-03]

2.4.4 manual control: Control of an operation by human intervention. [441-16-04]

2.4.5 automatic control: Control of an operation without human intervention, in response to the occurrence of predetermined conditions. [441-16-05]

2.4.6 local control: Control of an operation at a point on or adjacent to the controlled switching device. [441-16-06]

2.4.7 remote control: Control of an operation at a point distant from the controlled switching device. [441-16-07]

2.4.8 closing operation (of a mechanical switching device): An operation by which the device is brought from the open position to the closed position. [441-16-08]

2.4.9 opening operation (of a mechanical switching device): An operation by which the device is brought from the closed position to the open position. [441-16-09]

2.4.10 positive opening operation (of a mechanical switching device): An opening operation which, in accordance with specified requirements, ensures that all the main contacts are in the open position when the actuator is in the position corresponding to the open position of the device. [441-16-11]

2.4.11 positively driven operation: An 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. [441-16-12]

2.4.12 dependent manual operation (of a mechanical switching device): An operation solely by means of directly applied manual energy such that the speed and force of the operation are dependent upon the action of the operator. [441-16-13]

2.4.13 dependent power operation (of a mechanical switching device): An operation by means of energy other than manual, where the completion of the operation is dependent upon the continuity of the power supply (to solenoids, electric or pneumatic motors, etc.). [441-16-14]

2.4.14 stored energy operation (of a mechanical switching device): An operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions. [441-16-15]

NOTE – This kind of operation may be subdivided according to:

- 1 the manner of storing the energy (spring, weight, etc.);
- 2 the origin of the energy (manual, electric, etc.);
- 3 the manner of releasing the energy (manual, electric, etc.).

2.4.15 independent manual operation (of a mechanical switching device): A stored energy operation where the energy originates from manual power, stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator. [441-16-16]

2.4.16 independent power operation (of a mechanical switching device): A stored energy operation where the stored energy originates from an external power source and is released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator.

2.4.17 actuating force (moment): The force (moment) applied to an actuator necessary to complete the intended operation. [441-16-17]

2.4.18 restoring force (moment): The force (moment) provided to restore an actuator or a contact element to its initial position. [441-16-19]

2.4.19 travel (of a mechanical switching device or a part thereof): The displacement (translation or rotation) of a point on a moving element. [441-16-21]

NOTE – Distinction may be made between pre-travel, over-travel, etc.

2.4.20 closed position (of a mechanical switching device): The position in which the predetermined continuity of the main circuit of the device is secured. [441-16-22]

2.4.21 open position (of a mechanical switching device): The position in which the predetermined dielectric withstand voltage requirements are satisfied between open contacts in the main circuit of the device.

NOTE – This definition differs from IEC 441-16-23 to meet the requirements of dielectric properties.

2.4.22 tripping (operation): An opening operation of a mechanical switching device initiated by a relay or release.

2.4.23 trip-free mechanical switching device: A mechanical switching device, the moving contacts of which return to and remain in the open position when the opening (i.e. tripping) operation is initiated after the initiation of the closing operation, even if the closing command is maintained.

NOTES

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

2 The wording of IEC 441-16-31 has been completed by adding "(i.e. tripping)" since the opening operation of a trip-free mechanical switching device is automatically controlled.

2.4.24 instantaneous relay or release: A relay or release which operates without any intentional time-delay.

2.4.25 over-current relay or release: A relay or release which causes a mechanical switching device to open with or without time-delay when the current in the relay or release exceeds a predetermined value.

NOTE – This value can in some cases depend upon the rate-of-rise of current.

2.4.26 definite time-delay over-current relay or release: An over-current relay or release which operates with a definite time-delay which may be adjustable, but is independent of the value of the over-current.

2.4.27 inverse time-delay over-current relay or release: An over-current relay or release which operates after a time-delay inversely dependent upon the value of the over-current.

NOTE – Such a relay or release may be designed so that the time-delay approaches a definite minimum value for high values of over-current.

2.4.28 direct over-current relay or release: An over-current relay or release directly energized by the current in the main circuit of a switching device.

2.4.29 indirect over-current relay or release: An over-current relay or release energized by the current in the main circuit of a switching device through a current transformer or a shunt.

2.4.30 overload relay or release: An over-current relay or release intended for protection against overloads.

2.4.31 thermal overload relay or release: An inverse time-delay overload relay or release depending for its operation (including its time-delay) on the thermal action of the current flowing in the relay or release.

2.4.32 magnetic overload relay or release: An overload relay or release depending for its operation on the force exerted by the current in the main circuit exciting the coil of an electromagnet.

NOTE – Such a relay or release usually has an inverse time-delay/current characteristic.

2.4.33 shunt release: A release energized by a source of voltage. [441-16-41]

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

2.4.34 under-voltage relay or release: A relay or release which permits a mechanical switching device to open or close, with or without time-delay, when the voltage across the terminals of the relay or release falls below a predetermined value.

2.4.35 reverse current relay or release (d.c. only): A relay or release which permits a mechanical switching device to open, with or without time-delay, when the current flows in the reverse direction and exceeds a predetermined value.

2.4.36 operating current (of an over-current relay or release): The value of current at and above which the relay or release will operate.

2.4.37 current-setting (of an over-current or overload relay or release): The value of current of the main circuit to which the operating characteristics of the relay or release are referred and for which the relay or release is set.

NOTE – A relay or release may have more than one current setting, provided by an adjustment dial, interchangeable heaters, etc.

2.4.38 current setting range (of an over-current or overload relay or release): The range between the minimum and maximum values over which the current setting of the relay or release can be adjusted.

2.5 Characteristic quantities

2.5.1 nominal value: A suitable approximate quantity value used to designate or identify a component, device or equipment. [151-04-01]

2.5.2 limiting value: In a specification, the greatest or smallest admissible value of one of the quantities. [151-04-02]

2.5.3 rated value: A quantity value assigned, generally by the manufacturer, for a specified operating condition of a component, device or equipment. [151-04-03]

2.5.4 rating: The set of rated values and operating conditions. [151-04-04]

2.5.5 prospective current (of a circuit and with respect to a switching device or a fuse): The current that would flow in the circuit if each pole of the switching device or the fuse were replaced by a conductor of negligible impedance. [441-17-01]

NOTE – The method to be used to evaluate and to express the prospective current is to be specified in the relevant product standard.

2.5.6 prospective peak current: The peak value of a prospective current during the transient period following initiation. [441-17-02]

NOTE – The definition assumes that the current is made by an ideal switching device, i.e. with instantaneous transition from infinite to zero impedance. For circuits where the current can follow several different paths, e.g. polyphase circuits, it further assumes that the current is made simultaneously in all poles, even if only the current in one pole is considered.

2.5.7 prospective symmetrical current (of an a.c. circuit): The prospective current when it is initiated at such an instant that no transient phenomenon follows the initiation. [441-17-03]

NOTES

- 1 For polyphase circuits the condition of non-transient period can only be satisfied for the current in one pole at a time.
- 2 The prospective symmetrical current is expressed by its r.m.s. value.

