

Australian Standard™

Low-voltage switchgear and controlgear

Part 6.2: Multiple function equipment— Control and protective switching devices (or equipment) (CPS)



This Australian Standard was prepared by Committee EL-006, Industrial Switchgear and Controlgear. It was approved on behalf of the Council of Standards Australia on 22 July 2004.

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Australian Chamber of Commerce and Industry
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Australian Standard™

Low-voltage switchgear and controlgear

Part 6.2: Multiple function equipment— Control and protective switching devices (or equipment) (CPS)

Originated as AS 3947.6.2—1996.
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PREFACE

This Standard was prepared by the Standards Australia Committee EL-006, Industrial Switchgear and Controlgear to supersede AS/NZS 3947.6.2:2001.

The objective of this Standard, in addition to that stated in Clause 1, is to bring Australian requirements into line with Edition 2.0 (2002-10) of IEC 60947-6-2.

This Standard is Part 6.2 of a series which, when complete, will consist of the following:

AS 60947	Low-voltage switchgear and controlgear
AS 60947.1*	Part 1: General rules
AS 60947.2*	Part 2: Circuit-breakers
AS 60947.3	Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
AS 60947.3 Suppl	Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units, Supplement 1: Fuse-switch-disconnectors and switch-disconnectors for use with low-voltage aerial bundled cables
AS 60947.4.1*	Part 4.1: Contactors and motor-starters—Electromechanical contactors and motor-starters
AS 60947.4.2*	Part 4.2: Contactors and motor-starters—A.C. semiconductor motor controllers and starters
AS 60947.4.3	Part 4.3: Contactors and motor-starters—A.C. semiconductor controllers and contactors for non-motor loads
AS 60947.5.1*	Part 5.1: Control circuit devices and switching elements—Electromechanical control circuit devices
AS 60947.5.2*	Part 5.2: Control circuit devices and switching elements—Proximity switches
AS 60947.5.3	Part 5.3: Control circuit devices and switching elements—Requirements for proximity devices with defined behaviour under fault conditions
AS 60947.5.4*	Part 5.4: Control circuit devices and switching elements—Methods of assessing the performance of low-energy contacts—Special tests
AS 60947.5.5	Part 5.5: Control circuit devices and switching elements—Electrical emergency stop devices with mechanical latching function
AS 60947.5.6	Part 5.6: Control circuit devices and switching elements—D.C. interface for proximity sensors and switching amplifiers (NAMUR)
AS 60947.5.7*	Part 5.7: Control circuit devices and switching elements—Requirements for proximity devices with analogue output
AS 60947.6.1	Part 6.1: Multiple function equipment—Automatic transfer switching equipment
AS 60947.6.2*	Part 6.2: Multiple function equipment—Control and protective switching devices (or equipment) (CPS) (this Standard)
AS 60947.7.1*	Part 7.1: Ancillary equipment—Terminal blocks for copper conductors
AS 60947.7.2*	Part 7.2: Ancillary equipment—Protective conductor terminal blocks for copper conductors

AS 60947.7.3*	Part 7.3:	Ancillary equipment—Safety requirements for terminal blocks for the reception of cartridge fuse-links
AS 60947.8*	Part 8:	Control units for built-in thermal protection for rotating machines

It is the intention of the Committee to align the numbering of this series of Standards with that of the corresponding IEC 60947 series of Standards.

Standards from the list above that are marked with an asterisk (*) are, at the time of publication of this document, available as a part of the AS 60947 series of Standards.

Standards that are not so marked remain as AS/(NZS) 3947 series Standards. Following the next amendment or revision of the corresponding IEC Standard, each of these Standards remaining in the AS/(NZS) 3947 series will be revised and renumbered as a part of the AS 60947 series.

This Standard is identical with and has been reproduced from Edition 2.0 (2002-10) of IEC 60947-6-2:2002, *Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment—Control and protective switching devices (or equipment) (CPS)*.

The provisions of the general rules dealt with in AS 60947.1 (hereinafter referred to as Part 1) are applicable to this Standard, where specifically called for. Clauses and subclauses, tables, figures and appendices of the general rules thus applicable are identified by reference to Part 1, for example, 1.2.3 of Part 1, Table 4 of Part 1, or Annex A of Part 1. Where reference is made to other parts of the AS 60947 (AS/NZS 3947) series, they too are referred to as the relevant part, after the initial reference. AS/NZS 3947.6.1 is, therefore, referred to as Part 6.1.

This Standard differs from AS/NZS 3947.6.2:2001 in the following areas:

- (a) The numbering of tables has been brought into line with AS 60947.1.
- (b) Heat resistance requirements clarified for materials.
- (c) Additional safety requirements for CPS suitable for isolation have been clarified.
- (d) EMC immunity requirements have been expanded.
- (e) Tests of dielectric properties have been clarified.
- (f) EMC test requirements have been revised.
- (g) Test sequence 1 has been expanded.
- (h) Dielectric withstand requirements have been revised.
- (i) Figures 2 to 25 replace the former figures 2 to 8.
- (j) The condition and operation of the CPS following the electrical durability test of Annex A have been clarified.
- (k) Annex B has been deleted.

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

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

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the annex to which they apply. A ‘normative’ annex is an integral part of a Standard, whereas an ‘informative’ annex is only for information and guidance.

CONTENTS

	<i>Page</i>
1 Scope and object	1
2 Normative references	1
3 Definitions	3
3.1 Control and protective switching device (or equipment) (CPS)	3
3.2 CPS suitable for isolation	3
3.3 CPS for motor control and protection	4
3.3.1 Direct-on-line CPS	4
3.3.2 Reversing CPS	4
3.3.3 Two-direction CPS	4
3.4 Opening time	4
3.5 Phase loss sensitive relay or release (for motor protection)	4
4 Classification	4
5 Characteristics	4
5.1 Summary of characteristics	4
5.2 Type of CPS	5
5.2.1 Number of poles	5
5.2.2 Kind of current (a.c. or d.c.)	5
5.2.3 Method of operation	5
5.2.4 Method of control	5
5.2.5 Method of resetting after overload	5
5.2.6 Method of rearming after short-circuit	5
5.3 Rated and limiting values of the main circuit	5
5.3.1 Rated voltages	5
5.3.2 Currents and powers	5
5.3.3 Rated frequency	5
5.3.4 Rated duties	6
5.3.5 Normal load and overload characteristics	6
5.3.6 Short circuit characteristics	6
5.4 Utilization categories	6
5.4.1 Standard utilization categories	6
5.4.2 Assignment of utilization categories based on the results of tests	7
5.4.3 Application of utilization categories for motor control duty	8
5.5 Control circuits	8
5.6 Auxiliary circuits	8
5.7 Relays or releases	8
5.7.1 Types of relays or releases	8
5.7.2 Characteristic values	9
5.7.3 Designation and current setting of overload relays or releases	9
5.7.4 Time current characteristics of over current relays or releases	9
5.7.5 Influence of ambient air temperature	10
5.8 Switching overvoltages	10

