

Low-voltage switchgear and controlgear —

Part 1: General rules

The European Standard EN 60947-1:1999, with the incorporation of amendments A1:2000 and A2:2001, has the status of a British Standard

ICS 29.130.20

National foreword

This British Standard is the English language version of EN 60947-1:1999, including amendments A1:2000 and A2:2001. It is identical with IEC 60947-1:1999, Edition 3.2:2001, which comprises Edition 3.0:1999 consolidated by the incorporation of amendment 1:2000 and amendment 2:2001, published by the International Electrotechnical Commission (IEC). It also includes IEC Corrigendum December 2002. It supersedes BS EN 60947-1:1998 which will be withdrawn on 2001-11-01.

The UK participation in its preparation was entrusted by Technical Committee PEL/17, Switchgear, controlgear, and HV-LV co-ordination, 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 subcommittee 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

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 173 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Sidelining in this document indicates the most recent changes by amendment.

This British Standard was published under the authority of the Standards Policy and Strategy Committee and comes into effect on 15 May 1999

© BSI 14 February 2003

Amendments issued since publication

Amd. No.	Date	Comments
13274	7 June 2002	Indicated by a sideline
14330 Corrigendum No. 1	14 February 2003	Correction to 8.3.2.1

ISBN 0 580 32571 7

Contents

	Page
National foreword	Inside front cover
Foreword	2
Text of EN 60947-1	7

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

English version

Low-voltage switchgear and controlgear — Part 1: General rules

(includes amendments A1:2000 + A2:2001)

(IEC 60947-1:1999 + A1:2000 + A2:2001)

Appareillage à basse tension —
Partie 1: Règles générales
(inclut les amendements A1:2000 + A2:2001)
(CEI 60947-1:1999 + A1:2000 + A2:2001)

Niederspannungsschaltgeräte —
Teil 1: Allgemeine Festlegungen
(enthält Änderungen A1:2000 + A2:2001)
(IEC 60947-1:1999 + A1:2000 + A2:2001)

This European Standard was approved by CENELEC on 1999-01-01. Amendment A1:2000 was approved by CENELEC on 2000-09-01 and amendment A2:2001 was approved by CENELEC on 2001-12-01. 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

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

The text of document 17B/942 + 942A/FDIS, future amendment 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 A3 to EN 60947-1:1997 on 1999-01-01.

The text of this document, together with that of IEC 60947-1:1996 and its amendments 1:1997 and 2:1998, was published by IEC as the third edition of IEC 60947-1 in February 1999. According to a decision of principle taken by the Technical Board of CENELEC, the approval of EN 60947-1:1997/A3 has been converted into the approval of a new EN 60947-1.

This European Standard supersedes EN 60947-1:1997 + A1:1998 + A2:1998.

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) 1999-11-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2001-11-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

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

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60947-1:1999 was approved by CENELEC as a European Standard without any modification.

Foreword to amendment A1

The text of document 17B/1050/FDIS, future amendment 1 to IEC 60947-1:1999, 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 60947-1:1999 on 2000-09-01.

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) 2001-06-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2003-09-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard Annex ZA is normative and Annex O is informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of amendment 1:2000 to the International Standard IEC 60947-1:1999 was approved by CENELEC as an amendment to the European Standard without any modification.

Foreword to amendment A2

The text of document 17B/1158/FDIS, future amendment 2 to IEC 60947-1:1999, 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 A2 to EN 60947-1:1999 on 2001-12-01.

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) 2002-09-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 2004-12-01

Annexes designated “normative” are part of the body of the standard.

Annexes designated “informative” are given for information only.

In this standard Annex ZA is normative and Annex P is informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of amendment 2:2001 to the International Standard IEC 60947-1:1999 was approved by CENELEC as an amendment to the European Standard without any modification.

