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Appareillage de commande à basse tension

Première partie: Contacteurs

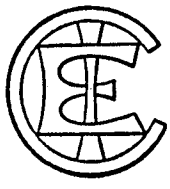
Second supplement to Publication 158-1 (1970)

Low-voltage controlgear

Part 1: Contactors

Descripteurs: contacteurs à basse tension, exigences, propriétés, essais d'endurance mécanique, analyse statistique, thermométrie des contacteurs, protection contre les courts-circuits.

Descriptors: low-voltage contactors, requirements, properties, mechanical endurance tests, statistical analysis, thermometry of conductors, protection against short circuits.



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

Second supplement to Publication 158-1 (1970)

LOW-VOLTAGE CONTROLGEAR

Part 1: Contactors

FOREWORD

1) The formal decisions or agreements of the IEC 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 international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

Part A of this standard has been prepared by Sub-Committee 17B, Low-voltage Switchgear and Controlgear, of IEC Technical Committee No. 17, Switchgear and Controlgear.

Part A, except new Clauses 4.3.5.3, 4.6 and 8.2.8, combines two documents prepared by two different working groups.

As concerns the first document, a first draft was circulated in April 1972, according to the decision taken in Brussels in June 1971, and examined in Stockholm in September 1972. A second draft was circulated in April 1975 and discussed in The Hague in September 1975. A third draft was circulated in August 1976 and discussed in Moscow in June 1977. The draft, Document 17B(Central Office)97, was submitted to the National Committees for approval under the Six Months' Rule in September 1977.

The following countries voted explicitly in favour of publication:

Australia
Austria
Belgium
Bulgaria
Canada
Denmark
Finland
France
Germany
Israel
Italy
Japan
Netherlands
Poland
Romania
South Africa (Republic of)
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States of America

A first draft of the second document was circulated in August 1975, according to the decision taken in Paris in April 1974. A second draft was circulated in December 1976 and discussed in Moscow in June 1977. The draft, Document 17B(Central Office)98, was submitted to the National Committees for approval under the Six Months' Rule in January 1978.

The following countries voted explicitly in favour of publication:

Australia
Belgium
Bulgaria
Canada
China
Egypt
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France
Germany
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Japan
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Poland
South Africa (Republic of)
Spain
Sweden
Turkey
Union of Soviet Socialist Republics
United Kingdom
United States of America

Part B of this standard and new Clauses 4.3.5.3, 4.6 and 8.2.8 of Part A have been prepared by Sub-Committee 17B of IEC Technical Committee No. 17.

A first draft was circulated in July 1973, according to the decision taken in Stockholm in September 1972, and discussed in Paris in February 1974. Three successive drafts were respectively circulated in November 1974, December 1975 and October 1976. The second draft was discussed in The Hague in September 1975, and the fourth in Moscow, in June 1977. The draft, Document 17B(Central Office)100, was submitted to the National Committees for approval under the Six Months' Rule in January 1978.

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France
Germany
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Poland
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Spain
Sweden
Switzerland
Turkey
United Kingdom
United States of America

Other IEC publications quoted in this standard:

Publications Nos. 157-1: Low-voltage Switchgear and Controlgear, Part 1: Circuit-breakers.
269-1: Low-voltage Fuses, Part 1: General Requirements.
292-1A: First supplement to Publication 292-1: Low-voltage Motor Starters, Part 1: Direct-on-line (Full Voltage) A.C. Starters.
410: Sampling Plans and Procedures for Inspection by Attributes.
439: Factory-built Assemblies of Low-voltage Switchgear and Controlgear.

Second supplement to Publication 158-1 (1970)

LOW-VOLTAGE CONTROLGEAR

Part 1: Contactors

A – Amendments to Publication 158-1 (1970)

Page 3

CONTENTS

4.3 Rated values

(Correction to the French text only.)

Replace the title of Clause 4.6 by the following:

4.6 Protection of a contactor by a short-circuit protection device

Replace the title of Appendix C by the following:

APPENDIX C – Protection of a contactor by a short-circuit protective device

Page 17

4.1 *Summary of characteristics*

(Correction to the French text only.)

4.3 *Rated values*

(Correction to the French text only.)

4.3.1 *Rated voltages*

(Correction to the French text only.)

4.3.1.1 *Rated operational voltages*

(Correction to the French text only.)

4.3.1.2 *Rated insulation voltage*

(Correction to the French text only.)

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4.3.2 *Rated currents*

(Correction to the French text only.)

Replace Clauses 4.3.2.1 and 4.3.2.2 by the following:

4.3.2.1 *Rated conventional thermal current*

The rated conventional thermal current (I_{th}) of a contactor is the maximum current stated by the manufacturer that the unenclosed contactor can carry in an 8 h duty (see Clause 4.3.4.1) when tested in free air in accordance with Clause 8.2.2, without the temperature-rise of its several parts exceeding the limits specified in Clause 7.3 (Tables V and VI).