	<i>Page</i>
6 Product information	10
6.1 Nature of information	10
6.1.1 Identification	10
6.1.2 Characteristics	10
6.2 Marking.....	11
6.3 Instructions for installation, operation and maintenance	11
7 Normal service, mounting and transport conditions	11
8 Constructional and performance requirements	12
8.1 Constructional requirements	12
8.1.1 Materials	12
8.1.2 Current-carrying parts and their connections	12
8.1.3 Clearances and creepage distances	12
8.1.4 Actuator	12
8.1.5 Indication of the contact position	12
8.1.6 Additional safety requirements for CPS's suitable for isolation	12
8.1.7 Terminals	12
8.1.8 Additional requirements for CPS's provided with a neutral pole	13
8.1.9 Provisions for protective earthing	13
8.1.10 Enclosures for CPS's	13
8.2 Performance requirements	13
8.2.1 Operating conditions	13
8.2.2 Temperature rise	16
8.2.3 Dielectric properties	19
8.2.4 Performance under no load, normal load and overload conditions	19
8.2.5 Ability to make, carry and break short-circuit currents	24
8.2.6 Switching overvoltages	24
8.3 Electromagnetic compatibility (EMC)	25
8.3.1 General	25
8.3.2 Immunity	25
8.3.3 Emission	25
9 Tests	26
9.1 Kind of tests	26
9.1.1 General	26
9.1.2 Type test	26
9.1.3 Routine tests	26
9.1.4 Sampling tests	26
9.1.5 Special tests	26
9.2 Compliance with constructional requirements	26
9.3 Compliance with performance requirements	26
9.3.1 Test sequences	27
9.3.2 General test conditions	27
9.3.3 Performance under no load, normal load and overload conditions	27
9.3.4 Performance under short-circuit conditions	30
9.3.5 EMC tests	32

	<i>Page</i>
9.4 Test sequences	42
9.4.1 Test Sequence I: Temperature-rise, operating limits, dielectric properties.....	44
9.4.2 Test Sequence II: Performance under normal load and overload conditions	46
9.4.3 Test sequence III: Operational performance before and after operating sequences at I_{cr} and "r" current test	47
9.4.4 Test Sequence IV: Operational performance before and after operating sequences at I_{cs}	48
9.4.5 Test Sequence V: Additional breaking capacity	49
9.4.6 Test Sequence VI: Additional test sequence for four-pole CPS's	49
9.4.7 Test Sequence VII: Additional test sequence for CPS's intended for use in an individual enclosure	50
9.4.8 Test sequence VIII: EMC.....	50
9.5 Routine tests.....	50
9.5.1 General.....	50
9.5.2 Operation and operating limits	50
9.5.3 Dielectric tests	51
9.6 Sampling plans and test procedure	51
Annex A (normative) Special tests.....	78
Annex B Vacant	81
Annex C (normative) Marking and identification of CPS terminals.....	82
Annex D (informative) Items subject to agreement between manufacturer and user.....	86
Figure 1 – Multiple of current setting limits for ambient air temperature time-delay overload relays or releases (see 8.2.1.5.1).....	51
Figure 2a – Elevation.....	52
Figure 2b – Sections A-A and B-B.....	53
Figure 2 – EUT mounted in metallic enclosure – Two-phase poles in series configuration	53
Figure 3a – Elevation.....	54
Figure 3b – Sections A-A and B-B	55
Figure 3 – EUT mounted in metallic enclosure – Three-phase poles in series configuration.....	55
Figure 4a – Elevation	56
Figure 4b – Sections A-A and B-B	57
Figure 4 – EUT mounted in metallic enclosure – Three-phase configuration	57
Figure 5 – Test circuit for emission tests, immunity to harmonics, current dips, electrostatic discharges and radiated electromagnetic fields – Two-phase poles in series configuration	58
Figure 6 – Test circuit for emission tests, immunity to harmonics, current dips, electrostatic discharges and radiated electromagnetic fields – Three-phase poles in series configuration	59
Figure 7 – Test circuit for emission tests, immunity to harmonics, current dips, electrostatic discharges and radiated electromagnetic fields – Three-phase configuration.....	60
Figure 8 – Test set-up for the verification of immunity to electrostatic discharges	61
Figure 9 – Test set-up for immunity to radiated electromagnetic fields.....	62

	<i>Page</i>
Figure 10 – Test set-up for conducted disturbances induced by radio-frequency fields (common mode) – Two-phase poles in series configuration	63
Figure 11 – Test set-up for conducted disturbances induced by radio-frequency fields (common mode) – Three-phase poles in series configuration	64
Figure 12 – Test set-up for conducted disturbances induced by radio-frequency fields (common mode) – Three-phase configuration	65
Figure 13 – Circuit for electrical fast transients/bursts (EFT/B) immunity test – Two-phase poles in series configuration	66
Figure 14 – Circuit for electrical fast transients/bursts (EFT/B) immunity test – Three-phase poles in series configuration	67
Figure 15 – Circuit for electrical fast transients/bursts (EFT/B) immunity test – Three-phase configuration	68
Figure 16 – Test set-up for electrical fast transients/bursts (EFT/B) immunity test	69
Figure 17 – Test circuit for the verification of the influence of surges in the main circuit (line-to-earth) – Two-phase poles configuration	70
Figure 18 – Test circuit for the verification of the influence of current surges in the main circuit – Two-phase poles configuration	71
Figure 19 – Test circuit for the verification of the influence of surges in the main circuit (line-to-earth) – Three-phase poles in series configuration	72
Figure 20 – Test circuit for the verification of the influence of current surges in the main circuit – Three-phase poles in series configuration	73
Figure 21 – Test circuit for the verification of the influence of surges in the main circuit (line to earth) – Three-phase configuration	74
Figure 22 – Test circuit for the verification of the influence of current surges in the main circuit – Three-phase configuration	75
Figure 23 – Representation of test current produced by back-to-back thyristors	76
Figure 24 – Test current for the verification of the influence of the current dips and interruptions	77
Figure 25 – Radiated emission test set-up	77
 Table 1 – Utilization categories	 7
Table 2 – Limits of operation of inverse time-delay overload relays or releases when energized on all poles	15
Table 3 – Trip classes of inverse time-delay overload relays or releases for utilization categories AC-42, AC-43, AC-44, DC-43, DC-45	15
Table 4 – Limits of operation of three-pole inverse time-delay overload relays or releases when energized on two poles only	16
Table 5 – Temperature rise limits of terminals	17
Table 6 – Temperature-rise limits of accessible parts	17
Table 7 – Temperature-rise limits for insulated coils in air	18
Table 8 – Intermittent duty test cycle data	18
Table 9 – Rated making and breaking capacities – Making and breaking conditions corresponding to the utilization categories	20
Table 10 – Relationship between current broken I_c and OFF time for the verification of rated making and breaking capacities	21
Table 11 – Conventional operational performance after making/breaking capacity tests	22
Table 12 – Operational performance before and after short-circuit tests at I_{cr} and I_c	23

	<i>Page</i>
Table 13 – Prospective conventional test current I_{cr} and "r" current (I_r) as a function of the maximum I_e for a given construction	24
Table 14 – Acceptance criteria when EM disturbances are present.....	25
Table 15 – Test parameters for current dips and interruptions	41
Table 16 – Test sequences	43

STANDARDS AUSTRALIA

Australian Standard

Low-voltage switchgear and controlgear
Part 6.2: Multiple function equipment—Control and protective switching
devices (or equipment) (CPS)

1 Scope and object

This part of IEC 60947 **AS/NZS 60947** applies to control and protective switching devices (or equipment) (CPS), the main contacts of which are intended to be connected to circuits of rated voltage not exceeding 1 000 V a.c. or 1 500 V d.c.