Contents

	Page		Page
Foreword	2	4.3 Rated and limiting values for the main circuit	35
1 General	7	4.4 Utilization category	41
1.1 Scope and object	7	4.5 Control circuits	41
1.2 Normative references	8	4.6 Auxiliary circuits	42
2 Definitions	10	4.7 Relays and releases	42
2.1 General terms	14	4.8 Co-ordination with short-circuit protective devices (SCPD)	42
2.2 Switching devices	17	4.9 Switching overvoltages	42
2.3 Parts of switching devices	19	5 Product information	42
2.4 Operation of switching devices	22	5.1 Nature of information	42
2.5 Characteristic quantities	26	5.2 Marking	43
2.6 Tests	33	5.3 Instructions for installation, operation and maintenance	44
3 Classification	34	6 Normal service, mounting and transport conditions	45
4 Characteristics	34	6.1 Normal service conditions	45
4.1 General	35	6.2 Conditions during transport and storage	46
4.2 Type of equipment	35	6.3 Mounting	46
		7 Constructional and performance requirements	47
		7.1 Constructional requirements	47
		7.2 Performance requirements	54
		7.3 Electromagnetic compatibility (EMC)	62
		8 Tests	63
		8.1 Kinds of tests	63
		8.2 Compliance with constructional requirements	65
		8.3 Performance	71
		8.4 Tests for EMC	91
		Annex A (informative) Examples of utilization categories for low-voltage switchgear and controlgear	121
		Annex B (informative) Suitability of the equipment when conditions for operation in service differ from the normal conditions	122
		Annex C (normative) Degrees of protection of enclosed equipment	123
		Annex D (informative) Examples of terminals	130
		Annex E (informative) Description of a method for adjusting the load circuit	136
		Annex F (informative) Determination of short-circuit power-factor or time-constant	138
		Annex G (informative) Measurement of creepage distances and clearances	140
		Annex H (informative) Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of equipment	146

	Page		Page
Annex J (informative) Items subject to agreement between manufacturer and user	148	Figure 11 — Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a three-pole equipment	115
Annex L (normative) Terminal marking and distinctive number	149	Figure 12 — Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a four-pole equipment	116
Annex M (normative) Flammability test	155	Figure 13 — Example of short-circuit making and breaking test record in the case of a single-pole equipment on single-phase a.c.	117
Annex N (normative) Requirements and tests for equipment with protective separation	158	Figure 14 — Verification of short-circuit making and breaking capacities on d.c.	118
Annex O (informative) Environmental aspects	162	Figure 15 — Determination of the prospective breaking current when the first calibration of the test circuit has been made at a current lower than the rated breaking capacity	119
Annex P (informative) Terminal lugs for low-voltage switchgear and controlgear connected to copper conductors	169	Figure 16 — Actuator test force	120
Annex ZA (normative) Normative references to international publications with their corresponding European publications	171	Figure C.1 — IP Codes	127
Figure 1 — Test equipment for flexion test	105	Figure D.1 — Screw terminals	130
Figure 2 — Gauges of form A and form B	105	Figure D.2 — Pillar terminals	131
Figure 3 — Diagram of the test circuit for the verification of making and breaking capacities of a single-pole equipment on single-phase a.c. or on d.c.	106	Figure D.3 — Stud terminals	132
Figure 4 — Diagram of the test circuit for the verification of making and breaking capacities of a two-pole equipment on single-phase a.c. or on d.c.	107	Figure D.4 — Saddle terminals	133
Figure 5 — Diagram of the test circuit for the verification of making and breaking capacities of a three-pole equipment	108	Figure D.5 — Lug terminals	134
Figure 6 — Diagram of the test circuit for the verification of making and breaking capacities of a four-pole equipment	109	Figure D.6 — Mantle terminals	135
Figure 7 — Schematic illustration of the recovery voltage across contacts of the first phase to clear under ideal conditions	110	Figure D.7 — Screwless-type terminals	135
Figure 8a — Diagram of a load circuit adjustment method: load star-point earthed	111	Figure E.1 — Determination of the actual value of the factor γ	137
Figure 8b — Diagram of a load circuit adjustment method: supply star-point earthed	112	Figure G.1 — Measurement of ribs	141
Figure 9 — Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a single-pole equipment on single-phase a.c. or on d.c.	113	Figure G.2 — Creepage distance across the fixed and moving insulation of contact carriers	141
Figure 10 — Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a two-pole equipment on single-phase a.c. or on d.c.	114	Figure M.1 — Test fixture for hot wire ignition test	155
		Figure M.2 — Circuit for arc ignition test	156
		Figure O.1 — Environmental aspects for products related to the life cycle	165
		Figure P.1 — Dimensions	169
		Table 1 — Standard cross-sections of round copper conductors	92
		Table 2 — Temperature-rise limits of terminals	92
		Table 3 — Temperature-rise limits of accessible parts	93
		Table 4 — Tightening torques for the verification of the mechanical strength of screw-type terminals	94
		Table 5 — Test values for flexion and pull-out tests for round copper conductors	95

