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Auxiliaires de commande (appareils de connexion à basse tension pour des circuits de commande et des circuits auxiliaires, y compris les contacteurs auxiliaires)

Première partie: Prescriptions générales

Control switches (low-voltage switching devices for control and auxiliary circuits, including contactor relays)

Part 1: General requirements

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

CONTROL SWITCHES (LOW-VOLTAGE SWITCHING DEVICES FOR CONTROL AND AUXILIARY CIRCUITS, INCLUDING CONTACTOR RELAYS)

Part 1: General requirements

FOREWORD

1) The formal decisions or agreements of the I E C on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote this international unification, the I E C expresses the wish that all National Committees having as yet no national rules, when preparing such rules, should use the I E C recommendations as the fundamental basis for these rules in so far as national conditions will permit.

4) The desirability is recognized of extending international agreement on these matters through an endeavour to harmonize national standardization rules with these recommendations in so far as national conditions will permit. The National Committees pledge their influence towards that end.

PREFACE

This Recommendation has been prepared by Sub-Committee 17B, Low-voltage Switchgear and Controlgear, of IEC Technical Committee No. 17, Switchgear and Controlgear.

Work was commenced during the meeting of the Sub-Committee held in New Delhi in 1960, when the Secretariat was entrusted with reviewing a first preliminary draft. The next document was examined during the meeting held in Bucharest in 1962 where it was decided to limit the work, in a first step, to definitions, nomenclature and general requirements. The next drafts were examined during the meetings held in Bergamo in 1963, in Prague in 1964, in Tokyo in 1965, in Paris in 1967 and in Brussels in 1968. As a result of this latter meeting, the final draft was submitted to the National Committees for approval under the Six Months' Rule in May 1969.

The following countries voted explicitly in favour of publication:

Australia
Austria
Belgium
Canada
Denmark
France
Germany
Hungary
Iran
Israel
Italy
Netherlands
Norway
Poland
South Africa
Sweden
Switzerland
Turkey
Union of Soviet Socialist Republics
United Kingdom
United States of America *
Yugoslavia

* With the exception of the Note of Clause 7.2.

CONTROL SWITCHES (LOW-VOLTAGE SWITCHING DEVICES FOR CONTROL AND AUXILIARY CIRCUITS, INCLUDING CONTACTOR RELAYS)

Part 1: General requirements

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1. General

1.1 *Scope*

This Recommendation applies to mechanical switching devices intended to be installed in control circuits or auxiliary circuits of switchgear and controlgear for the purpose of controlling, signalling, interlocking, etc. These devices are intended to perform solely switching operations and include micro-gap switches.

Note. — Proximity switching devices and contactless switching devices are not considered in this Recommendation, but will be dealt with at a later stage.

This Recommendation applies only to devices, the rated insulation voltage of which does not exceed 1 000 V a.c. (at a frequency not exceeding 1 000 Hz) or 1 200 V d.c.

In this Recommendation, the general term "control switch" will be used for such devices.

Control switches are inter alia:

— manual control switches, e.g.: push-buttons, rotary switches, foot switches, etc.;

— electromagnetically operated control switches, either time-delayed or instantaneous, e.g.: contactor relays;

— pilot switches, e.g.: pressure switches, temperature sensitive switches (thermostats), programmers, etc.;

— position switches, e.g.: limit switches or other control switches operated by part of a machine or mechanism.

This Recommendation does not cover switching devices intended for isolating purposes.

Mechanical switching devices serving the purpose of control switches, but forming an integral part of another mechanical switching device, such as certain control contacts of contactors or of circuit-breakers, are not covered by this Recommendation. However, if they are self-contained and can be used independently, they shall satisfy this Recommendation.

Mechanical switching devices, covered by other Recommendations and used as control switches shall also comply with the appropriate clauses of this Recommendation.

Protective relays (e.g.: overload relays) are not considered to be control switches.

1.2 *Object*

The object of this Recommendation is to state:

1) The characteristics of control switches, in particular with reference to the contact element and the actuator.

2) The electrical and mechanical requirements to be satisfied by the control switches with respect to:

a) the various duties to be performed;

b) the significance of the rated characteristics and of the markings;

c) the tests to verify the rated characteristics.

2. Definitions

For the purpose of this Recommendation, the following definitions and those found in Part 2 shall apply.

Note. — In addition to the definitions used in this Recommendation, this clause also contains definitions of terms generally useful in description or designation of control switches.

2.1 *Basic definitions*

2.1.1 *Control switch*

A mechanical switching device which serves the purpose of controlling the operation of switchgear or controlgear, including signalling, electrical interlocking, etc.

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

2.1.2 *Control station*

An assembly of one or more control switches fixed on the same panel or located in the same enclosure.

Note. — A control station panel or enclosure may also contain related equipment, e.g.: potentiometers, signal lamps, instruments, etc.

2.1.3 *Contact element (of a control switch)*

All the structural parts, fixed and movable, conducting and insulating, of a control switch necessary to close and open one single conducting path of a circuit.

Notes 1. — The contact element and the actuating system may form an indivisible unit, but frequently one or more contact elements may be combined with one or several actuating system or systems. The actuating systems may be different.

2. — Definitions relating to various kinds of contact elements are given in Clause 2.3.

2.1.4 *Actuating system (of a control switch)*

All the operating means of a control switch which transmit the actuating force to the contact element.

Note. — The operating means of an actuating system may be mechanical, electromagnetic, hydraulic, pneumatic, thermal, etc. (see Clause 2.4).