CPSs are intended to provide both protective and control functions for circuits and are operated otherwise than by hand. They may also fulfill additional functions, such as isolation.

The object of this part is to state:

- the characteristics of CPS's;
- the conditions with which CPS's shall comply with reference to their operation and behaviour, their dielectric properties, the degree of protection provided by their enclosure where applicable;
- the tests intended to verify that these conditions have been met, and the methods to be adopted for these tests;
- the information to be marked on or given with the CPS's.

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.

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

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

AS 1359.101, *Rotating electrical machines—General requirements—Rating and performance* (identical to IEC 60034-1:1996)

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

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

~~IEC 60695-2-10:2000, *Fire hazard testing—Part 2-10: Glowing/hot-wire based test methods—Glow-wire apparatus and common test procedure*~~

AS/NZS 60695.2.10; *Fire hazard testing, Part 2.10: Glowing/hot wire based test methods—Glow-wire apparatus and common test procedure*

~~IEC 60695-2-11:2000, Fire hazard testing — Part 2-11: Glowing/hot wire based test methods—
Glow-wire flammability test method for end-products~~

AS/NZS 60695.2.11, Fire hazard testing, Part 2.11: Glowing/hot wire based test methods—
Glow-wire flammability test method for end-products

~~IEC 60695-2-12:2000, Fire hazard testing — Part 2-12: Glowing/hot wire based test methods—
Glow-wire flammability test method for materials~~

AS/NZS 60695.2.12, Fire hazard testing, Part 2.12: Glowing/hot wire based test methods—
Glow-wire flammability test method for materials

~~IEC 60695-2-13:2000, Fire hazard testing — Part 2-13: Glowing/hot wire based test methods—
Glow-wire ignitability test method for materials~~

AS/NZS 60695.2.13, Fire hazard testing, Part 2.13: Glowing/hot wire based test methods—
Glow-wire ignitability test method for materials (identical to IEC 60695-2-13:2000)

~~IEC 60947-1:1999, Low-voltage switchgear and controlgear — Part 1: General rules —
Amendment 1 (2000) —
Amendment 2 (2001)~~

AS 60947.1, Low-voltage switchgear and controlgear, Part 1: General rules

~~IEC 60947-6-1:1998, Low-voltage switchgear and controlgear — Part 6-1: Multiple function
equipment — Automatic transfer switching equipment —
Amendment 1 (1994) —
Amendment 2 (1997)~~

AS/NZS 3947.6.1:2001, Low-voltage switchgear and controlgear—Multiple function
equipment—Automatic transfer switching equipment (identical to consolidated Edition 1.2
(1998-01) of IEC 60947-6-1 which contains Corrigendum:1991 plus Amendment 1:1994 and
Amendment 2:1997)

~~IEC 61000-4-2:1995, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement
techniques — Section 2: Electrostatic discharge immunity test — Basic EMC publication —
Amendment 1 (1998) —
Amendment 2 (2000)~~

AS/NZS 61000.4.2, Electromagnetic compatibility (EMC), Part 4.2: Testing and measurement
techniques—Electrostatic discharge immunity test

~~IEC 61000-4-3:1995, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement
techniques — Section 3: Radiated, radio-frequency, electromagnetic field immunity test —
Amendment 1 (1998) —
Amendment 2 (2000)~~

AS/NZS 61000.4.3, Electromagnetic compatibility (EMC), Part 4.3: Testing and measurement
techniques—Radiated radio-frequency electromagnetic field immunity test

IEC 61000-4-4:1995, Electromagnetic compatibility (EMC) – Part 4: Testing and measurement
techniques – Section 4: Electrical fast transient/burst immunity test – Basic EMC publication
Amendment 1 (2000)
Amendment 2 (2001)

~~IEC 61000-4-5:1995, Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 5: Surge immunity tests — Amendment 1 (2000)~~

AS/NZS 61000.4.5, *Electromagnetic compatibility (EMC), Part 4.5: Testing and measurement techniques—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)~~

AS/NZS 61000.4.6, *Electromagnetic compatibility (EMC), Part 4.6: Testing and measurement techniques—Immunity to conducted disturbances, induced by radio-frequency fields*

~~CISPR 11:1997, Industrial, scientific and medical (ISM) radio-frequency equipment—Electromagnetic disturbance characteristics—Limits and methods of measurement — Amendment 1 (1999) — Amendment 2 (2002)~~

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

3 Definitions

Clause 2 of Part 1 applies with the following additional definitions:

3.1 Control and protective switching device (or equipment) (CPS)

switching device (or equipment) capable of operation other than by hand, but with or without local manual operating means

NOTE 1 The term "capable of operation other than by hand" means that the device is intended to be controlled and kept in working position from one or more external supplies.

A CPS is capable of making, carrying and breaking currents under normal conditions, including specified operating overload conditions and of making, carrying for a specified time and breaking currents under specified abnormal conditions such as those of short-circuits.

A CPS has overload and short-circuit protection, these functions being associated and coordinated so as to permit continuity of service at all currents up to its rated service short-circuit breaking capacity I_{cs} . A CPS may or may not consist of a single device but is always rated as a unit. Coordination may be either inherent or obtained by correct selection of releases in accordance with the manufacturer's instructions.

NOTE 2 A CPS may have more than one position of rest.

NOTE 3 In the context of this standard, the term "manufacturer" means any person, company or organization with ultimate responsibility as follows:

- to verify compliance with this standard;
- to provide the product information according to clause 6 (marking, identification, characteristics).

NOTE 4 In the context of this standard "continuity of service" means that CPS can be returned to service after occurrence of an over-current under the conditions specified of this part.

3.2 CPS suitable for isolation

CPS which in the open position complies with the requirements specified for the isolating function (see 8.1.6)

3.3 CPS for motor control and protection

3.3.1 Direct-on-line CPS

CPS which connects the line voltage across the motor terminals in one step

3.3.2 Reversing CPS

CPS for starting a motor, intended to cause a motor to reverse the direction of rotation by reversing the motor primary connections while the motor may be running

3.3.3 Two-direction CPS

CPS for starting a motor, intended to cause a motor to reverse the direction of rotation by reversing the motor primary connections only when the motor is not running

3.4 Opening time

Subclause 2.5.39 of Part 1 applies, with the following additions:

- in the case of a CPS tripped by an over-current relay or release, the instant of initiation of the opening time is the instant when the current reaches a value large enough to cause the CPS to operate;
- in the case of a CPS operated by any form of auxiliary power, the instant of initiation of the opening time is the instant of application of the auxiliary power to or its removal from the opening release.