2.5.8 maximum prospective peak current (of an a.c. circuit): The prospective peak current when initiation of the current takes place at the instant which leads to the highest possible value. [441-17-04]

NOTE – For a multipole device in a polyphase circuit, the maximum prospective peak current refers to one pole only.

2.5.9 prospective making current (for a pole of a switching device): The prospective current when initiated under specified conditions. [441-17-05]

NOTE – The specified conditions may relate to the method of initiation, e.g. by an ideal switching device, or to the instant of initiation, e.g., leading to the maximum prospective peak current in an a.c. circuit, or to the highest rate of rise. The specification of these conditions is given in the relevant product standard.

2.5.10 prospective breaking current (for a pole of a switching device or a fuse): The prospective current evaluated at a time corresponding to the instant of the initiation of the breaking process. [441-17-06]

NOTE – Specifications concerning the instant of the initiation of the breaking process are given in the relevant product standard. For mechanical switching devices or fuses, it is usually defined as the moment of initiation of the arc during the breaking process.

2.5.11 breaking current (of a switching device or a fuse): The current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process. [441-17-07]

NOTE – For a.c., the current is expressed as the symmetrical r.m.s. value of the a.c. component.

2.5.12 breaking capacity (of a switching device or a fuse): A value of prospective breaking current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour. [441-17-08]

NOTES

- 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.
- 2 For a.c., the current is expressed as the symmetrical r.m.s. value of the a.c. component.
- 3 For short-circuit breaking capacity, see 2.5.14.

2.5.13 making capacity (of a switching device): A value of prospective making current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour. [441-17-09]

NOTES

- 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.
- 2 For short-circuit making capacity, see 2.5.15.

2.5.14 short-circuit breaking capacity: A breaking capacity for which prescribed conditions include a short circuit at the terminals of the switching device. [441-17-11]

2.5.15 short-circuit making capacity: A making capacity for which prescribed conditions include a short circuit at the terminals of the switching device. [441-17-10]

2.5.16 critical load current: A value of breaking current, within the range of service conditions, at which the arcing time is significantly extended.

2.5.17 critical short-circuit current: A value of breaking current, less than the rated short-circuit breaking capacity, at which the arc energy is significantly higher than at the rated short-circuit breaking capacity.

2.5.18 Joule integral (I^2t): The integral of the square of the current over a given time interval [441-18-23]:

$$I^2t = \int_{t_0}^{t_1} I^2 dt$$

2.5.19 cut-off current – let-through current: The maximum instantaneous value of current attained during the breaking operation of a switching device or a fuse. [441-17-12]

NOTE – This concept is of particular importance when the switching device or the fuse operates in such a manner that the prospective peak current of the circuit is not reached.

2.5.20 time-current characteristic: A curve giving the time, e.g. pre-arcing time or operating time, as a function of the prospective current, under stated conditions of operation. [441-17-13]

2.5.21 cut-off (current) characteristic – let-through (current) characteristic: A curve giving the cut-off current as a function of the prospective current, under stated conditions of operation. [441-17-14]

NOTE – In the case of a.c., the values of the cut-off currents are the maximum values which can be reached whatever the degree of asymmetry. In the case of d.c., the values of the cut-off currents are the maximum values reached related to the time constant as specified.

2.5.22 over-current protective co-ordination of over-current protective devices: Co-ordination of two or more over-current protective devices in series to ensure overcurrent discrimination (selectivity) and/or back-up protection.

2.5.23 over-current discrimination: Co-ordination of the operating characteristics of two or more over-current protective devices such that, on the incidence of over-currents within stated limits, the device intended to operate within these limits does so, while the other(s) does (do) not. [441-17-15]

NOTE – Distinction is made between series discrimination involving different over-current protective devices passing substantially the same over-current and network discrimination involving identical protective devices passing different proportions of the over-current.

2.5.24 back-up protection: Over-current co-ordination of two over-current protective devices in series where the protective device, generally but not necessarily on the supply side, effects the over-current protection with or without the assistance of the other protective device and prevents any excessive stress on the latter.

2.5.25 take-over current: The current co-ordinate of the intersection between the time-current characteristics of two over-current protective devices. [441-17-16]

2.5.26 short-time delay: Any intentional delay in operation within the limits of the rated short-time withstand current.

2.5.27 short-time withstand current: The current that a circuit or a switching device in the closed position can carry during a specified short time under prescribed conditions of use and behaviour. [441-17-17]

2.5.28 peak withstand current: The value of peak current that a circuit or a switching device in the closed position can withstand under prescribed conditions, of use and behaviour. [441-17-18]

2.5.29 conditional short-circuit current (of a circuit or a switching device): The prospective current that a circuit or a switching device, protected by a specified short-circuit protective device, can satisfactorily withstand for the total operating time of that device under specified conditions of use and behaviour.

NOTES

- 1 For the purpose of this standard, the short-circuit protective device is generally a circuit-breaker or a fuse.
- 2 This definition differs from IEC 441-17-20 by broadening the concept of current limiting device into a short-circuit protective device, the function of which is not only to limit the current.

2.5.30 conventional non-tripping current (of an over-current relay or release): A specified value of current which the relay or release can carry for a specified time (conventional time) without operating.

2.5.31 conventional tripping current (of an over-current relay or release): A specified value of current which causes the relay or release to operate within a specified time (conventional time).

2.5.32 applied voltage (for a switching device): The voltage which exists across the terminals of a pole of a switching device just before the making of the current. [441-17-4]

NOTE – This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.

2.5.33 recovery voltage: The voltage which appears across the terminals of a pole of a switching device or a fuse after the breaking of the current. [441-17-25]

NOTES

- 1 This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power-frequency voltage or the steady-state recovery voltage alone exists.
- 2 This definition applies to a single-pole device. For a multipole device it is the phase-to-phase voltage across the supply terminals of the device.

2.5.34 transient recovery voltage (abbreviation TRV): The recovery voltage during the time in which it has a significant transient character. [441-17-26]

NOTE – The transient voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit, the switching device or the fuse. It includes the voltage shift of the neutral of a polyphase circuit.

2.5.35 power-frequency recovery voltage: The recovery voltage after the transient voltage phenomena have subsided. [441-17-27]

2.5.36 d.c. steady-state recovery voltage: The recovery voltage in a d.c. circuit after the transient voltage phenomena have subsided, expressed by the mean value where ripple is present. [441-17-28]

2.5.37 prospective transient recovery voltage (of a circuit): The transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device. [441-17-29]

NOTE – The definition assumes that the switching device or the fuse, for which the prospective transient recovery voltage is sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow several different paths, e.g. a polyphase circuit, the definition further assumes that the breaking of the current by the ideal switching device takes place only in the pole considered.

2.5.38 peak arc voltage (of a mechanical switching device): The maximum instantaneous value of voltage which, under prescribed conditions, appears across the terminals of a pole of a switching device during the arcing time. [441-17-30]

2.5.39 opening time (of a mechanical switching device): The interval of time between the specified instant of initiation of the opening operation and the instant when the arcing contacts have separated in all poles. [441-17-36]

NOTE – The instant of initiation of the opening operation, i.e. the application of the opening command (e.g. energizing the release), is given in the relevant product standard.