	Page		Page
Table 6 — Test values for pull-out test for flat copper conductors		Table 17 — Limits of actuator test force for given types of actuator	102
Table 7 — Maximum conductor cross-sections and corresponding gauges	95	Table 18 — <i>Vacant</i>	102
Table 8 — Tolerances on test quantities	96	Table 19 — <i>Vacant</i>	102
Table 9 — Test copper conductors for test currents up to 400 A inclusive	96	Table 20 — Test values for conduit pull-out test	102
Table 10 — Test copper conductors for test currents above 400 A and up to 800 A inclusive	97	Table 21 — Test values for conduit bending test	103
Table 11 — Test copper bars for test currents above 400 A and up to 3 150 A inclusive	97	Table 22 — Test values for conduit torque test	103
Table 12 — Impulse withstand test voltages	98	Table 23 — Tests for EMC — Immunity	103
Table 12A — Dielectric test voltage corresponding to the rated insulation voltage	99	Table 24 — Acceptance criteria when EM disturbances are present	104
Table 13 — Minimum clearances in air	99	Table H.1 — Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage, in case of overvoltage protection by surge-arresters according to IEC 60099-1	147
Table 14 — Test voltages across the open contacts of equipment suitable for isolation	100	Table M.1 — HWI and AI characteristics	157
Table 15 — Minimum creepage distances	100	Table P.1 — Examples of terminal lugs for low voltage switchgear and controlgear connected to copper conductors	169
Table 16 — Values of power-factors and time-constants corresponding to test currents, and ratio n between peak and r.m.s. values of current	101		
	102		

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:

- 60947-2: Part 2: Circuit-breakers
- 60947-3: Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units
- 60947-4: Part 4: Contactors and motor-starters
- 60947-5: Part 5: Control-circuit devices and switching elements
- 60947-6: Part 6: Multiple function equipment
- 60947-7: 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 60439.

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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

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

IEC 60060, *High-voltage test techniques*

IEC 60068-2-3:1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 60071-1:1993, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60073:1991, *Coding of indicating devices and actuators by colours and supplementary means*

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

IEC 60112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions*

IEC 60216, *Guide for the determination of thermal endurance properties of electrical insulating materials*

IEC 60269-1:1986, *Low-voltage fuses – Part 1: General requirements*

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

IEC 60364-4-443:1990, *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 60417-2:1998, *Graphical symbols for use on equipment – Part 2: Symbol originals*

IEC 60439-1:1992, *Low-voltage switchgear and controlgear assemblies – Part 1: Type-tested and partially type-tested assemblies*

IEC 60445:1988, *Identification of equipment terminals and of terminations of certain designated conductors, including general rules of an alphanumeric system*

IEC 60447:1993, *Man-machine interface (MM) – Actuating principles*

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

IEC 60617-7:1983, *Graphical symbols for diagrams – Part 7: Switchgear, controlgear and protective devices*

IEC 60664-1:1992, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests – Basic safety publication*
Amendment 1 (2000)

IEC 60695-2-1/0:1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 0: Glow-wire test methods – General*

IEC 60695-2-1/1:1994, *Fire hazard testing – Part 2: Test methods – Section 1/sheet 1: Glow-wire end-product test and guidance*

IEC 60695-2-2:1991, *Fire hazard testing – Part 2: Test methods – Section 2: Needle-flame test*

IEC 60707:1981, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source*

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

IEC 60981:1989, *Extra-heavy duty rigid steel conduits for electrical installations*

IEC 60998-1:1990, *Connecting devices for low-voltage circuits for household and similar purposes – Part 1: General requirements*

IEC 61000-3-2:2000, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3:1994, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤ 16 A*

IEC 61000-4-2:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 2: Electrostatic discharge immunity test – Basic EMC publication*

IEC 61000-4-3:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 3: Radiated, radio-frequency, electromagnetic field immunity test*

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

IEC 61000-4-5:1995, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 5: Surge immunity test*