NOTE For CPS's "opening time" is commonly referred to as "tripping time", although strictly speaking, tripping time applies to the time between the instant of initiation of the opening time and the instant when the opening command becomes irreversible.

3.5 Phase loss sensitive relay or release (for motor protection)

multipole relay or release for motor protection which operates in case of loss of phase in accordance with specified requirements

4 Classification

Data which may be used as criteria for classification are given in 5.2.

5 Characteristics

5.1 Summary of characteristics

The characteristics of a CPS shall be stated in terms of the following, as applicable:

- type of CPS (5.2);
- rated and limiting values of the main circuit (5.3);
- utilization categories (5.4);
- control circuits (5.5);
- auxiliary circuits (5.6);
- relays and releases (5.7);
- switching over-voltages (5.8).

5.2 Type of CPS

The following shall be stated:

5.2.1 Number of poles

5.2.2 Kind of current (a.c. or d.c.)

5.2.3 Method of operation

For example:

- electromagnetic, manual, motor operated.

5.2.4 Method of control

For example:

- automatic (by pilot switch or sequence control);
- non automatic (such as by handle or by push-buttons).

5.2.5 Method of resetting after overload

The following types are recognized:

- self resetting;
- local manual resetting;
- remote resetting.

5.2.6 Method of rearming after short-circuit

The following types are recognized:

- CPS capable of remote re-arming after operation;
- CPS incapable of remote re-arming after operation:
 - Those not requiring replacement of a renewable short-circuit protective element, for example a normally operated circuit-breaker.
 - Those requiring replacement of a renewable short-circuit protective element, for example a fuse-link.

5.3 Rated and limiting values of the main circuit

These values shall be stated in accordance with 5.3.1 to 5.3.6 but it may not be necessary to establish all the values listed.

5.3.1 Rated voltages

Subclause 4.3.1 of Part 1 applies.

5.3.2 Currents and powers

A CPS is defined by the following currents and powers:

- conventional free air thermal current (I_{th}): 4.3.2.1 of Part 1 applies;
- conventional enclosed thermal current (I_{the}): 4.3.2.2 of Part 1 applies;
- rated operational currents (I_e) or, if applicable, rated operational powers): 4.3.2.3 of Part 1 applies.

5.3.3 Rated frequency

Subclause 4.3.3 of Part 1 applies.

5.3.4 Rated duties

Subclause 4.3.4 of Part 1 applies with the following addition to 4.3.4.3 of Part 1 (intermittent periodic duty or intermittent duty): In case of utilization categories AC-42 and AC-43, an operating cycle comprises starting, running to full speed and switching off the supply to the motor.

NOTE In the case of a CPS controlling a motor for intermittent duty, the difference between the thermal time-constant of the overload relay and that of the motor may render a thermal relay unsuitable for overload protection. It is recommended that, in this case, the question of overload protection be subject to an agreement between manufacturer and user.

5.3.5 Normal load and overload characteristics

5.3.5.1 Rated making and breaking capacities

Subclauses 4.3.5.2 and 4.3.5.3 of Part 1 apply with the following additions:

Requirements for the various utilization categories (5.4) are given in 8.2.4.1.

The rated making and breaking capacities are only valid when the CPS is operated in accordance with the requirements of 8.2.1.1 and 8.2.1.2.

5.3.6 Short circuit characteristics

5.3.6.1 Rated service short-circuit breaking capacity (I_{cs})

Subclause 4.3.6.3 of Part 1 applies with the following additions:

A rated short-circuit breaking capacity requires that the CPS shall be able to break any value of short-circuit current up to and including the value corresponding to the rated capacity at a power-frequency recovery voltage corresponding to the prescribed test voltage values and,

- for a.c., at any power-factor not less than that of table 16 of Part 1;
- for d.c., with a time constant up to that of table 16 of Part 1.

The rated service short-circuit breaking capacity of a CPS is the value of service short-circuit breaking capacity assigned to that CPS by the manufacturer for the corresponding rated operational voltage, under the conditions specified in 9.4.4.2. It is expressed as a value of prospective breaking current. I_{cs} shall be equal to or greater than I_{cr} (see 8.2.5a).

NOTE For a.c., the short-circuit making capacity of a CPS shall be not less than its rated service short-circuit breaking capacity, multiplied by the factor n of table 16 of Part 1.

For d.c., the short-circuit making capacity of a CPS shall be not less than its rated service short-circuit breaking capacity.

5.4 Utilization categories

Subclause 4.4 of Part 1 applies with the following additions:

5.4.1 Standard utilization categories

Utilization categories given in table 1 are considered as standard. Any other type of utilization shall be based on an agreement between manufacturer and user, but information given in the manufacturer's catalogue or a tender may constitute such an agreement.

Each utilization category is characterized by the values of currents (including prospective conventional test current, see 8.2.5a), voltages, power factors, or time constants and other data in tables 9, 10, 11, 12 and 13 and by the test conditions specified in this standard.

For CPS's defined by their utilization categories, it is therefore unnecessary to specify separately the rated making and breaking capacities as these values depend directly on the utilization category as shown in table 9.

The voltage for all utilization categories is the rated operational voltage of the CPS.

Table 1 – Utilization categories

Utilization categories*	Typical application
AC-40	Distribution circuits comprising mixed resistive and reactive loads having a resultant inductive reactance
AC-41	Non-inductive or slightly inductive loads, resistance furnaces
AC-42	Slip-ring motors: starting, switching off
AC-43	Squirrel-cage motors: starting, switching off motors during running ¹⁾
AC-44	Squirrel-cage motors: starting, plugging, inching
AC-45a	Switching of electric discharge lamp controls
AC-45b	Switching of incandescent lamps
DC-40	Distribution circuits comprising mixed resistive and ractive loads having a resultant inductive reactance
DC-41	Non-inductive or slightly inductive loads, resistance furnaces
DC-43	Shunt-motors: starting, plugging, inching. Dynamic breaking of d.c. motors
DC-45	Series-motors: starting, plugging, inching. Dynamic breaking of d.c. motors
DC-46	Switching of incandescent lamps
¹⁾ AC-43 category may be used for occasional inching (jogging) or plugging for limited time periods such as machine set up; during such limited time periods the number of operations should not exceed five per minute nor 10 in a 10-min period. * The first digit designates a CPS. The second digit designates a typical application.	

5.4.2 Assignment of utilization categories based on the results of tests

- a) A CPS which has been tested for one utilization category or at any combination of parameters (such as highest operational voltage and current, etc.) can be assigned other utilization categories without additional testing provided that the values of test current, voltages, power-factors or time-constants, number of operating cycles, the on and off times and the test circuit for the assigned utilization categories are not more severe than those at which the equipment has been tested and temperature rise has been verified at a current in continuous duty.

For example, when tested for utilization category AC-44, a CPS may be assigned utilization category AC-43 provided that I_e for AC-43 is not higher than 1,2 times I_e for AC-44 at the same rated operational voltage.