2.5.40 arcing time (of a pole or a fuse): The interval of time between the instant of the initiation of the arc in a pole or a fuse and the instant of final arc extinction in that pole or that fuse. [441-17-37]

2.5.41 arcing time (of a multipole switching device): The interval of time between the instant of the first initiation of an arc and the instant of final arc extinction in all poles. [441-17-38]

2.5.42 break time: The interval of time between the beginning of the opening time of a mechanical switching device (or the pre-arcing time of a fuse) and the end of the arcing time. [441-17-39]

2.5.43 make time: The interval of time between the initiation of the closing operation and the instant when the current begins to flow in the main circuit. [441-17-40]

2.5.44 closing time: The interval of time between the initiation of the closing operation and the instant when the contacts touch in all poles. [441-17-41]

2.5.45 make-break time: The interval of time between the instant when the current begins to flow in a pole and the instant of final arc extinction in all poles, with the opening release energized at the instant when current begins to flow in the main circuit. [441-17-43]

2.5.46 clearance: The distance between two conductive parts, along a string stretched the shortest way between these conductive parts. [441-17-31]

2.5.47 clearance between poles: The clearance between any conductive parts of adjacent poles. [441-17-32]

2.5.48 clearance to earth: The clearance between any conductive parts and any parts which are earthed or intended to be earthed. [441-17-33]

2.5.49 clearance between open contacts (gap): The total clearance between the contacts, or any conductive parts connected thereto, of a pole of a mechanical switching device in the open position. [441-17-34]

2.5.50 isolating distance (of a pole of a mechanical switching device): The clearance between open contacts meeting the safety requirements specified for disconnectors. [441-17-35]

2.5.51 creepage distance: The shortest distance along the surface of an insulating material between two conductive parts.

NOTE – A joint between two pieces of insulating material is considered part of the surface.

2.5.52 working voltage: The highest r.m.s. value of the a.c. or d.c. voltage across any particular insulation which can occur when the equipment is supplied at rated voltage.

NOTES

1 Transients are disregarded.

2 Both open-circuit conditions and normal operating conditions are taken into account.

2.5.53 temporary overvoltage: The phase-to-earth, phase-to-neutral or phase-to-phase overvoltage at a given location and of relatively long duration (several seconds).

2.5.54 transient overvoltages: The transient overvoltages in the sense of this standard are the following:

2.5.54.1 switching overvoltage: A transient overvoltage at a given location on a system due to a specific switching operation or a fault.

2.5.54.2 lightning overvoltage: A transient overvoltage at a given location on a system due to a specific lightning discharge [see also IEC 60 and IEC 71-1].

2.5.54.3 functional overvoltage: A deliberately imposed overvoltage necessary for the functioning of a device.

2.5.55 impulse withstand voltage: The highest peak value of an impulse voltage, of prescribed form and polarity, which does not cause breakdown under specified conditions of test.

2.5.56 power-frequency withstand voltage: The r.m.s. value of a power-frequency sinusoidal voltage which does not cause breakdown under specified conditions of test.

2.5.57 pollution: Any condition of foreign matter, solid, liquid or gaseous (ionized gases), that may affect dielectric strength or surface resistivity.

2.5.58 pollution degree (of environmental conditions): A conventional number based on the amount of conductive or hygroscopic dust, ionized gas or salt and on the relative humidity and its frequency of occurrence, resulting in hygroscopic absorption or condensation of moisture leading to reduction in dielectric strength and/or surface resistivity.

NOTES

1 The pollution degree to which equipment is exposed may be different from that of the macro-environment where the equipment is located because of protection offered by means such as an enclosure or internal heating to prevent absorption or condensation of moisture.

2 For the purpose of this standard, the pollution degree is that of the micro-environment.

2.5.59 micro-environment (of a clearance or creepage distance): The ambient conditions which surround the clearance or creepage distance under consideration.

NOTE – The micro-environment of the creepage distance or clearance and not the environment of the equipment determines the effect on the insulation. The micro-environment might be better or worse than the environment of the equipment. It includes all factors influencing the insulation, such as climatic and electromagnetic conditions, generation of pollution, etc.

2.5.60 overvoltage category (of a circuit or within an electrical system): A conventional number based on limiting (or controlling) the values of prospective transient overvoltages occurring in a circuit (or within an electrical system having different nominal voltages) and depending upon the means employed to influence the overvoltages.

NOTE – In an electrical system, the transition from one overvoltage category to another of lower category is obtained through appropriate means complying with interface requirements, such as an overvoltage protective device or a series-shunt impedance arrangement capable of dissipating, absorbing, or diverting the energy in the associated surge current, to lower the transient overvoltage value to that of the desired lower overvoltage category.

2.5.61 co-ordination of insulation: The correlation of insulating characteristics of electrical equipment with the expected overvoltages and the characteristics of overvoltage protective devices on the one hand, and with the expected micro-environment and the pollution protective means on the other hand.

2.5.62 homogeneous (uniform) field: An electric field which has an essentially constant voltage gradient between electrodes, such as that between two spheres where the radius of each sphere is greater than the distance between them.

2.5.63 inhomogeneous (non-uniform) field: An electric field which has not an essentially constant voltage gradient between electrodes.

2.5.64 tracking: The progressive formation of conducting paths which are produced on the surface of a solid insulating material, due to the combined effects of electric stress and electrolytic contamination on this surface.

2.5.65 comparative tracking index (CTI): The numerical value of the maximum voltage in volts at which a material withstands 50 drops of a test solution without tracking.

NOTES

1 The value of each test voltage and the CTI should be divisible by 25.

2 This definition reproduces 2.3 of IEC 112.

2.6 Tests

2.6.1 type test: A test of one or more devices made to a certain design to show that the design meets certain specifications. [151-04-15]

2.6.2 routine test: A test to which each individual device is subjected during and/or after manufacture to ascertain whether it complies with certain criteria. [151-04-16]

2.6.3 sampling test: A test on a number of devices taken at random from a batch. [151-04-17]

2.6.4 special test: A test, additional to type tests and routine tests, made either at the discretion of the manufacturer or according to an agreement between manufacturer and user.

3 Classification

This clause is intended to list the characteristics of an equipment on which information may be given by the manufacturer and which may not necessarily have to be verified by testing.

This clause is not mandatory in product standards which should, however, leave space for it in order to list, where necessary, classification criteria.