IEC 61000-4-6:1996, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 6: Immunity to conducted disturbances, induced by radio-frequency fields* Amendment 1 (2000)

IEC 61000-4-8:1993, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 8: Power frequency magnetic field immunity test – Basic EMC Publication* Amendment 1 (2000)

IEC 61000-4-11:1994, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 11: Voltage dips, short interruptions and voltage variations immunity tests* Amendment 1 (2000)

IEC 61000-4-13:—, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power ports, low-frequency immunity tests – Basic EMC Publication* ¹⁾

IEC 61140:1997, *Protection against electric shock – Common aspects for installation and equipment*

CISPR 11:1997, *Industrial, scientific and medical (ISM) radio-frequency equipment – Electromagnetic disturbance characteristics – Limits and methods of measurement* Amendment 1 (1999)

2 Definitions

NOTE Most of the definitions listed in this clause are taken unchanged from the IEV (IEC 60050). 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.

Alphabetical index of definitions

NOTE The alphabetical list of ratings, characteristics and symbols is given in clause 4.

	Reference	Page
A		
"a" contact	2.3.12	39
Actuating force (moment)	2.4.17	47
Actuating system (of a mechanical switching device)	2.3.16	41
Actuator	2.3.17	41
Ambient air temperature	2.1.9	29
Anti-pumping device	2.3.20	41
Applied voltage (for a switching device)	2.5.32	57
Arcing contact	2.3.8	39
Arcing time (of a multipole switching device)	2.5.41	59
Arcing time (of a pole or a fuse)	2.5.40	59
Automatic control	2.4.5	43
Auxiliary circuit (of a switching device)	2.3.4	37
Auxiliary contact	2.3.10	39
Auxiliary switch (of a mechanical switching device)	2.3.11	39
B		
"b" contact	2.3.13	39
Back-up protection	2.5.24	55
Break contact	2.3.13	39
Breaking capacity (of a switching device or a fuse)	2.5.12	53
Breaking current (of a switching device or a fuse)	2.5.11	53
Break time	2.5.42	59

¹⁾ To be published.

	Reference	Page
C		
Circuit-breaker	2.2.11	35
Clamping unit	2.3.25	43
Clearance	2.5.46	61
Clearance between open contacts (gap)	2.5.49	61
Clearance between poles	2.5.47	61
Clearance to earth.	2.5.48	61
Closed position (of a mechanical switching device)	2.4.20	47
Closing operation (of a mechanical switching device)	2.4.8	45
Closing time	2.5.44	61
Comparative tracking index (CTI)	2.5.65	65
Conditional short-circuit current (of a circuit or a switching device)	2.5.29	57
Conductive part	2.1.10	29
Contact (of a mechanical switching device)	2.3.5	39
Contact piece	2.3.6	39
Contact (mechanical)	2.2.12	35
Contact relay	2.2.14	35
Control circuit (of a switching device)	2.3.3	37
Control circuit device	2.2.16	35
Control contact	2.3.9	39
Control gear	2.1.3	29
Control switch (for control and auxiliary circuits)	2.2.17	35
Conventional non-tripping current (of an over-current relay or release)	2.5.30	57
Conventional tripping current (of an over-current relay or release)	2.5.31	57
Co-ordination of insulation	2.5.61	65
Creepage distance	2.5.51	61
Critical load current	2.5.16	55
Critical short-circuit current	2.5.17	55
Current setting (of an over-current or overload relay or release)	2.4.37	51
Current setting range (of an over-current or overload relay or release)	2.4.38	51
Cut-off current	2.5.19	55
Cut-off (current) characteristic	2.5.21	55
D		
DC steady-state recovery voltage	2.5.36	59
Definite time-delay over-current relay or release	2.4.26	49
Dependent manual operation (of a mechanical switching device)	2.4.12	45
Dependent power operation (of a mechanical switching device)	2.4.13	45
Direct over-current relay or release	2.4.28	49
Disconnecter	2.2.8	33
Discrimination – see Over-current discrimination		
E		
Electric shock	2.1.20	31
Enclosure	2.1.16	31
Exposed conductive part	2.1.11	29
Extraneous conductive part	2.1.12	29
F		
Functional overvoltage	2.5.54.3	61
Fuse	2.2.4	31
Fuse-combination unit	2.2.7	31
Fuse-element	2.2.6	31
Fuse-link	2.2.5	31
H		
Homogeneous (uniform) field	2.5.62	65