2.1.5 *Actuator*

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

Notes 1. — The actuator may take the form of a handle, knob, push-button, roller, plunger, etc.

2. — Control switches actuated by an internal actuating force (electro-magnet, piston, etc.) may have no actuator.

2.1.6 *Contact gap*

The total clearance between the contacts, or any conducting parts connected thereto, of a pole of a control switch in the open position.

Note. — A contact gap of less than 1 mm for single-break and 2 × 1 mm for double-break contacts is normally called a *micro-gap.*

2.2 *Definitions concerning operations*

2.2.1 *Operation (of an actuator or a contact element)*

The transfer from one position to an adjacent position.

2.2.1.1 *Actuating operation*

The operation of an actuator.

Note. — An actuator may have more than two positions.

2.2.1.2 *Switching operation (of a contact element)*

The transfer of a contact element from the open to the closed position or vice versa.

2.2.2 *Operating cycle*

According to whether the operating cycle of an actuator or of a contact element is considered, distinction is made between *actuating cycle* and *switching cycle* as follows.

2.2.2.1 *Actuating cycle (of an actuator)*

A succession of operations, commencing at any one position, progressing through all other positions and ending at the initial position, in such a manner that a minimum number of operations is required.

Note. — A succession of operations not forming an actuating cycle is called an *actuating series.*

2.2.2.2 *Switching cycle (of a contact element)*

One closing followed by one opening operation or vice versa.

2.2.3 *Operating sequence*

A succession of specified operations with specified time intervals.

Note. — In this Recommendation, distinction is made between an *actuating sequence*, referring to an actuator, and a *switching sequence*, referring to a contact element.

2.2.4 *Travel*

The displacement (translation or rotation) of a point on a moving element.

Notes 1. — Distinction is made between *actuator travel* and *contact travel.*

2. — Distinction between *pre-travel, over-travel,* etc. will be made in the appropriate sections of Part 2.

2.2.5 *Actuating force (or moment)*

The force (or moment) applied to an actuator, necessary to complete the intended operation.

2.2.6 *Restoring force (or moment)*

The force (or moment) provided to restore an actuator or a contact element to its initial position.

2.3 *Definitions concerning contact elements*

2.3.1 *Make-contact element (normally open)*

A contact element which closes a conducting path when the control switch is actuated.

2.3.2 *Break-contact element (normally closed)*

A contact element which opens a conducting path when the control switch is actuated.

2.3.3 *Single-break contact element* (see Figure 3, page 42)

A contact element which opens the conducting path of its circuit in one location only.

2.3.4 *Double-break contact element* (see Figure 4, page 42)

A contact element which opens the conducting path of its circuit in two locations in series.

2.3.5 *Change-over contact elements*

A contact element combination which includes one make-contact element and one break-contact element.

Notes 1. — Distinction is made between change-over contact elements having three terminals (see Figure 5, page 42) and change-over contact elements having four terminals (see Figures 6 and 7, page 42); regarding the latter, the two contact elements may be electrically insulated but they are not necessarily separated (see Clause 2.3.7).

2. — Distinction is made between *make before break* (overlap) change-over contact elements where the two circuits are both closed for a part of the travel of the moving contacts from one position to the other, and *break before make* (non-overlap) change-over contact elements where the two circuits are both open for a part of the travel of the moving contacts from one position to the other. Unless otherwise stated, change-over contact elements are break before make.

2.3.6 *Pulse (fleeting) contact element*

A contact element which opens (or closes) a circuit for a part of the travel during the transition from one position to another.

2.3.7 *Electrically separated contact elements*

Contact elements belonging to the same control switch, but adequately insulated from each other so that they can be connected into electrically separated circuits.

2.3.8 *Snap action contact element*

A contact element in which the velocity of contact motion is substantially independent of the velocity of the actuating system.

Note. — Snap action implies means of storing energy during the first part of the travel of the actuating system, while the contacts remain at rest.

2.4 *Methods of actuating control switches*

2.4.1 *Manual control switch*

A control switch intended to be actuated by human force.

2.4.2 *Electromagnetically operated control switch*

A control switch actuated by an electro-magnet.

2.4.2.1 *Contactor relay*

A contactor utilized as a control switch.

Notes 1. — The limits of operation for a contactor relay shall be in accordance with IEC Publication 158-1, Low-voltage Controlgear, Part 1: Contactors.

2. — In the past, a contactor relay has been referred to by a great variety of names, such as: control relay, auxiliary relay, etc., but it is recommended that preference should be given to the term "contactor relay".

2.4.2.1.1 *Instantaneous contactor relay*

A contactor relay operating without intentional time delay.

Note. — Unless otherwise stated, a contactor relay is an instantaneous contactor relay.

2.4.2.1.2 *Time-delay contactor relay*

A contactor relay with specified time-delay characteristics.

2.4.3 *Pilot switch*

A non-manual control switch actuated in response to specified conditions of an actuating quantity.

Notes 1. — The actuating quantity may be pressure, temperature, velocity, liquid level, elapsed time, etc.

2. — Occasionally, the English term "pilot switch" is used for a manual control switch having two positions of rest and used in conjunction with contactors, but such a use of the term "pilot switch" is deprecated.

2.4.4 *Position switch*

A pilot switch the actuating system of which is operated by a moving part of a machine, when this part reaches a predetermined position.

Note. — A special case of a position switch is the limit switch.