4 Characteristics

Alphabetical list of characteristics (whether rated or not) and symbols

Characteristic	Symbol	Subclause
Conventional enclosed thermal current	I_{the}	4.3.2.2
Conventional free air thermal current	I_{th}	4.3.2.1
Eight-hour duty	—	4.3.4.1
Intermittent duty	—	4.3.4.3
Periodic duty	—	4.3.4.5
Rated breaking capacity	—	4.3.5.3
Rated conditional short-circuit current	—	4.3.6.4
Rated control circuit voltage	U_c	4.5.1
Rated control supply voltage	U_s	4.5.1
Rated current	I_n	1)
Rated frequency	—	4.3.3
Rated impulse withstand voltage	U_{imp}	4.3.1.3
Rated insulation voltage	U_i	4.3.1.2
Rated making capacity	—	4.3.5.2
Rated operational current	I_e	4.3.2.3
Rated operational power	—	4.3.2.3
Rated operational voltage	U_e	4.3.1.1
Rated rotor insulation voltage	U_{ir}	1)
Rated rotor operational current	I_{er}	1)
Rated rotor operational voltage	U_{er}	1)
Rated service short-circuit breaking capacity	I_{cs}	1)
Rated short-circuit breaking capacity	I_{cn}	4.3.6.3
Rated short-circuit making capacity	I_{cm}	4.3.6.2
Rated short-time withstand current	I_{cw}	4.3.6.1
Rated starting voltage of an autotransformer starter	—	1)
Rated stator insulation voltage	U_{is}	1)
Rated stator operational current	I_{es}	1)
Rated stator operational voltage	U_{es}	1)
Rated ultimate short-circuit breaking capacity	I_{cu}	4.3.2.4
Rated uninterrupted current	I_u	1)
Rotor thermal current	I_{thr}	1)
Selectivity limit current	I_s	1)
Stator thermal current	I_{ths}	1)
Take-over current	I_B	2.5.25
Temporary duty	—	4.3.4.4
Uninterrupted duty	—	4.3.4.2
Utilization category	—	4.4

1) This rating is defined in the relevant product standard.

NOTE – The above list is not exhaustive.

4.1 General

The characteristics of an equipment shall be stated in the relevant product standard in respect of the following, where applicable:

- type of equipment (4.2);
- rated and limiting values for the main circuit (4.3);
- utilization category (4.4);
- control circuits (4.5);
- auxiliary circuits (4.6);
- relay and releases (4.7);
- co-ordination with short-circuit protective devices (4.8);
- switching overvoltages (4.9).

4.2 Type of equipment

The product standard shall state the following, where applicable:

- kind of equipment: e.g. contactor, circuit-breaker, etc.;
- number of poles;
- kind of current;
- interrupting medium;
- operating conditions (method of operation, method of control, etc.).

NOTE – The above list is not exhaustive.

4.3 Rated and limiting values for the main circuit

Ratings are assigned by the manufacturer. They shall be stated in accordance with 4.3.1 to 4.3.6 as required by the relevant product standard, but it is not necessary to establish all the ratings listed.

4.3.1 Rated voltages

An equipment is defined by the following rated voltages:

NOTE – Certain types of equipment may have more than one rated voltage or may have a rated voltage range.

4.3.1.1 Rated operational voltage (U_e)

A rated operational voltage of an equipment is a value of voltage which, combined with a rated operational current, determines the application of the equipment and to which the relevant tests and the utilization categories are referred.

For single-pole equipment, the rated operational voltage is generally stated as the voltage across the pole.

For multipole equipment, it is generally stated as the voltage between phases.

NOTES

- 1 For certain devices and particular applications a different method of stating U_e , may apply: this should be stated in the relevant product standard.
- 2 For multipole equipment for use on polyphase circuits a distinction may be made between
 - a) equipment for use on systems where a single fault to earth will not cause the full phase-to-phase voltage to appear across a pole;

- neutral earthed systems;
 - unearthed and impedance earthed systems.
- b) equipment for use on systems where a single fault to earth will cause the full phase-to-phase voltage to appear across a pole (i.e. phase earthed systems).
- 3 An equipment may be assigned a number of combinations of rated operational voltages and rated operational currents or powers for different duties and utilization categories.
- 4 An equipment may be assigned a number of rated operational voltages and associated making and breaking capacities for different duties and utilization categories.
- 5 Attention is drawn to the fact that the operational voltage may differ from the working voltage (see 2.5.52) within an equipment.

4.3.1.2 Rated insulation voltage (U_i)

The rated insulation voltage of an equipment is the value of voltage to which dielectric tests and creepage distances are referred.

In no case shall the maximum value of the rated operational voltage exceed that of the rated insulation voltage.

NOTE – For equipment not having a specified rated insulation voltage, the highest value of the rated operational voltage is considered to be the rated insulation voltage.

4.3.1.3 Rated impulse withstand voltage (U_{imp})

The peak value of an impulse voltage of prescribed form and polarity which the equipment is capable of withstanding without failure under specified conditions of test and to which the values of the clearances are referred.

The rated impulse withstand voltage of an equipment shall be equal to or higher than the values stated for the transient overvoltages occurring in the circuit in which the equipment is fitted.

NOTE – Preferred values of rated impulse withstand voltage are given in table 12.

4.3.2 Currents

An equipment is defined by the following currents:

4.3.2.1 Conventional free air thermal current (I_{th})

The conventional free air thermal current is the maximum value of test current to be used for temperature-rise tests of unenclosed equipment in free air (see 8.3.3.3).

The value of the conventional free air thermal current shall be at least equal to the maximum value of the rated operational current (see 4.3.2.3) of the unenclosed equipment in eight-hour duty (see 4.3.4.1).

Free air is understood to be air under normal indoor conditions reasonably free from draughts and external radiation.

NOTES

1 This current is not a rating and is not mandatorily marked on the equipment.

2 An unenclosed equipment is an equipment supplied by the manufacturer without an enclosure or an equipment supplied by the manufacturer with an integral enclosure which is not normally intended to be the sole equipment protective enclosure.

4.3.2.2 Conventional enclosed thermal current (I_{the})

The conventional enclosed thermal current is the value of current stated by the manufacturer to be used for the temperature-rise tests of the equipment when mounted in a specified enclosure. Such tests shall be in accordance with 8.3.3.3 and are mandatory if the equipment is described as enclosed equipment in the manufacturer's catalogues and normally intended for use with one or more enclosures of specified type and size (see note 2).

The value of the conventional enclosed thermal current shall be at least equal to the maximum value of the rated operational current (see 4.3.2.3) of the enclosed equipment in eight-hour duty (see 4.3.4.1).

If the equipment is normally intended for use in unspecified enclosures, the test is not mandatory if the test for conventional free air thermal current (I_{th}) has been made. In this case, the manufacturer shall be prepared to give guidance on the value of enclosed thermal current or the derating factor.

NOTES

- 1 This current is not a rating and is not mandatorily marked on the equipment.
- 2 The conventional enclosed thermal current value may be for unventilated equipment in which case the enclosure used for the test shall be of the size stated by the manufacturer as being the smallest that is applicable in service. Alternatively, the value may be for a ventilated equipment according to the manufacturer's data.
- 3 An enclosed equipment is an equipment normally intended for use with a specified type and size of enclosure or intended for use with more than one type of enclosure.