	Reference	Page
I		
Impulse withstand voltage	2.5.55	63
Independent manual operation (of a mechanical switching device)	2.4.15	45
Independent power operation (of a mechanical switching device)	2.4.16	45
Indicator light	2.3.19	41
Indirect over-current relay or release	2.4.29	49
Inhomogeneous (non-uniform) field	2.5.63	65
Instantaneous relay or release	2.4.24	47
Integral enclosure	2.1.17	31
Interlocking device	2.3.21	31
Inverse time-delay over-current relay or release	2.4.27	49
Isolating distance (of a pole of a mechanical switching device)	2.5.50	61
Isolation (isolating function)	2.1.19	31
J		
Joule integral (I^2t)	2.5.18	55
L		
Let-through current	2.5.19	55
Let-through (current) characteristic	2.5.21	55
Lightning overvoltage	2.5.54.2	63
Limiting value	2.5.2	51
Live part	2.1.13	31
Local control	2.4.6	43
M		
Magnetic overload relay or release	2.4.32	49
Main circuit (of a switching device)	2.3.2	37
Main contact	2.3.7	39
Make-break time	2.5.45	61
Make contact	2.3.12	39
Make time	2.5.43	61
Making capacity (of a switching device)	2.5.13	53
Manual control	2.4.4	43
Maximum prospective peak current (of an a.c. circuit)	2.5.8	53
Mechanical switching device	2.2.2	33
Micro-environment (of a clearance or creepage distance)	2.5.59	63
N		
Neutral conductor (symbol N)	2.1.15	31
Nominal value	2.5.1	51
O		
Open position (of a mechanical switching device)	2.4.21	47
Opening operation (of a mechanical switching device)	2.4.9	45
Opening time (of a mechanical switching device)	2.5.39	59
Operating current (of an over-current relay or release)	2.4.36	49
Operating cycle (of a mechanical switching device)	2.4.2	43
Operating sequence (of a mechanical switching device)	2.4.3	43
Operation (of a mechanical switching device)	2.4.1	43
Over-current	2.1.4	29
Over-current discrimination	2.5.23	55
Over-current protective co-ordination of over-current protective devices	2.5.22	55
Over-current relay or release	2.4.25	47
Overload	2.1.7	29
Overload current	2.1.8	29
Overload relay or release	2.4.30	49
Overvoltage category (of a circuit or within an electrical system)	2.5.60	65

	Reference	Page
P		
Peak arc voltage (of a mechanical switching device).....	2.5.38	59
Peak withstand current.....	2.5.28	57
Pilot switch.....	2.2.18	37
Pole of a switching device	2.3.1	37
Pollution.....	2.5.57	63
Pollution degree (of environmental conditions).....	2.5.58	63
Position indicating device	2.3.18	41
Positively driven operation.....	2.4.11	45
Positive opening operation (of a mechanical switching device).....	2.4.10	45
Power-frequency recovery voltage	2.5.35	59
Power-frequency withstand voltage.....	2.5.56	63
Prepared conductor.....	2.3.27	43
Prospective breaking current (for a pole of a switching device or a fuse).	2.5.10	53
Prospective current (of a circuit and with respect to a switching device or a fuse)	2.5.5	51
Prospective making current (for a pole of a switching device)	2.5.9	53
Prospective peak current.....	2.5.6	51
Prospective symmetrical current (of an a.c. circuit).....	2.5.7	51
Prospective transient recovery voltage (of a circuit)	2.5.37	59
Protective conductor (symbol PE).....	2.1.14	31
Push-button	2.2.19	37
R		
Rated value.....	2.5.3	51
Rating	2.5.4	51
Recovery voltage	2.5.33	57
Relay (electrical).....	2.3.14	39
Release (of a mechanical switching device).....	2.3.15	39
Remote control	2.4.7	43
Restoring force (moment).....	2.4.18	47
Reverse current relay or release (d.c. only)	2.4.35	49
Routine test	2.6.2	65
S		
Sampling test.....	2.6.3	65
Screw-type terminal	2.3.23	41
Screwless-type terminal	2.3.24	41
Selectivity (see 2.5.22).....		
Semiconductor contactor (solid-state contactor)	2.2.13	35
Semiconductor switching device	2.2.3	33
Short circuit	2.1.5	29
Short-circuit breaking capacity.....	2.5.14	53
Short-circuit current	2.1.6	29
Short-circuit making capacity.....	2.5.15	53
Short-circuit protective device (SCPD).....	2.2.21	37
Short-time delay.....	2.5.26	57
Short-time withstand current.....	2.5.27	57
Shunt release.....	2.4.33	49
Special test.....	2.6.4	67
Starter	2.2.15	35
Stored energy operation (of a mechanical switching device).....	2.4.14	45
Surge arrester.....	2.2.22	37
Switch (mechanical)	2.2.9	33
Switch-disconnector	2.2.10	35
Switchgear	2.1.2	27
Switchgear and controlgear	2.1.1	27
Switching device	2.2.1	33
Switching overvoltage	2.5.54	63