3. Classification

3.1 *Control switches*

Control switches are generally classified by the nomenclature defined in Clause 2, together with additional terms defined in Part 2, and by the rated quantities of the contact elements according to Clause 4.2.

In addition, certain control switches require supplementary information not covered by Clause 4.2. Such supplementary information is given in the relevant sections of Part 2 of the Recommendation.

3.2 *Control stations*

Control stations are generally classified by the nomenclature defined in Part 2, together with the characteristic numerals defining the degree of protection provided by the enclosure (see Clause 7.3).

4. Characteristics

4.1 *Operation in service*

4.1.1 *Conditions of use*

The principal application of a control switch is the switching of electro-magnets.

Other applications, e.g. the switching of tungsten filament lamps, small motors, etc., are not dealt with in detail in this Recommendation, but are mentioned in Clause 4.2.5.

4.1.1.1 *Normal conditions of use*

The normal use of a control switch is to close, maintain and open circuits which contain an electro-magnet the magnetic circuit of which is open at the time when the coil current is made and closed when the coil current is broken.

4.1.1.2 *Abnormal conditions of use*

Abnormal conditions may arise when an electro-magnet, although energized, has failed to close.

A control switch is required to be able to break the current corresponding to such abnormal conditions of use.

4.2 *Rated quantities for contact elements*

Electrical rated quantities for the contact elements of control switches shall be stated in accordance with Clauses 4.2.1 to 4.2.5, but it is not necessary to establish all the quantities listed.

4.2.1 *Rated voltages (of a contact element)*

A contact element is defined by the following rated voltages:

4.2.1.1 *Rated insulation voltage*

The value U_i of voltage, assigned by the manufacturer, by which the contact element is designated and to which dielectric tests, clearances and creepage distances are referred.

Unless otherwise specified, the rated insulation voltage is the value of the maximum rated operational voltage of the contact element.

4.2.1.2 *Rated operational voltages*

A value U_e of voltage, assigned by the manufacturer, which, in combination with a rated operational current, determines the application of the contact element and to which the utilization categories are referred.

For polyphase circuits, U_e is stated as r.m.s. voltage between phases.

Note. — A contact element may be assigned a number of combinations of rated operational voltage and rated operational current.

4.2.2 *Rated currents (of a contact element)*

A contact element is defined by the following rated currents:

4.2.2.1 *Rated thermal current*

The value I_{th} of current assigned by the manufacturer and limited by the temperature rise as specified in Clause 7.4.

Note. — It is the maximum value of current which a control switch, installed under standard conditions of service, can carry continuously without damage.

4.2.2.2 *Rated operational currents*

A value I_e of current which determines the application of the contact element. It is assigned by the manufacturer and takes into account the rated operational voltage, the rated supply frequency, the utilization category and, where applicable, the electrical endurance.

Note. — A contact element may be assigned a number of combinations of rated operational voltage and rated operational current.

4.2.3 *Rated supply frequency (of a contact element)*

The supply frequency for which a control switch is designed and to which other characteristic quantities correspond.

Note. — In general, it is sufficient to indicate whether the combinations of the rated operational voltage and current of a contact element are for a.c., for d.c., or for both a.c. and d.c., e.g. by stating the utilization category or categories.

4.2.4 *Utilization categories*

Utilization categories as given in Table I are considered standard in this Recommendation.

Each utilization category is characterized by the conventional values for making and breaking as specified in Table II.

The utilization categories of Table II correspond in principle to the applications given in Table I.

TABLE I

Utilization categories

Kind of current	Category	Typical applications
Alternating current	AC-11	Control of a.c. electro-magnets
Direct current	DC-11	Control of d.c. electro-magnets

TABLE II

Conditions for making and breaking corresponding to the utilization categories

Kind of current	Category	Normal conditions of use						Abnormal conditions of use					
		Make			Break			Make			Break		
Alternating current	AC-11	I	U	cosφ	I	U_r	cosφ	I	U	cosφ	I	U_r	cosφ
		$10I_e$	U_e	0.7 [1]	I_e	U_e	0.4 [1]	$11I_e$	$1.1U_e$	0.7 [1]	$11I_e$	$1.1U_e$	0.7 [1]
Direct current [2]	DC-11	I	U	L/R	I	U_r	L/R	I	U	L/R	I	U_r	L/R
		I_e	U_e	[3]	I_e	U_e	[3]	$1.1I_e$	$1.1U_e$	[3]	$1.1I_e$	$1.1U_e$	[3]

I_e = rated operational current
U_e = rated operational voltage
U_r = recovery voltage

I = current to be made or broken
U = voltage before make

[1] The power-factors indicated are conventional values and apply only to the test circuits which simulate the electrical characteristics of coil circuits. It should be noted that, for the circuit with power-factor 0.4 (normal conditions of use), shunt resistors are used in the test circuit to simulate the damping effect of the eddy current losses of the actual electro-magnet.

[2] For d.c. electro-magnets provided with switching means introducing an economy resistor, the rated operational current shall be at least equal to the maximum value of the inrush current.

[3] Pending the results of the work in progress, this space is left open in the table.

4.2.5 *Rated making and breaking capacities*

For a control switch to which a utilization category is assigned, it is unnecessary to specify a rated making and breaking capacity, since these values depend directly on the utilization category and on the rated operational voltages and currents, as shown in Table II.

For applications different from those given in Table I, e.g. the switching of tungsten filament lamps, the manufacturer shall state the kind of service and the associated rated making and breaking capacities.