4.3.2.3 Rated operational current (I_e) or rated operational power

A rated operational current of an equipment is stated by the manufacturer and takes into account the rated operational voltage (see 4.3.1.1), the rated frequency (see 4.3.3), the rated duty (see 4.3.4), the utilization category (see 4.4) and the type of protective enclosure, if appropriate.

In the case of equipment for direct switching of individual motors, the indication of a rated operational current may be replaced or supplemented by an indication of the maximum rated power output, at the rated operational voltage considered, of the motor for which the equipment is intended. The manufacturer shall be prepared to state the relationship assumed between the operational current and the operational power, if any.

4.3.2.4 Rated uninterrupted current (I_u)

The rated uninterrupted current of an equipment is a value of current, stated by the manufacturer, which the equipment can carry in uninterrupted duty (see 4.3.4.2).

4.3.3 Rated frequency

The supply frequency for which an equipment is designed and to which the other characteristic values correspond.

NOTE – The same equipment may be assigned a number or a range of rated frequencies or be rated for both a.c. and d.c.

4.3.4 Rated duties

The rated duties considered as normal are:

4.3.4.1 Eight-hour duty

A duty in which the main contacts of an equipment remain closed, whilst carrying a steady current long enough for the equipment to reach thermal equilibrium but not for more than eight hours without interruption.

NOTES

- 1 This is the basic duty on which the conventional thermal currents I_{th} and I_{the} of the equipment are determined.
- 2 Interruption means breaking of the current by operation of the equipment.

4.3.4.2 Uninterrupted duty

A duty without any off-load period in which the main contacts of an equipment remain closed, whilst carrying a steady current without interruption for periods of more than eight hours (weeks, months, or even years).

NOTE – This kind of service is set apart from the eight-hour duty because oxides and dirt can accumulate on the contacts and lead to progressive heating. Uninterrupted duty can be taken account of either by a derating factor, or by special design considerations (e.g. silver contacts).

4.3.4.3 Intermittent periodic duty or intermittent duty

A duty with on-load periods, in which the main contacts of an equipment remain closed, having a definite relation to off-load periods, both periods being too short to allow the equipment to reach thermal equilibrium.

Intermittent duty is characterized by the value of the current, the duration of the current flow and by the on-load factor which is the ratio of the in-service period to the entire period, often expressed as a percentage.

Standardized values of the on-load factor are 15 %, 25 %, 40 % and 60 %.

According to the number of operating cycles which they shall be capable of carrying out per hour, equipments are divided into the following classes:

- | | | |
|---------|----------|------------------------------------|
| – class | 1: | 1 operating cycle per hour; |
| – class | 3: | 3 operating cycles per hour; |
| – class | 12: | 12 operating cycles per hour; |
| – class | 30: | 30 operating cycles per hour; |
| – class | 120: | 120 operating cycles per hour; |
| – class | 300: | 300 operating cycles per hour; |
| – class | 1 200: | 1 200 operating cycles per hour; |
| – class | 3 000: | 3 000 operating cycles per hour; |
| – class | 12 000: | 12 000 operating cycles per hour; |
| – class | 30 000: | 30 000 operating cycles per hour; |
| – class | 120 000: | 120 000 operating cycles per hour; |
| – class | 300 000: | 300 000 operating cycles per hour. |

For intermittent duty with a large number of operating cycles per hour, the manufacturer shall indicate, either in terms of the true cycle if this is known, or in terms of conventional cycles designated by him, the values of the rated operational currents which shall be such that:

$$\int_0^T i^2 dt \leq I_{th}^2 \times T \quad \text{or} \quad I_{the}^2 \times T$$

whichever is applicable

where T is the total operating cycle time.

NOTE – The above formula does not take account of the switching arc energy.

A switching device intended for intermittent duty may be designated by the characteristics of the intermittent duty.

Example: An intermittent duty comprising a current flow of 100 A for 2 min in every 5 min may be stated as 100 A, class 12, 40%.

4.3.4.4 Temporary duty

Duty in which the main contacts of an equipment remain closed for periods insufficient to allow the equipment to reach thermal equilibrium, the unload periods being separated by off-load periods of sufficient duration to restore equality of temperature with the cooling medium.

Standardized values of temporary duty are 3 min, 10 min, 30 min, 60 min and 90 min, with contacts closed.

4.3.4.5 Periodic duty [151-04-11]

A type of duty in which operation, whether at constant or variable load, is regularly repeated.

4.3.5 Normal load and overload characteristics

This subclause gives general requirements concerning ratings under normal load and overload conditions.

NOTE – Where applicable, the utilization categories referred to in 4.4 may include requirements in respect of performance under overload conditions.

Detailed requirements are given in 7.2.4.

4.3.5.1 Ability to withstand motor switching overload currents

An equipment intended for switching motors shall be capable of withstanding the thermal stresses due to starting and accelerating a motor to normal speed and due to operating overloads.

The detailed requirements to meet these conditions are given in the relevant product standard.

4.3.5.2 Rated making capacity

The rated making capacity of an equipment is a value of current, stated by the manufacturer, which the equipment can satisfactorily make under specified making conditions.

The making conditions which shall be specified are:

- the applied voltage (see 2.5.32);
- the characteristics of the test circuit.

The rated making capacity is stated by reference to the rated operational voltage and rated operational current, according to the relevant product standard.

NOTE – Where applicable, the relevant product standard states the relationship between rated making capacity and utilization category.

For a.c., the rated making capacity is expressed by the r.m.s. value of the symmetrical component of the current, assumed to be constant.

NOTE – For a.c., the peak value of the current during the first half-cycles following the closing of the main contacts of the equipment may be appreciably greater than the peak value of the current under steady-state conditions used in the determination of making capacity, depending on the power-factor of the circuit and the instant on the voltage wave when closing occurs.

An equipment should be capable of closing on a current having the a.c. component equal to that which defines its rated making capacity, whatever the value of the inherent d.c. component, within the limits resulting from the power-factors indicated in the relevant product standard.

4.3.5.3 Rated breaking capacity

The rated breaking capacity of all equipment is a value of current, stated by the manufacturer, which the equipment can satisfactorily break, under specified breaking conditions.

The breaking conditions which shall be specified are:

- the characteristics of the test circuit;
- the power-frequency recovery voltage.

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current, according to the relevant product standard.

An equipment shall be capable of breaking any value of current up to and including its rated breaking capacity.

NOTE – A switching device may have more than one rated breaking capacity, each corresponding to an operational voltage and a utilization category.

For a.c., the rated breaking capacity is expressed by the r.m.s. value of the symmetrical component of the current.

NOTE – Where applicable, the relevant product standard states the relationship between rated breaking capacity and utilization category.

4.3.6 Short-circuit characteristics

This subclause gives general requirements concerning ratings under short-circuit conditions.

4.3.6.1 Rated short-time withstand current (I_{cw})

The rated short-time withstand current of an equipment is the value of short-time withstand current, assigned to the equipment by the manufacturer, that the equipment can carry without damage, under the test conditions specified in the relevant product standard.