	Reference	Page
T		
Take-over current.....	2.5.25	57
Temporary overvoltage.....	2.5.53	63
Terminal	2.3.22	41
Terminal block	2.2.20	37
Thermal overload relay or release	2.4.31	49
Time-current characteristic.....	2.5.20	55
Tracking.....	2.5.64	65
Transient overvoltages	2.5.54	63
Transient recovery voltage (abbreviation TRV)	2.5.34	59
Travel (of a mechanical switching device or a part thereof)	2.4.19	47
Trip-free mechanical switching device	2.4.23	47
Tripping (operation).....	2.4.22	47
Type test.....	2.6.1	65
U		
Under-voltage relay or release.....	2.4.34	49
Unprepared conductor.....	2.3.26	43
Utilization category (for a switching device or a fuse).....	2.1.18	31
W		
Working voltage	2.5.52	61

2.1 General terms

2.1.1

switchgear and controlgear

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

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**

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**

current exceeding the rated current [441-11-06]

2.1.5**short circuit**

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**

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**

over-current occurring in an electrically undamaged circuit

2.1.9**ambient air temperature**

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**

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**

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**

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

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)

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)

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

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

enclosure which forms an integral part of the equipment

2.1.18

utilization category (for a switching device or a fuse)

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

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

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

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

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

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

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

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

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)

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

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

2.2.11

circuit-breaker

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)

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)

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

contactor used as a control switch [441-14-35]

2.2.15

starter

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

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)

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**

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**

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**

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)**

device intended to protect a circuit or parts of a circuit against short-circuit currents by interrupting them

2.2.22**surge arrester**

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**

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

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

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

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)

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

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

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)

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)

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)

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**

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**

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**

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**

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**

conductive part of a device provided for electrical connection to external circuits

2.3.23**screw-type terminal**

terminal intended for the connection and disconnection of conductors or for the interconnection 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**

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

part(s) of a terminal necessary for the mechanical clamping and the electrical connection of the conductor(s)

2.3.26

unprepared conductor

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

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)

transfer of the moving contact(s) from one position to an adjacent position [441-16-01]

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

NOTE 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)

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)

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)

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)

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)

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**

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)

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)

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)

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)

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)

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)

force (moment) applied to an actuator necessary to complete the intended operation [441-16-17]

2.4.18

restoring force (moment)

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)

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)

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)

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)

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

2.4.23

trip-free mechanical switching device

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

NOTE 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.

NOTE 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

relay or release which operates without any intentional time-delay

2.4.25

over-current relay or release

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**

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**

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**

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**

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**

over-current relay or release intended for protection against overloads

2.4.31**thermal overload relay or release**

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**

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**

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**

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)**

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)**

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)

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)

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

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

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

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)

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

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)

prospective current when it is initiated at such an instant that no transient phenomenon follows the initiation [441-17-03]

NOTE 1 For polyphase circuits the condition of non-transient period can only be satisfied for the current in one pole at a time.

NOTE 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)

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)

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)

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)

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)

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]

NOTE 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.

NOTE 2 For a.c., the current is expressed as the symmetrical r.m.s. value of the a.c. component.

NOTE 3 For short-circuit breaking capacity, see 2.5.14.

2.5.13**making capacity** (of a switching device)

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]

NOTE 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.