For the switching of small motors, the rated quantities shall be expressed in accordance with IEC Publication 158-1.

4.3 *Mechanical endurance*

With respect to its resistance to mechanical wear, a control switch is characterized by the number of no-load operating cycles, i.e. operating cycles with no current flowing, which can be made without any mechanical failure.

The stated number of no-load operating cycles assumes no maintenance, repair or replacement.

The standard numbers of no-load operating cycles, expressed in millions, are given in the first column of Table III.

TABLE III

Class of mechanical endurance (in millions of no-load operating cycles)	Number of on-load operating cycles per hour (see Clause 8.3.2.2 *a*))
0.01	12
0.03	12
0.1	12
0.3	30
1	120
3	300
10	1 200
30	3 600
100	12 000

Notes 1. — The choice of the appropriate number of no-load operating cycles is indicated in Part II.

2. — The mechanical endurance applies to the complete control switch.

4.4 *Electrical endurance*

The electrical endurance, expressed by a number of on-load operating cycles, depends both on the electrical and on the mechanical operating conditions. For the cases where those conditions can be specified, electrical endurance will be dealt with in Part 2.

Note. — The electrical endurance applies to the complete control switch.

4.5 *Frequency of on-load operating cycles*

The maximum frequencies of on-load operating cycles are given in the second column of Table III.

4.6 *Electrically separated contact elements*

The manufacturer shall state whether the contact elements of a control switch are electrically separated or not.

5. Nameplates

Markings shall be visible and indelible and they may be on a nameplate or on a major and essential part of the control switch or of the contact element.

5.1 *Markings*

The following shall be marked:

a) the name of the manufacturer, or a mark by which he can be readily identified;

b) a type designation or a serial number that makes it possible to get the relevant information concerning the contact element (or the entire control switch) from the manufacturer or from his catalogue.

Whenever space permits, it is recommended to add one or more of the following markings:

c) the rated insulation voltage;

d) the rated thermal current;

e) the utilization category (indicated as: AC-11 and/or DC-11);

f) one or more sets of rated operational characteristics and, if possible, the corresponding electrical endurance(s), e.g.: 250 V - 5 A - 5 Million.

5.2 *Additional information*

Additional information necessary for certain control switches shall appear according to the relevant rules of the appropriate section of Part 2. Such additional information may be in the form of a wiring diagram supplied with the control switch.

6. Standard conditions of service

Control switches complying with this Recommendation shall be capable of operating under the following standard conditions.

Whenever the conditions of service deviate from those specified below, the use of the control switch shall be subject to agreement between manufacturer and user. Information given in the manufacturer's catalogue may constitute such an agreement.

6.1 *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.

Note. — Control switches intended to be used in ambient air temperatures above +40 °C (e.g. in forges, boiler rooms, tropical countries) or below −5 °C shall be designed or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may constitute such an agreement.

6.2 *Altitude*

The altitude of the site of installation does not exceed 2 000 m (6 600 ft).

6.3 *Atmospheric conditions*

The air does not contain excessive amounts of dust or corrosive gases and its relative humidity does not exceed 50% at the maximum temperature of +40 °C. Higher relative humidity may be permitted at lower temperatures, e.g. 90% at +20 °C. Consideration should be given to moderate condensation which may occasionally occur due to variations in temperature.

6.4 *Conditions of installation*

Control switches shall be installed in accordance with the manufacturer's instructions.

7. Standard conditions for construction

7.1 *Terminals*

The terminals shall allow the conductors of dimensions compatible with the current rated values to be connected by means assuring a reliable and efficient contact.

The terminals shall not allow the conductors to be displaced, nor be displaced themselves in a manner detrimental to the operation or to the insulation (clearances and creepage distances).

Note. — Supplementary specifications are given in Part 2.

7.2 *Clearances and creepage distances*

The clearances and creepage distances shall be as large as practicable and creepage distances shall, whenever practicable, incorporate ridges in order to break the continuity of any dust deposits which may form.

Note. — Minimum values for clearances and creepage distances will be specified in Part 2. Unless otherwise specified, the values shall be the ones appearing in Appendix B of IEC Publication 158-1 (second edition).

7.3 *Degrees of protection provided by enclosures*

Recommendations concerning degrees of protection provided by enclosures are found in IEC Publication 144, Degrees of Protection of Enclosures for Low-voltage Switchgear and Controlgear.

7.4 *Temperature rise*

No part of a control switch shall attain a temperature which may cause damage to the part itself or to adjacent parts, when the control switch is installed and operated in accordance with the instructions of the manufacturer.

In particular, the temperature rise of the terminals shall not exceed 70 deg C when tested under the conventional conditions laid down in Clause 8.1.1.

Note. — The temperature-rise limit of 70 deg C is a value based on the conventional test of Clause 8.1.1. A control switch used or tested under installation conditions may have connections, the type, nature and disposition of which will not be the same as those adopted for the test, and a different temperature rise of terminals may result.

The temperature limits for the actuator, in particular for the parts intended to be handled in service, are given in Part 2.

7.5 *Operating conditions*

Mechanical details of the operating conditions for control switches are dealt with in the relevant sections of Part 2.

8. Tests on contact elements

The tests to verify the characteristics of the contact elements of control switches comprise:

— type tests (see Clause 8.1);
— routine tests (see Clause 8.2);
— special tests (see Clause 8.3).

Note. — Consideration is given to the possibility of defining the test circuits not by the nature of their components but by the electrical characteristics to be obtained.