4.3.6.2 Rated short-circuit making capacity (I_{cm})

The rated short-circuit making capacity of an equipment is the value of short-circuit making capacity assigned to that equipment by the manufacturer for the rated operational voltage, at rated frequency, and at a specified power-factor for a.c. or time constant for d.c. It is expressed as the maximum prospective peak current, under prescribed conditions.

4.3.6.3 Rated short-circuit breaking capacity (I_{cn})

The rated short-circuit breaking capacity of an equipment is the value of short-circuit breaking capacity assigned to that equipment by the manufacturer for the rated operational voltage, at rated frequency, and at a specified power-factor for a.c. or time constant for d.c. It is expressed as the value of the prospective breaking current (r.m.s. value of the a.c. component in the case of a.c.), under prescribed conditions.

4.3.6.4 Rated conditional short-circuit current

The rated conditional short-circuit current of an equipment is the value of prospective current, stated by the manufacturer, which the equipment, protected by a short-circuit protective device specified by the manufacturer, can withstand satisfactorily for the operating time of this device under the test conditions specified in the relevant product standard.

The details of the specified short-circuit protective device shall be stated by the manufacturer.

NOTES

- 1 For a.c., the rated conditional short-circuit current is expressed by the r.m.s. value of the a.c. component.
- 2 The short-circuit protective device may either form an integral part of the equipment or be a separate unit.

4.4 Utilization category

The utilization category of an equipment defines the intended application and shall be specified in the relevant product standard; it is characterized by one or more of the following service conditions:

- current(s), expressed as multiple(s) of the rated operational current;
- voltage(s), expressed as multiple(s) of the rated operational voltage;
- power-factor or time-constant;
- short-circuit performance;
- selectivity;
- other service conditions, as applicable.

Examples of utilization categories for low-voltage switchgear and controlgear are given in annex A.

4.5 Control circuits

4.5.1 Electrical control circuits

The characteristics of electrical control circuits are:

- kind of current;
- rated frequency if a.c.;

- rated control circuit voltage U_c (nature, and frequency if a.c.);
- rated control supply voltage U_s (nature, and frequency if a.c.), where applicable.

NOTE – A distinction has been made above between the control circuit voltage, which is the voltage which would appear across the "a" contacts (see 2.3.12) in the control circuit, and the control supply voltage, which is the voltage applied to the input terminals of the control circuit of the equipment and may be different from the control circuit voltage, due to the presence of built-in transformers, rectified, resistors, etc.

The rated control circuit voltage and rated frequency, if any, are the values on which the operating and temperature-rise characteristics of the control circuit are based. The correct operating conditions are based upon a value of the control supply voltage not less than 85% of its rated value, with the highest value of control circuit current flowing, nor more than 110 % of its rated value.

NOTE – The manufacturer should be prepared to state the value or values of the current taken by the control circuit(s) at the rated control supply voltage.

The ratings and characteristics of control circuit devices shall comply with the requirements of IEC 947-5 (see note of clause 1).

4.5.2 Air-supply control circuits (pneumatic or electro-pneumatic)

The characteristics of air-supply control circuits are:

- rated pressure and its limits;
- volumes of air, at atmospheric pressure, required for each closing and each opening operation.

The rated supply pressure of a pneumatic or electro-pneumatic equipment is the air pressure on which the operating characteristics of the pneumatic control system are based.

4.6 Auxiliary circuits

The characteristics of auxiliary circuits are the number and kind of contacts (a-contact, b-contact, etc.) in each of these circuits and their ratings according to IEC 947-5 (see note of clause 1).

The characteristics of auxiliary contacts and switches shall comply with the requirements of the above standard.

4.7 Relays and releases

The following characteristics of relays and releases shall be stated in the relevant product standard, where applicable:

- type of relay or release;
- rated values;
- current setting or current setting range;
- time/current characteristics (for presentation of time/current characteristics, see 4.8);
- influence of ambient air temperature.

4.8 Co-ordination with short-circuit protective devices (SCPD)

The manufacturer shall state the type or the characteristics of the SCPD to be used with or within the equipment, as the case may be, and the maximum prospective short-circuit current for which the equipment, including the SCPD, is suitable, at the stated operational voltage(s).

NOTE – It is recommended that the current be plotted as abscissa and the time as ordinate, using logarithmic scales. It is recommended that the current be plotted as a multiple of the current setting and the time in seconds on the standard graph sheet detailed in IEC 269-1 (First edition, 5.6.4) and IEC 269-2 (figures 1 to 7).

4.9 Switching overvoltages

The manufacturer shall specify the maximum value of switching overvoltages caused by the operation of the switching device, when tested according to 8.3.3.5.4.

This value shall not exceed that of the rated impulse withstand voltage (see 4.3.1.3).

5 Product information

5.1 Nature of information

The following information shall be given by the manufacturer, when required by the relevant product standard:

Identification:

- manufacturer's name or trademark;
- type designation or serial number;
- number of the relevant product standard, if the manufacturer claims compliance.

Characteristics:

- rated operational voltages (see 4.3.1.1 and note to 5.2);
- utilization category and rated operational currents (or rated powers or rated uninterrupted currents), at the rated operational voltages of the equipment (see 4.3.1.1, 4.3.2.3, 4.3.2.4 and 4.4). In certain cases, this information may have to be completed by the value of the reference ambient air temperature at which the equipment has been calibrated;
- the value of the rated frequency/frequencies, e.g.: 50 Hz, 50 Hz/60 Hz, and/or the indication "d.c." or the symbol == ;
- rated duty, with the indication of the class of intermittent duty, if any (see 4.3.4);
- rated making and/or breaking capacities. These indications may be replaced, where applicable, by the indication of the utilization category;
- rated insulation voltage (see 4.3.1.2);
- rated impulse withstand voltage (see 4.3.1.3);
- switching overvoltage (see 4.9);
- rated short-time withstand current together with its duration, where applicable (see 4.3.6.1);
- rated short-circuit making and/or breaking capacities, where applicable (see 4.3.6.2 and 4.3.6.3);

- rated conditional short-circuit current, where applicable (see 4.3.6.4);
- IP code, in case of enclosed equipment (see annex C);
- pollution degree (see 6.1.3.2);
- type and maximum ratings of short-circuit protective device, where applicable;
- class of protection against electric shock (under consideration), where applicable;
- rated control circuit voltage, kind of current and frequency;
- rated control supply voltage, kind of current and frequency, if different from those of the control coil;
- rated supply pressure of the air-pressure and limits of pressure variations (for air-pressure controlled equipment);
- suitability for isolation.

NOTE – This list is not exhaustive.

5.2 Marking

All relevant information, as detailed in 5.1, which is to be marked on the equipment, shall be specified in the relevant product standard.

Markings shall be indelible and easily legible.

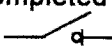
Marking of the manufacturer's name or trademark and type designation or serial number is mandatory on the equipment and preferably on the nameplate, if any, in order to permit the complete data to be obtained from the manufacturer.