- b) DC-43 or DC-45 CPS is assumed to be capable of opening and closing loads other than those on which they have been tested provided that:
- the voltage and current do not exceed the specified values of U_e and I_e ;
 - the energy J stored in the actual load is equal to or less than the energy J_c stored in the load with which the CPS has been tested.

The values of the energy stored in the test circuit are as follows:

Utilization category	Stored energy J_c
DC-43	$0,00525 \times U_e \times I_e$
DC-45	$0,0315 \times U_e \times I_e$

The values of the constants 0,00525 and 0,0315 are derived from: $I_c = 1/2 LI^2$ where the time constant has been replaced by $2,5 \times 10^{-3}$ s for DC-43 and 15×10^{-3} s for DC-45 and where $U = 1,05 U_e$ and $I = 4 I_e$ (see table 9).

5.4.3 Application of utilization categories for motor control duty

Typical service conditions are:

- rotation in one direction, the motor being switched off while running under normal service conditions (utilization categories AC-42, AC-43);
- rotation in two directions, but running of the motor in the second direction being started only after the CPS has been switched off and the motor completely stopped (utilization categories AC-42, AC-43);
- rotation in one direction, or in two directions as in the previous paragraph, but with the possibility of infrequent inching. For this service condition, a direct-on-line CPS is generally used (utilization category AC-43);
- rotation in one direction with frequent inching (jogging); a direct-on-line CPS is generally used (utilization category AC-44);
- rotation in one or two directions but with the possibility of infrequent plugging in order to stop the motor, the plugging being associated with rotor resistor braking if this is provided. In this case a CPS may be used in the stator circuit (utilization category AC-42);
- rotation in two direction but with the possibility of reversing the supply connections to the motor while it is running in the first direction (plugging), in order to obtain its rotation in the other direction while switching off the motor running under normal service conditions. A direct-on-line reversing CPS is generally used for this service condition (utilization category AC-44).

Unless otherwise stated CPS's used as starters are designed on the basis of the starting characteristics of the motors compatible with the making capacities of table 9. When the starting current of a motor exceeds these values, a CPS having a suitably higher rated operational current should be used.

5.5 Control circuits

Subclause 4.5 of Part 1 applies.

5.6 Auxiliary circuits

Subclause 4.6 of Part 1 applies.

5.7 Relays or releases

Subclause 4.7 of Part 1 applies with the following additions:

5.7.1 Types of relays or releases

5.7.1.1 Shunt release (2.4.33 of Part 1)

5.7.1.2 Under-voltage and under-current relay or release (for opening) (2.4.34 of Part 1).

5.7.1.3 Over-current relays or releases.

5.7.1.3.1 Overload relays or releases (2.4.25 and 2.4.30 of Part 1):

- a) Instantaneous overload relay or release (2.4.24 and 2.4.30 of Part 1).
- b) Definite time delay overload relay or release (2.4.26 of Part 1).
- c) Inverse time delay overload relay or release (2.4.27 of Part 1):
 - i) substantially independent of previous load (e.g. magnetic overload relay or release);
 - ii) dependent on previous load (e.g.: thermal overload relay or release);
 - iii) dependent on previous load and also sensitive to phase loss (see 3.5).

5.7.1.3.2 Short-circuit relays or releases:

- a) Instantaneous short-circuit relay or release (2.4.24 of Part 1);
- b) Definite time delay short-circuit relay or release (2.4.26 of Part 1).

NOTE A CPS has a combination of relays or releases from 5.7.1.3.1 and 5.7.1.3.2 above.

5.7.1.4 Other relays and releases (e.g. phase failure relay, control relay associated with devices for motor thermal protection, residual current relay).

NOTE Types referred to under 5.7.1.4 require consultation between manufacturer and user according to the particular application.

5.7.2 Characteristic values

Shunt release, under voltage (under current) relay or release:

- rated voltage (current);
- rated frequency;
- operating voltage (current).

Over-current relay or release:

- current setting (or range of settings);
- rated frequency, where necessary (e.g. in the case of a current transformer operated overload relay);
- time-current characteristics (or range of characteristics);
- trip class, where applicable (see table 3);
- number of poles;
- nature of the relay or release: thermal, magnetic, solid-state.

5.7.3 Designation and current setting of overload relays or releases

Overload relays or releases are designated by their current setting (or the upper and lower limits of current setting range, if adjustable) and their trip class, where applicable. The current setting (or current setting range) shall be marked on the relay or release.

5.7.4 Time current characteristics of over current relays or releases

Time-delay relay or release:

- Definite time delay: the time delay of such relays or releases is independent of the over-current. The tripping time setting shall be stated as the duration in seconds of the opening time of the CPS if the time delay is not adjustable, or the minimum and maximum values of the opening time, if the time delay is adjustable.

- Inverse time delay: the time-current characteristics shall be given in the form of curves supplied by the manufacturer. These shall indicate how the opening time, starting from the cold state, varies with current within the range of operation of the relay or release. The manufacturer shall indicate, by suitable means, the tolerances applicable to these curves. These curves shall be given for the minimum and maximum values of the current setting and, if the time setting for a given current setting is adjustable, it is recommended that they be given in addition for each minimum and maximum values of the time setting.

NOTE Note of 4.8 of Part 1 applies.

5.7.5 Influence of ambient air temperature

Unless otherwise specified, the operating value of over-current relays or releases other than those of the thermal type is independent of the ambient air temperature within the limits of $-5\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$.

For relays or releases of the thermal type:

The time-current characteristics refer to a stated value of ambient air temperature and are based on no previous loading of the overload relay (i.e. from an initial cold state).

This value of the ambient air temperature shall be clearly given on the time curves; the preferred values are $+20\text{ }^{\circ}\text{C}$ or $+40\text{ }^{\circ}\text{C}$.

The overload-relays or releases shall be able to operate within the ambient air temperature range of $-5\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$ and the manufacturer shall be prepared to state the effect of variation in ambient air temperature on the characteristics of overload relays or releases.

5.8 Switching overvoltages

Subclause 4.9 of Part 1 applies.

6 Product information

6.1 Nature of information

The following information shall be given by the manufacturer concerning:

6.1.1 Identification

- a) The manufacturer's name or trademark.
- b) Type designation or serial number.
- c) Number of this part, if the manufacturer claims compliance.

6.1.2 Characteristics

- d) Rated operational voltages (U_e).
- e) Utilization category and rated operational currents (or, where applicable, rated powers) at the rated-operational voltages.
- f) Either the rated frequency (e.g.: 50 Hz, 50 Hz/60 Hz) and/or the indication "d.c." (or the symbol $\text{—}=\text{—}$).
- g) Rated duty with the indication of the class of intermittent duty, if any.
- h) Rated service short-circuit breaking capacity (I_{cs}) (see 5.3.6.1).
- i) Rated impulse withstand voltage (U_{imp}).
- j) Indication of the open and closed positions (see 8.1.4 and 8.1.5).
- k) Pollution degree (see 7.1.3.2).