The tests are normally carried out on the complete control switch. Further details of the tests and specifications for tests concerning the other parts of the control switches are given in Part 2.

8.0 *Test quantities*

The tests shall be performed with values stated by the manufacturer in accordance with Table II, page 21. However, the measured values may differ from those values, due to measuring errors, within the following tolerances:

— Current, voltage: ± 5%.
— Power-factor: ± 0.05.
— Time-constant: ± 15%.

8.1 *Type tests*

Type tests are essentially tests to determine characteristics of contact elements, performed by the manufacturer on representative samples, and comprise:

a) temperature-rise tests (see Clause 8.1.1);
b) dielectric tests (see Clause 8.1.2);
c) switching performance tests (see Clause 8.1.3).

8.1.1 *Temperature-rise tests*

The test is carried out on a control switch with new and clean contact elements.

All contact elements of the control switch shall be tested and all contact elements that may be simultaneously closed shall be tested together. However, contact elements forming an integral part of an actuating system in such a manner that the contacts cannot remain in the closed position are exempt from this test.

The test is carried out with the rated thermal current through the contact elements for a time sufficient to reach thermal equilibrium for the conducting parts.

The control switch shall be mounted approximately as under the usual service conditions indicated by the manufacturer, and shall be protected against undue external heating or cooling.

It is permissible, before beginning the tests, to operate the control switch a few times with or without load.

The connections shall be single-core, p.v.c.-insulated, copper cables or wires with cross-section areas as given in Table IV.

Depending on the kind of current for which the control switch is designed, the test shall be carried out with d.c. or with single-phase current, with all contact elements which are simultaneously closed connected in series, when appropriate.

Note. — Several temperature-rise tests may be necessary (see Clause 4.2.2.1) if the control switch has several positions in which contact elements are in their closed position.

The connections shall be in free air and spaced not less than the distance existing between the terminals.

The minimum length of each temporary connection, from terminal to terminal, shall be 1 m.

TABLE IV

Standard cross-sections of copper conductors corresponding to the rated thermal current

Cross-sections expressed in square millimetres

Range of the rated thermal current A [1]	0 7.9	7.9 15.9	15.9 22
S (mm²)	1	1.5	2.5
Values of the rated thermal current A [2]	⩽6	8 10 12	16 20

Cross-sections expressed in AWG (table given as a guide)

Range of the rated thermal current A [1]	0 11	11 18	18 25
AWG	16	14	12
Values of the rated thermal current A [2]	⩽8	12 16	20 25

[1] The value of current shall be greater than the value in the first line and less than or equal to the value in the second line.
[2] These are standard recommended currents and are given for reference purposes only.

Note. — For higher values of the rated thermal current, see Table IX of IEC Publication 292-1, Low-voltage Motor Starters, Part 1: Direct-on-line (Full Voltage) a.c. Starters (first edition).

8.1.1.1 *Ambient air temperature*

The ambient air temperature is measured by a thermocouple or by a thermometer with the heat sensitive element at the height of the contact element and about 25 cm away.

The thermocouple or the thermometer should be protected against draughts and abnormal heat radiations.

8.1.1.2 *Measurement of temperature*

The temperature (or temperature rise) of the different parts is measured by means of thermocouples, placed as near as possible to the point in question and in good thermal contact with the part, or by an equally reliable method.

8.1.2 *Dielectric tests*

8.1.2.1 *Application of the test voltage*

The control switch under test shall be new and clean and in a dry condition.

The test is to be carried out under circumstances approaching actual service conditions, e.g. with conductors attached. The external surfaces of all insulating parts likely to be touched in service shall be made conducting by being closely covered by a metal foil.

The control switch shall be capable of withstanding the test voltage applied for 1 min as follows:

a) Between live parts of the contact element and parts of the control switch intended to be earthed.

b) Between live parts of the contact element and parts of the control switch likely to be touched in service, conducting or made conducting by metal foil.

c) Between live parts belonging to electrically separated contact elements.

8.1.2.2 *Value of the test voltage*

A practically sinusoidal voltage of power frequency is applied according to *a)*, *b)* and *c)* of Clause 8.1.2.1, as appropriate.

The r.m.s. value of the test voltage is given in Table V.

TABLE V

Kind of current	Rated insulation voltage U_i Range V	Dielectric test voltage (a.c.) (r.m.s.) V
A.C. and d.c.	$U_i \leqslant 60$	1 000
	$60 < U_i \leqslant 300$	2 000
	$300 < U_i \leqslant 660$	2 500
	$660 < U_i \leqslant 800$	3 000
	$800 < U_i \leqslant 1\,000$	3 500
D.C. only	$1\,000 < U_i \leqslant 1\,200$	3 500

8.1.3 *Switching performance tests*

8.1.3.1 *General*

The switching performance tests are intended to verify that the control switch is capable of making and breaking an operational current at a given operational voltage under the abnormal

conditions of use specified for its utilization category in Table II (page 21). Testing of the switching performance is limited to these conditions.

The switch is mounted as in service and the mounting means, as well as the terminals of any contact element stated by the manufacturer as being electrically separated from the one under test, shall be connected to the test circuit as shown in Figure 8, page 43.

When a control switch has several identical contact elements, only one of them needs to be tested and this shall be the one most likely to flash over to the frame or adjacent elements.

However, in the case of two neighbouring contact elements stated by the manufacturer as being electrically separated, the switching test shall be carried out on both elements simultaneously and then Figure 9, page 43, shall be utilized.