NOTE – In the USA and Canada, the rated operational voltage U_o , may be marked as follows:

- a) on equipment for use on three-phase – four-wire systems, by both the value of phase-to-earth voltage and that of phase-to-phase voltage, e.g. 277/480 V;
- b) on equipment for use on three-phase – three-wire systems, by the value of phase-to-phase voltage, e.g. 480 V.

The following information shall also be marked and visible after mounting:

- direction of movement of the actuator (see 7.1.4.2), if applicable;
- indication of the position of the actuator (see also 7.1.5.1 and 7.1.5.2);
- approval or certification mark, if applicable;
- for miniaturized equipment, symbol, colour code or letter code;
- terminal identification and marking (see 7.1.7.4);
- IP code and class of protection against electric shock, when applicable (marked preferably on the equipment as far as possible);
- suitability for isolation, where applicable, with the symbol 

This symbol may be completed with the appropriate qualifying symbol of the switching function of the equipment: e.g.  for a switch disconnect.

NOTE – These symbols are in accordance with IEC 617-7.

5.3 Instructions for installation, operation and maintenance

The manufacturer shall specify in his documents or catalogues the conditions, if any, for installation, operation and maintenance of the equipment during operation and after a fault, and the measures to be taken with regard to the equipment, if any, concerning EMC.

If necessary, the instructions for the transport, installation and operation of the equipment shall indicate the measures that are of particular importance for the proper and correct installation, commissioning and operation of the equipment.

These documents shall indicate the recommended extent and frequency of maintenance, if any.

NOTE – All equipment covered by this standard is not necessarily designed to be maintained.

6 Normal service, mounting and transport conditions

6.1 Normal service conditions

Equipment complying with this standard shall be capable of operating under the following standard conditions:

NOTE – For non-standard conditions in service, see annex B. These may require agreement between manufacturer and user.

6.1.1 Ambient air temperature

The ambient air temperature does not exceed +40 °C and its average over a period of 24 h does not exceed +35 °C.

The lower limit of the ambient air temperature is –5 °C.

Ambient air temperature is that existing in the vicinity of the equipment if supplied without enclosure, or in the vicinity of the enclosure if supplied with an enclosure.

NOTES

1 Equipment intended to be used in ambient air temperature above +40°C (e.g. in forges, boiler rooms, tropical countries) or below –5 °C (e.g. –25 °C, as required by IEC 439-1 for outdoor installed low-voltage switchgear and controlgear assemblies) should be designed or used according to the relevant product standard, where applicable, or according to agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

2. Standard reference air temperature for certain types of equipment, e.g., circuit-breakers or overload relays for starters, is indicated in the relevant product standard.

6.1.2 Altitude

The altitude of the site of installation does not exceed 2 000 m.

NOTE – For equipment to be used at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and the cooling effect of the air. Electrical equipment intended to operate under these conditions shall be designed or used in accordance with an agreement between manufacturer and user.

6.1.3 Atmospheric conditions

6.1.3.1 Humidity

The relative humidity of the air does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities may be permitted at lower temperatures, e.g. 90 % at +20 °C. Special measures may be necessary in cases of occasional condensation due to variations in temperature.

NOTE – Pollution degrees, as stated in 6.1.3.2, define the environmental conditions more precisely.

6.1.3.2 *Pollution degree*

The pollution degree (see 2.5.58) refers to the environmental conditions for which the equipment is intended.

NOTE – The micro-environment of the creepage distance or clearance and not the environment of the equipment determines the effect on the insulation. The micro-environment might be better or worse than the environment of the equipment. It includes all factors influencing the insulation, such as climatic and electromagnetic conditions, generation of pollution, etc.

For equipment intended for use within an enclosure or provided with an integral enclosure, the pollution degree of the environment in the enclosure is applicable.

For the purpose of evaluating clearances and creepage distances, the following four degrees of pollution of the micro-environment are established (clearances and creepage distances according to the different pollution degrees are given in tables 13 and 15):

Pollution degree 1:

No pollution or only dry, non-conductive pollution occurs.

Pollution degree 2:

Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation may be expected.

Pollution degree 3:

Conductive pollution occurs, or dry, non-conductive pollution occurs which becomes conductive due to condensation.

Pollution degree 4:

The pollution generates persistent conductivity caused, for instance, by conductive dust or by rain or snow.

Standard pollution degree of industrial applications:

Unless otherwise stated by the relevant product standard, equipment for industrial applications is generally for use in pollution degree 3 environment. However, other pollution degrees may be considered to apply depending upon particular applications or the micro-environment.

NOTE – The pollution degree of the micro-environment for the equipment may be influenced by installation in an enclosure.

Standard pollution degree of household and similar applications:

Unless otherwise stated by the relevant product standard, equipment for household and similar applications is generally for use in pollution degree 2 environment.

6.1.4 *Shock and vibration*

Standard conditions of shock and vibration to which the equipment can be submitted are under consideration.

6.2 Conditions during transport and storage

A special agreement shall be made between user and manufacturer if the conditions during transport and storage, e.g. temperature and humidity, differ from those defined in 6.1, except that, unless otherwise specified, the following temperature range applies during transport and storage: between $-25\text{ }^{\circ}\text{C}$ and $+55\text{ }^{\circ}\text{C}$ and, for short periods not exceeding 24 hours, up to $+70\text{ }^{\circ}\text{C}$.

Equipment subjected to these extreme temperatures without being operated shall not undergo any irreversible damage and shall then operate normally under the specified conditions.

6.3 Mounting

The equipment shall be mounted in accordance with the manufacturer's instructions.

7 Constructional and performance requirements

7.1 Constructional requirements

The equipment with its enclosure, if any, whether integral or not, shall be designed and constructed to withstand the stresses occurring during installation and normal use and, in addition, shall provide a specified degree of resistance to abnormal heat and fire.

7.1.1 Materials

The suitability of materials used is verified by making tests:

- a) on the equipment; or
- b) on sections taken from the equipment; or
- c) on samples of identical material having representative cross-section.

The suitability shall be determined with respect to resistance to abnormal heat and fire.

If an identical material having representative cross-sections has already satisfied the requirements of any of the tests of 8.2.1, then those tests need not be repeated.

7.1.1.1 Resistance to abnormal heat and fire

Parts of insulating materials which might be exposed to thermal stresses due to electrical effects, and the deterioration of which might impair the safety of the equipment, shall not be adversely affected by abnormal heat and by fire.

Tests on equipment shall be made by the glow-wire test of IEC 695-2-1/0 to IEC 695-2-1/3.

Parts of insulating materials necessary to retain current-carrying parts in position shall conform to the glow-wire tests of 8.2.1.1.1 at a test temperature of $850\text{ }^{\circ}\text{C}$ or $960\text{ }^{\circ}\text{C}$ according to the expected fire hazard. Product standards shall specify the value appropriate to the product, taking into account the annex A to IEC 695-2-1/1.

Parts of insulating materials other than those specified in the previous paragraph, shall conform to the requirements of the glow-wire test of 8.2.1.1.1 at a temperature of $650\text{ }^{\circ}\text{C}$.