- l) Rated control circuit voltage (U_c), nature of current and rated frequency (if a.c.).
- m) Switching overvoltage.
- n) IP code, for enclosed CPS's.
- o) If necessary, nature of current, rated frequency and rated control supply voltage (U_s).
- p) Ratings of auxiliary circuits.
- r) Current setting and identification of time-current characteristic of over current relays or releases.
- s) Other characteristics of over-current relays or releases according to 5.7.
- t) In the case of renewable short-circuit protective elements (see 5.2) current rating, type and characteristics in accordance with relevant standard.
- u) Suitability for isolation where applicable (see 5.2 of Part 1).
- v) Environment A or environment B (see 7.3.1 of Part 1).
- w) Special requirements, if applicable, for example shielded or twisted conductors.

NOTE Unshielded or untwisted conductors are considered as normal installation conditions.

6.2 Marking

Sub-clause 5.2 of Part 1 applies with the following additions related to 6.1.1 and 6.1.2 above:

- Data a and b and relevant operational data under d, e, and f.
- Data a and b shall be marked on the CPS and preferably on the nameplate if any
- Data under c and n shall be preferably marked on the CPS
- Data under h and t and relevant operational data under d, e and f shall be marked on the CPS
- Data under r shall be marked on the relay or release
- Data under u shall be marked on the CPS, the global symbol being: 
- Any remaining data shall be marked on the CPS, or included in the manufacturer's published literature.
- Terminals shall be marked so as to clearly identify line and load terminals (see 8.1.7.4).

6.3 Instructions for installation, operation and maintenance

Subclause 5.3 of Part 1 applies.

7 Normal service, mounting and transport conditions

Clause 6 of Part 1 applies with the following additions:

7.1.3.2 Degrees of pollution

Unless otherwise stated by the manufacturer's, a CPS is for use in pollution degree 3 environmental conditions, as defined in 6.1.3.2 of Part 1. However, other pollution degrees may be considered to apply depending upon the micro-environment.

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 Materials

Subclause 7.1.1 of Part 1 applies except that the text of 7.1.1.1 is replaced by the following:

Tests on equipment shall be made by the glow-wire tests of ~~IEC 60695-2-10~~ AS/NZS 60695.2.10, ~~IEC 60695-2-11~~ AS/NZS 60695.2.11, ~~IEC 60695-2-12~~ AS/NZS 60695.2.12 and ~~IEC 60695-2-13~~ AS/NZS 60695.2.13.

Parts of insulating materials necessary to retain in position current carrying parts of the main circuit in service shall conform to the glow-wire test of 8.2.1.1.1 of Part 1, at a temperature of 960 °C.

Parts of insulating materials other than those specified in the previous paragraph shall conform to the requirements of the glow-wire tests of 8.2.1.1.1 of Part 1, at a temperature of 650 °C.

8.1.2 Current-carrying parts and their connections

Subclause 7.1.2 of Part 1 applies.

8.1.3 Clearances and creepage distances

Subclause 7.1.3 of Part 1 applies.

8.1.4 Actuator

Subclause 7.1.4 of Part 1 applies.

8.1.5 Indication of the contact position

Subclause 7.1.5 of Part 1 applies.

8.1.6 Additional safety requirements for CPS's suitable for isolation

Subclause 7.1.6 of Part 1 applies with the following addition:

CPS's suitable for isolation shall be provided with means for locking in the isolated position.

CPS's shall be designed so that the actuator, front plate or cover is fitted to the CPS in a manner which ensures correct contact position indication and locking, if provided.

NOTE 1 The indicated open position is the only position in which the specified isolating distance between the contacts is ensured.

NOTE 2 CPS provided with positions like trip position or stand-by position which are not the indicated open position should be clearly marked.

NOTE 3 An actuator having only one position of rest should not be considered as appropriate to indicate the position of the main contact.

Further requirements are under consideration.

8.1.7 Terminals

Subclause 7.1.7 of Part 1 applies with the following addition:

8.1.7.4 Terminal identification and marking

Subclause 7.1.7.4 of Part 1 applies with additional requirements as given in annex C with the following addition:

Line and load terminals of CPS for utilization categories AC-40 and DC-40 having trip units which are not removable or sealed against removal may not be identified, in which case control circuits shall not be internally connected to the main circuit.

8.1.8 Additional requirements for CPS's provided with a neutral pole

Subclause 7.1.8 of Part 1 applies.

8.1.9 Provisions for protective earthing

Subclause 7.1.9.1 of Part 1 applies.

8.1.10 Enclosures for CPS's

Subclause 7.1.10 of Part 1 applies with the following addition:

In the case of enclosed CPS's provided with an externally manually operated actuator, the door or cover shall be interlocked so that they cannot be opened without the CPS being in the open position. However, provision may be made to open the door or cover with the CPS in the ON position by the use of a tool.

8.2 Performance requirements

8.2.1 Operating conditions

8.2.1.1 General

Subclause 7.2.1.1 of Part 1 applies with the following additions:

CPS's shall be so constructed that they are trip free (see 2.4.23 of Part 1).

CPS's shall not trip due to the shock caused by their operation when tested according to 9.3.3.1 after having carried their maximum rated operational current at the reference ambient air temperature and reached thermal equilibrium at both minimum and maximum settings of the overload relay if adjustable.

Resetting of relays and releases shall not result in a closing operation of the CPS in the absence of a closing command.

8.2.1.2 Limits of operation of power operated CPS's

Subclause 7.2.1.2 of Part 1 applies with the following addition:

The limits apply to d.c and a.c. at each rated frequency.

8.2.1.3 Limits of operation of under-voltage relays and releases

Subclause 7.2.1.3 of Part 1 applies.

8.2.1.4 Limits of operation of shunt releases

Subclause 7.2.1.4 of Part 1 applies.

8.2.1.5 Limits of operation of over-current relays or releases

8.2.1.5.1 Opening under overload conditions

- a) *Instantaneous and definite time-delay overload relays or releases* (types a) and b) in 5.7.1.3.1)

For all values of the current setting the CPS shall trip with an accuracy of $\pm 10\%$ of the specified tripping current value corresponding to the current setting.

- b) *Inverse time-delay overload relays or releases* (types c) in 5.7.1.3.1)

- i) *Utilization categories AC-42, AC-43, AC-44, DC-43, DC-45.*

When all poles are energized

The relays or releases are classified for these utilization categories according to table 3 and shall comply with the requirements of tables 2 and 3 when tested as follows:

- With the CPS in its enclosure, if normally fitted, and at A times the current setting, tripping shall not occur in less than 2 h starting from the cold state, at the value of reference ambient air temperature stated in table 2. However, when the overload relay terminals have reached thermal equilibrium at the test current in less than 2 h, the test duration can be the time to reach such thermal equilibrium.
- When the current is subsequently raised to B times the current setting, tripping shall occur in less than 2 h.
- For trip class 10A overload relays or releases energized at C times the current setting, tripping shall occur in less than 2 min, starting from thermal equilibrium at 1,0 times the current setting, in accordance with 18.2 of ~~IEC 60034-1~~ AS 1359.101.
- For trip classes 10, 20 and 30 overload relays or releases energized at C times the current setting, tripping shall occur in less than 4 min, 8 min or 12 min respectively, starting from thermal equilibrium at 1,0 times the current setting.
- At D times the current setting, tripping time T_p shall lie within the limits given in table 3 for the appropriate trip class starting from the cold state.
- In the case of overload relays or releases having a current setting range, the limits of operation shall apply both when the relay or release is carrying the current associated with the maximum setting and when the relay or release is carrying the current associated with the minimum setting.
- For non-compensated overload relays or releases the current multiple/ambient temperature characteristic shall be not greater than 1,2 %/K.