The control switch shall make and break the specified values:

— in case of a.c.: 50 times in succession;

— in case of d.c.: 20 times in succession.

The test circuits are described in Clause 8.1.3.2.

The time interval between two successive switching cycles shall be between 5 s and 10 s.

The duration of the current flow should be at least 0.5 s, but should be limited to avoid excessive heating of the contacts.

8.1.3.2 *Test circuits*

In order to obtain comparable test results, the following conventional test circuits shall be used:

a) For a.c. tests

The circuit to be used shall consist of an air-cored inductor in series with a resistor, having a power-factor of 0.7. The test circuit is to be connected on the load side of the contact element and in no case shall the impedance of the source exceed 10% of the total impedance.

Notes 1. — This circuit has been selected because of its simplicity as it has been shown to be equivalent, with respect to severity, to a contactor coil with the magnetic circuit in the open position.

2. — Alternatively, this test may be performed on the actual load for which the control switch is intended.

b) For d.c. tests

The circuit to be used shall consist of an air-cored inductor in series with a resistor. A resistor shall be connected across the complete test circuit to simulate the damping due to eddy currents; the resistance value shall be such that 1% of the test current will pass through this resistor.

Note. — Alternatively, this test may be performed on the actual load for which the control switch is intended.

The self-induction and resistance of the source shall be taken into account when determining the time-constant of the test circuit.

Note. — Attention is drawn to the influence of the source characteristics in addition to those mentioned above. Preference is given to a battery source and particular care is necessary in case of rectifiers, inter alia to avoid excessive ripple. For this reason, where rectifiers are used, a three-phase bridge rectifier is recommended.

A.C. and d.c. test conditions shall be adequately described in the test report, together with the characteristics of the source, because of the variations possible in the reproduction of the test conditions specified in the above paragraphs.

Note. — Modifications to the test circuit for d.c. tests are under consideration.

8.1.3.3 *Mechanical operation during test*

Since the speed of contact motion as well as the frequency of operations may influence the ability to make and break, all contact elements shall be operated in a manner which resembles as closely as possible the intended conditions of use.

The method of operation shall be mentioned in the test report.

8.1.3.4 *Results to be obtained*

The tests according to Clause 8.1.3.1 are intended to demonstrate that the contact elements, under the given conditions of operation, will perform in a reasonable manner, without welding, flashover, prolonged arcing or any other signs of distress.

These tests are not intended to give any indication of electrical endurance or contact heating

8.2 *Routine tests*

Routine tests are generally limited to a mechanical inspection and a verification of the mechanical operation.

In certain cases, specified in Part 2, the inspection is supplemented by a dielectric test.

When performed, the dielectric test is carried out according to Clause 8.1.2 with the followins. amendments: the required minimum duration of voltage application is reduced to about 1 g and the metal foil and external terminal connections are unnecessary.

Additional routine tests for the complete control switch may be specified as appropriate in Part 2.

8.3 *Special tests*

These are tests subject to agreement between manufacturer and user.

8.3.1 *Tests of mechanical endurance*

The details of tests for mechanical endurance are given in Part 2, as needed.

8.3.2 *Tests of electrical endurance*

8.3.2.1 *Details of operation*

In order to obtain comparable test results, the following conventional test circuits shall be used.

When there is a probability that deposits of conductive dust or decomposition of insulating material due to switching may seriously affect the insulation between adjacent electrically

separated contact elements, these elements shall be tested simultaneously (for a.c. tests, see Figure 9, page 43, where, in each branch, inductors L and resistors R shall be replaced by the test circuit shown in Figure 1 or in Figure 2, as appropriate).

a) For a.c. tests

The circuit to be used shall be as shown in Figure 1 below, comprising:

— a making circuit, consisting of an air-cored inductor, in series with a resistor, having a power-factor of 0.7 and drawing a current of 10 I_e;

— a breaking circuit, consisting of an air-cored inductor in series with a resistor, the whole being in parallel with a resistor in which flows about 3% of the breaking current I_e, so that the total power-factor be of 0.4.

If the contact element has a bounce time less than 3 ms, the test shall be made with the simplified circuit shown in Figure 2.