NOTE 2 For short-circuit making capacity, see 2.5.15.

2.5.14**short-circuit breaking capacity**

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**

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

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

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)

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

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

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

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**

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**

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**

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)

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

NOTE 1 For the purpose of this standard, the short-circuit protective device is generally a circuit-breaker or a fuse.

NOTE 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)

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)

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)

voltage which exists across the terminals of a pole of a switching device just before the making of the current [441-17-24]

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**

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]

NOTE 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.

NOTE 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)

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

recovery voltage after the transient voltage phenomena have subsided [441-17-27]

2.5.36

d.c. steady-state recovery voltage

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)

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)

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)

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)

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)

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

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**

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**

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**

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**

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**

clearance between any conductive parts of adjacent poles [441-17-32]

2.5.48**clearance to earth**

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)**

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)

clearance between open contacts meeting the safety requirements specified for disconnectors [441-17-35]

2.5.51**creepage distance**

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**

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

NOTE 1 Transients are disregarded.

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

2.5.53

temporary overvoltage

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

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

2.5.54.1

switching overvoltage

transient overvoltage at a given location on a system due to a specific switching operation or a fault

2.5.54.2

lightning overvoltage

transient overvoltage at a given location on a system due to a specific lightning discharge [see also IEC 60060 and IEC 60071-1]

2.5.54.3

functional overvoltage

deliberately imposed overvoltage necessary for the functioning of a device

2.5.55

impulse withstand voltage

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

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)

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

NOTE 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.

NOTE 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)

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)

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**

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**

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**

electric field which has not an essentially constant voltage gradient between electrodes

2.5.64**tracking**

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)**

numerical value of the maximum voltage in volts at which a material withstands 50 drops of a test solution without tracking

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

NOTE 2 This definition reproduces 2.3 of IEC 60112.

2.6 Tests**2.6.1****type test**

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**

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**

test on a number of devices taken at random from a batch [151-04-17]

2.6.4**special test**

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.

NOTE 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.

NOTE 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).

NOTE 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.

NOTE 4 An equipment may be assigned a number of rated operational voltages and associated making and breaking capacities for different duties and utilization categories.

NOTE 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.

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

NOTE 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.

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

NOTE 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.

NOTE 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.

NOTE 1 This is the basic duty on which the conventional thermal currents I_{th} and I_{the} of the equipment are determined.

NOTE 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.

NOTE 1 For a.c., the rated conditional short-circuit current is expressed by the r.m.s. value of the a.c. component.

NOTE 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 60947-5 (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 60947-5 (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 60269-1 (first edition, 5.6.4) and IEC 60269-2 (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 required by the product standard.

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 (see IEC 61140), 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_e , may be marked as follows:

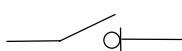
- a) on equipment for use on three-phase – four-wire systems, by both the value of phase-to-earth voltage and that of phase-to-phase voltage, e.g. 277/480 V;
- b) on equipment for use on three-phase – three-wire systems, by the value of phase-to-phase voltage, e.g. 480 V.

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 isolation function symbol according to IEC 60617-7, reference 07-01-03, combined with the appropriate function symbol for the equipment, e.g.:



for a circuit-breaker suitable for isolation;



for a switch-disconnector.

This symbol shall be:

- clearly and unmistakably marked;
- visible when the equipment is installed as in service and the actuator is accessible.

This requirement applies whether the equipment is unenclosed, or enclosed according to 7.1.10.

This requirement also applies if the symbol is integrated into a wiring diagram and this diagram is the only marking indicating suitability for isolation.

5.3 Instructions for installation, operation and maintenance

The manufacturer shall specify in his documents or catalogues the conditions for installation, operation and maintenance, if any, of the equipment during operation and after a fault.

The manufacturer shall also specify the measures to be taken with regard to EMC, if any. For equipment only suitable in environment A (see 7.3.1) the manufacturer shall provide in the documentation the following notice:

NOTICE

This product has been designed for environment A. Use of this product in environment B may cause unwanted electromagnetic disturbances in which case the user may be required to take adequate mitigation measures.

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.

NOTE 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 60439-1 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.

NOTE 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°C and $+55^{\circ}\text{C}$ and, for short periods not exceeding 24 h, up to $+70^{\circ}\text{C}$.

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.