NOTE 1,2 %/K is the derating characteristic of PVC insulated cables.

An overload relay or release is regarded as compensated if it complies with the relevant requirements of table 2 at 20 °C and is within the limits shown in figure 1 at other temperatures.

Table 2 – Limits of operation of inverse time-delay overload relays or releases when energized on all poles

Utilization category	Type of relay or release	Multiples of current setting				Reference ambient temperature
		A	B	C	D	
AC-42 AC-43 AC-44 DC-43 DC-45	a) Independent of or dependent on previous load and not compensated for ambient air temperature variations	1,0	1,2	1,5	7,2	+40 °C
	b) Dependent on previous load and compensated for ambient air temperature	1,05	1,2	1,5	7,2	+20 °C
AC-40 AC-41 AC-45a AC-45b DC-40 DC-41 DC-46	Independent of or dependent on previous load	1,05	1,3	–	–	+30 °C

NOTE For intermittent duty see the note of 5.3.4.

Table 3 – Trip classes of inverse time-delay overload relays or releases for utilization categories AC-42, AC-43, AC-44, DC-43, DC-45

Trip class	Tripping time T_p in seconds under conditions specified in item b) of 8.2.1.5.1
10A	$2 < T_p \leq 10$
10	$4 < T_p \leq 10$
20	$6 < T_p \leq 20$
30	$9 < T_p \leq 30$

When two poles are energized

With reference to table 4, with the relay or release energized on three poles, at A times the current setting tripping shall not occur in less than 2 h, starting from the cold state, at the value of the ambient air temperature stated in table 4.

Moreover, when the value of the current flowing in two poles (in phase loss sensitive relays those carrying the higher current) is subsequently increased to B times the current setting, and the third pole de-energized, tripping shall occur in less than 2 h.

The values shall apply to all combinations of poles.

In the case of relays or releases having an adjustable current setting, the characteristics shall apply both when the relay or release is carrying the current associated with the maximum setting, and also when the relay is carrying the current associated with the minimum setting.

Table 4 – Limits of operation of three-pole inverse time-delay overload relays or releases when energized on two poles only

Type of relay or release	Multiples of overload current setting		Reference ambient air temperature
	A	B	
Not compensated for ambient air temperature variations. Not phase loss sensitive	Three poles 1,0	Two poles 1,25 One pole, 0	+40 °C
Compensated for ambient air temperature variations. Not phase-loss sensitive	Three poles 1,0	Two poles 1,32 One pole, 0	+20 °C
Compensated for ambient air temperature variations. Phase-loss sensitive	Two poles 1,0 One pole, 0,9	Two poles 1,15 One pole, 0	+20 °C

ii) *Utilization categories AC-40, AC-41, AC-45a, AC-45b; DC-40, DC-41, DC-46*

Conventional values for inverse time-delay overload relays or releases operation are given in table 2.

At the reference temperature of $30\text{ °C} \pm 2\text{ °C}$ and at 1,05 times the current setting, i.e. with the conventional non-tripping current (see 2.5.30 of Part 1), the opening release being energized on all poles, tripping shall not occur in less than the conventional time 2 h (1 h when $I_e < 63\text{ A}$) from the cold state i.e. with the CPS at the reference temperature.

Moreover, when at the end of the conventional time the value of current is immediately raised to 1,30 times the current setting, i.e. with the conventional tripping current (see 2.5.31 of Part 1), tripping shall occur in less than the conventional time above.

NOTE The reference temperature is the ambient air temperature on which the time/current characteristic of the CPS is based.

If a relay or release is declared by the manufacturer as substantially independent of ambient temperature, the values of current table 2 shall apply within the temperature band declared by the manufacturer, within a tolerance of 0,3 % per K. The width of the temperature band shall be at least $\pm 10\text{ K}$ from the reference temperature.

8.2.1.5.2 Opening under short-circuit conditions

Instantaneous and definite time delay short-circuit relays or releases (items a) and b) of 5.7.1.3.2).

For all values of the current setting the CPS shall trip with an accuracy of $\pm 20\%$ of the published tripping current value corresponding to the current setting.

8.2.2 Temperature rise

Subclause 7.2.2 of Part 1 applies.

8.2.2.1 Terminals

The temperature rise of terminals shall not exceed the values stated in table 5.

Table 5 – Temperature rise limits of terminals

Terminal material	Temperature-rise limits ²⁾ K
Bare copper	60
Bare brass	65
Tin plated copper or brass	65
Silver plated or nickel plated copper or brass	70 ¹⁾
Other metals	³⁾
¹⁾ The terminal temperature-rise limit of 70 K is based on the connection of PVC cables. The use in service of connected conductors or cables significantly smaller than those listed in table 9 and 10 of Part 1 could result in higher terminal and internal part temperatures and such conductors should not be used without the manufacturer's consent since higher temperatures could lead to equipment failure. ²⁾ The specified temperature-rise limits apply to a new sample, as in test sequence I of 9.4.1. Those applicable to temperature-rise verifications, as in test sequence IV (9.4.4) are increased by 10 K. ³⁾ Temperature rise limits to be based on service experience or life tests but not exceeding 65 K.	

8.2.2.2 Accessible parts

The temperature-rise of accessible parts shall not exceed the values stated in table 6.

Table 6 – Temperature-rise limits of accessible parts

Description of part ¹⁾	Temperature-rise limits ²⁾ K
Manual operating means: – metallic – non-metallic	15 25
Parts intended to be touched but not hand held: – metallic – non-metallic	30 40
Parts which need not be touched for normal operation: – metallic – non-metallic	40 50
¹⁾ No value is specified for parts other than those listed but no damage shall be caused to adjacent parts of insulating materials. ²⁾ The temperature-rise limits specified apply to a new sample.	

8.2.2.3 Ambient air temperature

Subclause 7.2.2.3 of Part 1 applies.

8.2.2.4 Main circuit

Subclause 7.2.2.4 of Part 1 applies with the following addition:

The main circuit of a CPS, including the over current relays or releases, shall be capable of carrying the maximum rated operational current corresponding to the utilization category for uninterrupted, intermittent or temporary duty without the temperature-rise exceeding the limits specified in tables 5 and 6. An uninterrupted duty rating is required for utilization categories AC-40 and DC-40.

8.2.2.5 Control circuits

The control circuits, including control circuit devices to be used for the closing and opening operations of a CPS, shall permit the rated duty as specified in 5.3.4 and also the temperature-rise tests specified in 9.3.3.3.5 without the temperature-rise exceeding the limits specified in tables 5 and 6.

8.2.2.6 Windings of coils and electromagnets

8.2.2.6.1 Uninterrupted and 8 h duty windings

With the maximum value of current flowing through the main circuit, the windings of the coils shall withstand under continuous load and at the rated frequency, if applicable, their rated control supply voltage without the temperature rise exceeding the limits specified in table 7.