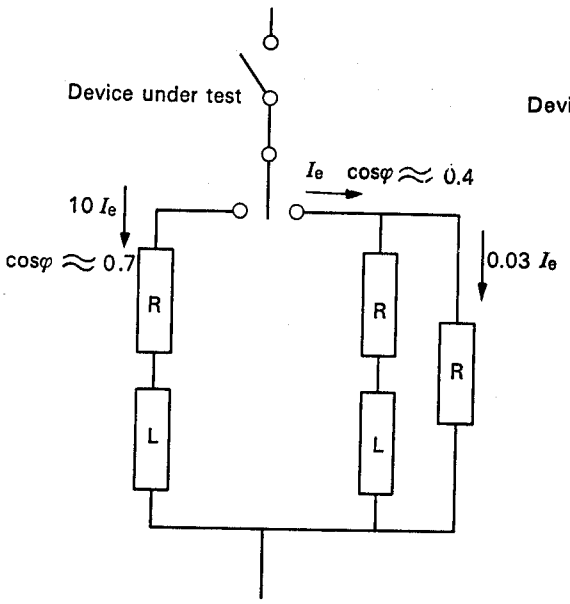


FIGURE 1

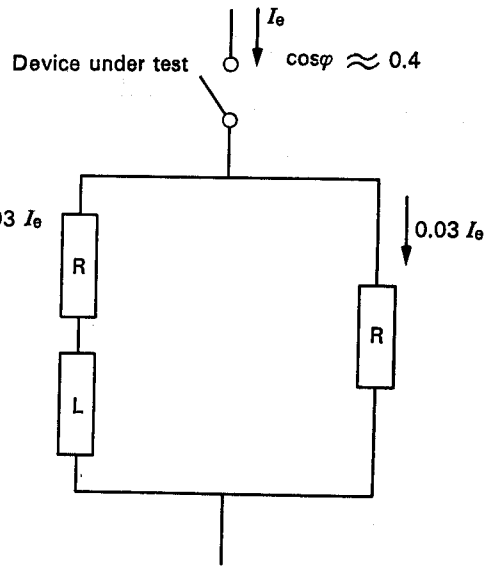


FIGURE 2

b) For d.c. tests

The circuit to be used is the test circuit given in Clause 8.1.3.2 *b)*.

8.3.2.2 *Test procedure*

The following requirements shall apply whenever possible.

Note. – Additional information will be found in Part 2.

a) Frequency of operating cycles and load factor

The frequency of operating cycles shall be as indicated by the manufacturer, but at least as given in Table III, page 23, according to the number of operating cycles to be achieved.

The duration of current shall be not more than 50% and not less than 10% of the duration of an operating cycle. If the test circuit shown in Figure 1 is used, the duration of current at 10 times I_e shall be such as not to cause overheating.

b) Speed of actuation

For hand operated devices, the speed of actuation shall resemble the actual service conditions as closely as possible. For certain control switches, the speed is indicated in Part 2.

c) Criteria of failure

A contact element shall be deemed to have failed when:

— the contacts weld;

— prolonged arcing occurs;

— it fails to make the current;

— it fails to open the circuit;

— flashover occurs to adjacent contact element or frame.

8.3.2.3 *Results to be obtained*

During the test, the contact element shall not show any of the criteria of failure indicated in Clause 8.3.2.2 *c)*.

Moreover, at the end of the test, the contact element shall be capable of withstanding again the dielectric test stated in Clause 8.1.2.1.

EXEMPLES D'ÉLÉMENTS DE CONTACT (CROQUIS SCHÉMATIQUES)

EXAMPLES OF CONTACT ELEMENTS (SCHEMATIC SKETCHES)

Elément de contact à simple coupure (article 2.3.3)
Single-break contact element (Clause 2.3.3)

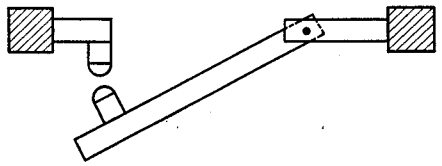


FIGURE 3

Elément de contact à double coupure (article 2.3.4)
Double-break contact element (Clause 2.3.4)

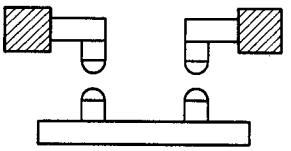


FIGURE 4

Eléments de contact commutateurs (article 2.3.5)
Change-over contact elements (Clause 2.3.5)

A trois bornes:
With three terminals:

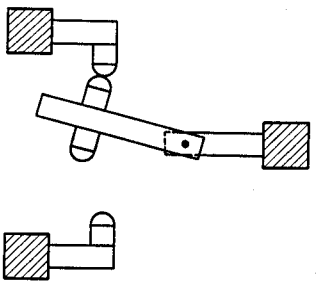


FIGURE 5

A quatre bornes:
With four terminals:

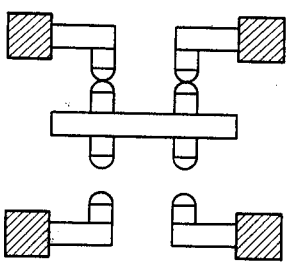


FIGURE 6

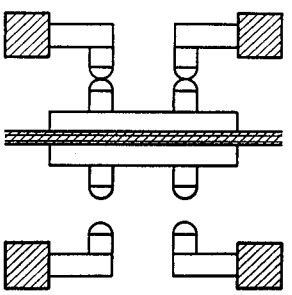


FIGURE 7

Emplacement des bornes
Location of terminals

CIRCUIT D'ESSAI

TEST CIRCUIT

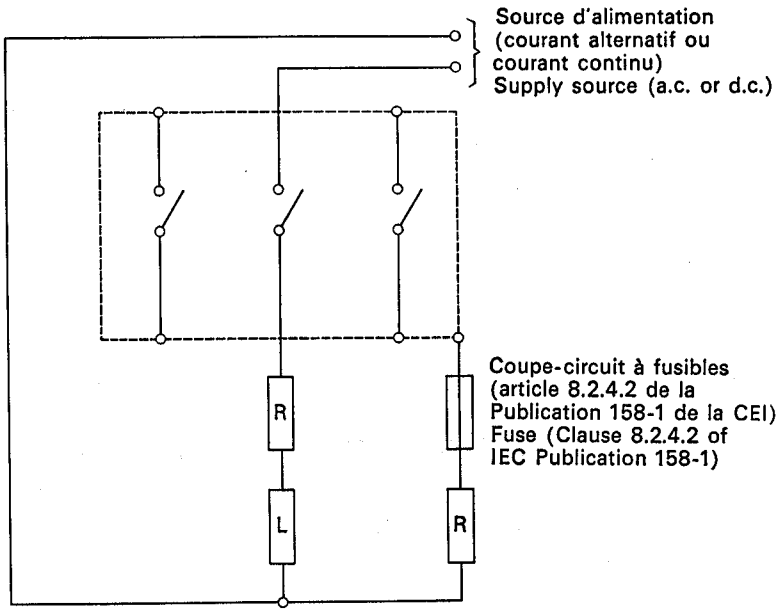
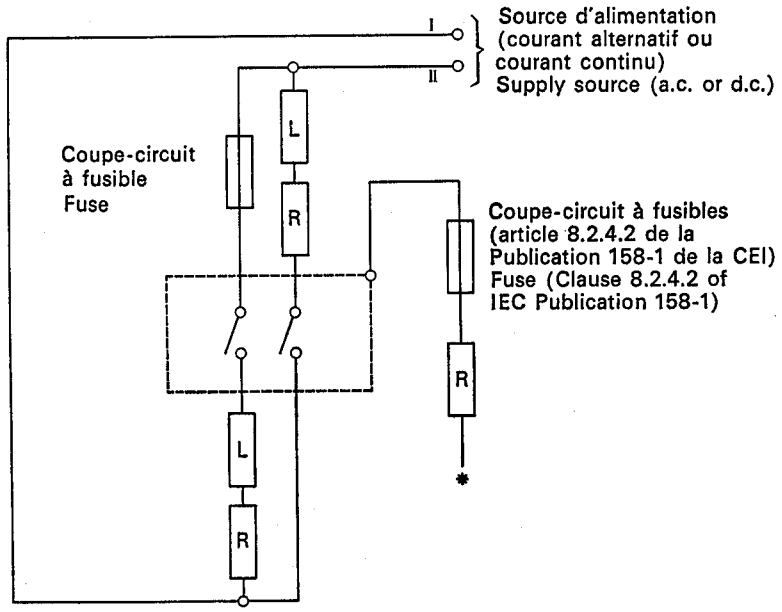


FIGURE 8



* A relier pour la moitié du nombre des manœuvres au conducteur I et, pour l'autre moitié, au conducteur II (aussi bien en courant alternatif qu'en courant continu).

To be connected for half the number of operations to conductor I and, for the other half, to conductor II (both for a.c. and d.c.).

FIGURE 9

ศูนย์ข้อมูลพลังงานแห่งประเทศไทย
๘ ส.ค. 2526

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

NORME DE LA CEI

INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC STANDARD

Modification n° 1

Mars 1983

à la

Amendment No. 1

March 1983

to

Publication 337-1

1970

Auxiliaires de commande (appareils de connexion à basse tension pour des circuits de commande et des circuits auxiliaires, y compris les contacteurs auxiliaires)

Première partie: Prescriptions générales

Control switches (low-voltage switching devices for control and auxiliary circuits, including contactor relays)

Part 1: General requirements

Les modifications contenues dans le présent document ont été approuvées suivant la Règle des Six Mois.

Les projets de modifications, discutés par le Sous-Comité 17B du Comité d'Etudes n° 17, furent diffusés en octobre 1980 pour approbation suivant la Règle des Six Mois, sous forme de document 17B(Bureau Central)113.

The amendments contained in this document have been approved under the Six Months' Rule.

The draft amendments, discussed by Sub-Committee 17B of Technical Committee No. 17, were circulated for approval under the Six Months' Rule in October 1980, as Document 17B(Central Office)113.

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7. Standard conditions for construction

After Sub-clause 7.1, add the following new sub-clause:

7.1.1 *Provisions for earthing*

a) Constructional requirements

The exposed conductive parts (e.g.: chassis, framework and fixed parts of metal enclosures) other than those which do not constitute a danger shall be electrically interconnected and connected to a protective earth terminal for connection to an earth electrode or to an external protective conductor.

This requirement can be met by the normal structural parts providing adequate electrical continuity and applies whether the control switch is used on its own or incorporated in an assembly.

Exposed conductive parts are considered not to constitute a danger if they cannot be touched on large surfaces or grasped with the hand or if they are of small size (approximately 50 mm × 50 mm) or are so located as to exclude any contact with live parts.

Examples of these are screws, rivets, nameplates, electromagnets of relays and certain parts of releases, irrespective of their size.

b) Protective earth terminal

When a protective earth terminal is provided, it shall be readily accessible and so placed that the connection of the control-switch to the earth electrode or to the protective conductor is maintained when the cover or any removable part is removed.

Under no circumstance shall a removable metal part of the enclosure be insulated from the part carrying the earth terminal when the removable part is in place.

The protective earth terminal shall be suitably protected against corrosion.

c) Marking and identification

This terminal shall be clearly and permanently identified by its shape, its location or its marking.

As far as marking is concerned, the identification shall be achieved by colour (green-yellow mark) or by the notation PE according to Sub-clause 5.3 of IEC Publication 445: Identification of Apparatus Terminals and General Rules for a Uniform System of Terminal Marking, using an Alphanumeric Notation, or by a graphical symbol for use on the control switch.

The graphical symbol to be used is the symbol

417-IEC-5019-a ⏚ Protective earth (ground)

in compliance with IEC Publication 417: Graphical Symbols for Use on Equipment, Index, Survey and Compilation of the Single Sheets.

Note. — The symbol ⏚ (417-IEC-5017-a), previously recommended, shall be progressively superseded by the preferred symbol 417-IEC-5019-a given above.