NOTE – For small parts (having surface dimensions not exceeding 14 mm x 14 mm), the relevant product standard may specify another test (for example needle flame test, according to IEC 695-2-2). The same procedure may be applicable for other practical reasons when the metal part is large compared to the insulating material (such as terminal blocks).

When tests on materials are used, they shall be made according to the tests for flammability classification, hot wire ignition and, where applicable, arc ignition, as specified in 8.2.1.1.2.

The relevant product standard shall specify the required flammability category of IEC 707.

Tests shall be made in accordance with annex M. The hot wire ignition (HWI) and arc ignition (AI) test value requirements related to the materials flammability category shall conform to table M.1.

The manufacturer may provide data from the insulating material supplier to demonstrate compliance with this requirement.

7.1.2 *Current-carrying parts and their connections*

Current-carrying parts shall have the necessary mechanical strength and current-carrying capacity for their intended use.

For electrical connections, no contact pressure shall be transmitted through insulating material other than ceramic or other material with characteristics not less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or yielding of the insulation material.

Compliance shall be verified by inspection.

NOTE – In the USA, the use of clamping units in which pressure is transmitted through insulating materials other than ceramic is permitted only in the following circumstances:

- 1 where the clamping unit is part of a terminal block;
- 2 where a temperature test demonstrates that the temperature limitations of the insulation material and of the terminals in accordance with the product standard are not exceeded, and
- 3 resilient metal is used in the clamping unit construction to compensate for loss of clamping pressure due to insulating material deformation.

7.1.3 *Clearances and creepage distances*

For equipment tested according to 8.3.3.4 of this standard, minimum values are given in tables 13 and 15.

Electrical requirements are given in 7.2.3.

In the other cases, guidance for minimum values is given in the relevant product standard.

7.1.4 *Actuator*

7.1.4.1 *Insulation*

The actuator of the equipment shall be insulated from the live parts for the rated insulation voltage and, if applicable, the rated impulse withstand voltage.

Moreover:

- if it is made of metal, it shall be capable of being satisfactorily connected to a protective conductor unless it is provided with additional reliable insulation;
- if it is made of or covered by insulating material, any internal metal part, which, might become accessible in the event of insulation failure, shall also be insulated from live parts for the rated insulation voltage.

7.1.4.2 *Direction of movement*

The direction of operation for actuators of devices shall normally conform to IEC 60447. Where devices cannot conform to these requirements, e.g. due to special applications or alternative mounting positions, they shall be clearly marked such that there is no doubt as to the "I" and "O" positions and the direction of operation.

7.1.5 *Indication of the contact position*

7.1.5.1 *Indicating means*

When an equipment is provided with means for indicating the closed and open positions, these positions shall be unambiguous and clearly indicated. This is done by means of a position indicating device (see 2.3.18).

NOTE – In the case of enclosed equipment, the indication may or may not be visible from the outside.

The relevant product standard may specify whether the equipment is to be provided with such an indicating device.

If symbols are used, they shall indicate the closed and open positions respectively, in accordance with IEC 417:

417-IEC-5007		On (power)
417-IEC-5008		Off (power)

For equipment operated by means of two push-buttons, only the push-button designated for the opening operation shall be red or marked with the symbol "O".

Red colour shall not be used for any other push-button.

The colours of other push-buttons, illuminated push-buttons and indicator lights shall be in accordance with IEC 73.

7.1.5.2 *Indication by the actuator*

When the actuator is used to indicate the position of the contacts, it shall automatically take up or stay, when released, in the position corresponding to that of the moving contacts; in this case, the actuator shall have two distinct rest positions corresponding to those of the moving contacts, but for automatic opening a third distinct position of the actuator may be provided.

|| 7.1.6 *Additional requirements for equipment suitable for isolation*

NOTE – In the USA, devices meeting these additional requirements are not accepted as assuring isolation by themselves. Isolation requirements and procedures are covered in the relevant Federal regulations and maintenance standards.

|| 7.1.6.1 *Additional constructional requirements*

Equipment suitable for isolation shall provide in the open position (see 2.4.21) an isolation distance in accordance with the requirements necessary to satisfy the isolating function (see 7.2.3.1 and 7.2.7). Indication of the position of the main contacts shall be provided by one or more of the following means:

- the position of the actuator;
- a separate mechanical indicator;
- visibility of the moving contacts.

The effectiveness of each of the means of indication provided on the equipment and its mechanical strength shall be verified in accordance with 8.2.5.

When means are provided or specified by the manufacturer to lock the equipment in the open position, locking in that position shall only be possible when the main contacts are in the open position. This shall be verified in accordance with 8.2.5. Equipment shall be designed so that the actuator, front plate or cover are fitted to the equipment in a manner which ensures correct contact position indication and locking, if provided.

NOTES

1 Locking in the closed position is permitted for particular applications.

2 If auxiliary contacts are provided for interlocking purposes, the operating time of the auxiliary and main contacts should be declared by the manufacturer. More specific requirements may be given in the relevant product standard.

7.1.6.2 *Supplementary requirements for equipment with provision for electrical interlocking with contactors or circuit-breakers*

If equipment suitable for isolation is provided with an auxiliary switch for the purpose of electrical interlocking with contactor(s) or circuit-breaker(s) and intended to be used in motor circuits, the following requirements shall apply unless the equipment is rated for AC-23 utilization category.

An auxiliary switch shall be rated according to IEC 60947-5-1 as stated by the manufacturer.

The time interval between the opening of the contacts of the auxiliary switch and the contacts of the main poles shall be sufficient to ensure that the associated contactor or circuit-breaker interrupts the current before the main poles of the equipment open.

Unless otherwise stated in the manufacturer's technical literature, the time interval shall be not less than 20 ms when the equipment is operated according to the manufacturer's instructions.

Compliance shall be verified by measuring the time interval between the instant of opening of the auxiliary switch and the instant of opening of the main poles under no-load conditions when the equipment is operated according to the manufacturer's instructions.

During the closing operation the contacts of the auxiliary switch shall close after or simultaneously with the contacts of the main poles.

A suitable opening time interval may also be provided by an intermediate position (between the ON and OFF positions) at which the interlocking contact(s) is (are) open and the main poles remain closed.

7.1.6.3 *Supplementary requirements for equipment provided with means for padlocking the open position*

The locking means shall be designed in such a way that it cannot be removed with the appropriate padlock(s) installed. When the equipment is locked by even a single padlock, it shall not be possible by operating the actuator, to reduce the clearance between open contacts to the extent that it no longer complies with the requirements of 7.2.3.1 b).

Alternatively, the design may provide padlockable means to prevent access to the actuator.

Compliance with the requirements to padlock the actuator shall be verified using a padlock specified by the manufacturer or an equivalent gauge, giving the most adverse conditions, to simulate locking. The force F specified in 8.2.5.2.1 shall be applied to the actuator in an attempt to operate the equipment from the open position to the closed position. Whilst the force F is applied the equipment shall be subjected to a test voltage across open contacts. The equipment shall be capable of withstanding the test voltage required according to table 14 appropriate to the rated impulse withstand voltage.