8.2.2.6.2 Intermittent duty windings

With no current flowing through the main circuit the windings of the coils shall withstand, at the rated frequency, if applicable, their rated control supply voltage (or the maximum rated control voltage in case of a range) applied as detailed in table 8 according to their intermittent duty class, without the temperature-rise exceeding the limits specified in table 7.

Table 7 – Temperature-rise limits for insulated coils in air

Class of insulating material	Temperature-rise limit (measured by resistance variation) K
A	85
E	100
B	110
F	135
H	160

NOTE Classification of insulating materials is that given in clause 2 of IEC 60085.

Table 8 – Intermittent duty test cycle data

Intermittent duty class of CPS	One close-open operating cycle every:	Interval of time during which the supply to the control coil is maintained
1	3 600 s	"ON time" shall correspond to the on load factor specified by the manufacturer
3	1 200 s	
12	300 s	
30	120 s	
120	30 s	
300	12 s	
1 200	3 s	

8.2.2.6.3 Specially rated (short-time or periodic duty) windings

Specially rated windings shall be tested under operating conditions corresponding to the most severe duty for which they are intended and their ratings shall be stated by the manufacturer.

8.2.2.7 Auxiliary circuits

Subclause 7.2.2.7 of Part 1 applies.

8.2.2.8 Other Parts

Subclause 7.2.2.8 of Part 1 applies.

8.2.3 Dielectric properties

Subclause 7.2.3 of Part 1 applies.

8.2.4 Performance under no load, normal load and overload conditions

Unless otherwise specified all tests are made by energizing and de-energizing remotely the control function circuit.

8.2.4.1 Making and breaking capacities

CPS shall be capable of making and breaking currents without failure, under the conditions stated in table 9 for the required utilization categories.

The values of the OFF time and the ON time stated in tables 9 and 10 shall not be exceeded.

Table 9 – Rated making and breaking capacities – Making and breaking conditions corresponding to the utilization categories

Utilization category	Make and break conditions					
	I_c/I_e	U_r/U_e	$\cos \phi$	On time ²⁾ s	Off time s	Number of operating cycles
AC-40	6	1,05	0,5	0,05	5)	24
AC-41	1,5	1,05	0,8	0,05	5)	50
AC-42	4,0	1,05	0,65	0,05	5)	50
AC-43 ⁷⁾	8,0	1,05	1)	0,05	5)	50
AC-44 ⁷⁾	10,0	1,05	1)	0,05	5)	50
AC-45a	3,0	1,05	0,45	0,05	5)	50
AC-45b	1,5 ³⁾	1,05	3)			
			L/R (ms)			
DC-40	2,5	1,05	2,5	0,05	5)	24 ⁴⁾
DC-41	1,5	1,05	1,0	0,05	5)	50 ⁴⁾
DC-43	4,0	1,05	2,5	0,05	5)	50 ⁴⁾
DC-45	4,0	1,05	15,0	0,05	5)	50 ⁴⁾
DC-46	1,5 ³⁾	1,05	3)	0,05	5)	50 ⁴⁾
Utilization category	Make conditions					
	I/I_e	U_r/U_e	$\cos \phi$	On time ²⁾ s	Off time s	Number of operating cycles
AC-43	10,0	1,05 ⁶⁾	1)	0,05	10	50
AC-44	12,0	1,05 ⁶⁾	1)	0,05	10	50
<i>I</i> Current made. The making current is expressed in d.c. or a.c. r.m.s. symmetrical values but it is understood that for a.c. the peak value of the asymmetrical current corresponding to the power factor of that circuit may assume a higher value I_c Current made and broken, expressed in d.c. or a.c. r.m.s. symmetrical values I_e Rated operational current U Applied voltage U_r Power frequency recovery voltage U_e Rated operational voltage $\cos \phi$ Power factor of test circuit L/R Time constant of test circuit 1) $\cos \phi$ is 0,45 for $I_e \leq 100$ A, 0,35 for $I_e > 100$ A. 2) Time may be less than 0,05 s provided that contacts are allowed to become properly seated before re-opening. 3) Tests to be carried out with an incandescent light load. 4) Half the operations with one polarity and the other half with reverse polarity. 5) See table 10. 6) For U/U_e a tolerance of ± 20 % is accepted. 7) The make conditions shall also be verified. The verification may be made during the make break test, but only with the manufacturer's agreement. In this case, the making current multiples shall be as shown for I/I_e and the breaking current as shown for I_c/I_e. Twenty-five operating cycles shall be made at a control supply voltage equal to 110 % of the rated control supply voltage U_s and 25 operating cycles at 85 % of U_s. The off-times are to be determined from table 10.						

Table 10 – Relationship between current broken I_c and OFF time for the verification of rated making and breaking capacities

Current broken I_c A	OFF time s
$I_c \leq 100$	10
$100 < I_c \leq 200$	20
$200 < I_c \leq 300$	30
$300 < I_c \leq 400$	40
$400 < I_c \leq 600$	60
$600 < I_c \leq 800$	80
$800 < I_c \leq 1\,200$	100
$1\,000 < I_c \leq 1\,300$	140
$1\,300 < I_c \leq 1\,600$	180
$1\,600 < I_c$	240

8.2.4.2 Operational performance

Subclause 7.2.4.2 of Part 1 applies with the following additions:

a) *Conventional operational performance after making breaking capacity tests*

CPS's shall be capable of making and breaking currents after making/breaking capacity tests, without failure under the conventional conditions stated in table 11 for the required utilization categories and the number of operating cycles indicated.

ON time shall be 0,05 s. It may be less than 0,05 s provided that contacts are allowed to become properly seated before re-opening.

OFF time shall be not greater than the values specified in table 10 except for utilization categories AC-45b and DC-46 where the OFF time shall be 60 s.

b) *Operational performance before and after short-circuit tests at I_{cr} and I_{cs}*

CPS's shall be capable of making and breaking currents before and after short-circuit tests at I_{cr} and I_{cs} (see 8.2.5 a)) without failure under the conditions stated in table 12 for the required utilization categories and the number of operating cycles indicated. The first 25 operating cycles after the I_{cs} short circuit test shall be performed by the local manual operating means, if any, the control function circuit being energized. A local manual operating means may be activated locally or remotely (e.g. handle, motor drive, solenoid etc.).

For all but the above 25 operating cycles, ON time shall be 0,05 s. It may be less than 0,05 s provided that contacts are allowed to become properly seated before re-opening and the OFF time shall be not greater than the values specified in table 10 except for utilization categories AC-45b and DC-46 where the OFF time shall be 60 s.

c) *Conventional mechanical operational performance*

In addition to the electrical operational performance requirements of item a) CPS's shall be capable of effecting mechanical close-open operating cycles without current in accordance with table 11 and under the test conditions specified in 9.4.2.2.

For CPS's which can be fitted with under-voltage and/or shunt releases 10 % of the total number of operating cycles shall be closing-tripping operations for each release, 5 % at the beginning and 5 % at the end of the test.