Notes 1. – Free air is understood to be that obtained under normal indoor conditions reasonably free from dust and external radiation.

2. – An unenclosed contactor is a contactor supplied by the manufacturer without an enclosure or a contactor supplied by the manufacturer with an enclosure forming an integral part of the contactor.

4.3.2.2 *Rated enclosed thermal current*

The rated enclosed thermal current (I_{the}) of a contactor is the maximum current stated by the manufacturer that the contactor can carry in the stated duty (see Clause 4.3.4) when mounted in a specified enclosure. Tests for this rating shall be in accordance with Clause 8.2.2, but are not mandatory if the test for "rated conventional thermal current" has been made, and the manufacturer is prepared to state an enclosed thermal current rating.

The rating may be an unventilated rating, in which case the enclosure shall be of the size stated by the manufacturer to be the smallest that is applicable in service. Alternatively, the rating may be a ventilated rating with the ventilation in accordance with the manufacturer's data.

Note. – It is not possible to usefully define a rated service thermal current as the installation and service conditions can vary greatly (the "rated current" in Clause 4.2 of IEC Publication 439, Factory-built Assemblies of Low-voltage Switchgear and Controlgear, is in effect the "rated service thermal current").

Add the following new sub-clause:

4.3.2.3 *Rated operational currents or rated operational powers*

A rated operational current (I_e) of a contactor is stated by the manufacturer and takes into account the rated operational voltage (see Clause 4.3.1.1), the rated frequency (see Clause 4.3.3), the rated duty (see Clause 4.3.4), the utilization category (see Clause 4.3.6) and the type of protective enclosure.

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

4.3.4 *Rated duty*

(Correction to the French text only.)

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4.3.5.3 *Ability to withstand overload currents*

Replace "Under consideration" *by the following:*

A contactor shall be capable of withstanding the thermal stresses due to starting and accelerating a motor to normal speed and operating overloads.

Contactors of utilization categories AC-2, AC-3 and AC-4 shall withstand a current equivalent to eight times their maximum rated operational current for category AC-3 ($8 \times I_e$ max/AC-3).

The duration of the test shall be 10 s for rated operational currents not exceeding 630 A.

For rated operational currents exceeding 630 A, this duration may be shorter and, if so, the manufacturer shall state the duration.

Note. – The overload current withstand test is considered to cover cases where the starting current is less than $8 \times I_e$ max/AC-3 and the starting duration longer than 10 s, provided that the value of I^2t is not larger than that corresponding to $8 \times I_e$ max/AC-3 during 10 s.

Pages 25 and 27

TABLES II and III

Replace "(see Clause 4.3.2.2)" *by* "(see Clause 4.3.2.3)" *after the reference to* I_e.

4.3.7 *Mechanical endurance*

After the first paragraph of this clause, add the following text:

By convention, the mechanical endurance of a design of contactor is defined as the number of no-load operating cycles which would be attained or exceeded by 90% of all the apparatus of this design under the conditions specified in the preceding paragraph.

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4.6 *Co-ordination with short-circuit protective devices*

Replace the title of this clause and "Under consideration" *by the following:*

4.6 *Protection of a contactor by a short-circuit protective device*

The following information shall be given by the manufacturer:

- type of protection (see Appendix C, Clause C4);
- types and characteristics of short-circuit protective devices (see Appendix C, Clause C5).

5. **Nameplates**

Replace the text (in brackets) of Item h) of this clause by the following:

(see Clauses 4.3.2.1 and 4.3.2.2);

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8.2.2 *Verification of temperature-rise limits*

Replace Clauses 8.2.2.1 and 8.2.2.2 by the following:

8.2.2.1 *Ambient air temperature*

The ambient air temperature shall be measured during the last quarter of the test period by means of at least two thermometers or thermocouples equally distributed around the contactor at about half its height and at a distance of about 1 m from it. The thermometers or thermocouples shall be protected against air currents, heat radiation and indicating errors due to rapid temperature changes.

8.2.2.2 *Temperature-rise tests of the main circuit*

The contactor shall be mounted approximately as under usual service conditions and shall be protected against undue external heating or cooling.

Contactors having an integral enclosure and contactors only intended for use with a special type of enclosure shall be tested in their enclosure for the rated conventional thermal current test. No openings giving false ventilation shall be allowed.

Details of any enclosure, ventilation arrangements, and sizes of test conductors shall be stated in the test report.

For tests with a.c. single-phase or d.c. currents, the test current shall be not less than the rated conventional thermal current. For tests with multi-phase currents, the current shall be balanced in each phase within ± 5%, and the average of these currents shall be not less than the rated conventional thermal current.

The temperature-rise test of the main circuit is made at the rated conventional thermal current.

Tests on d.c. rated contactors may be made with an a.c. supply for convenience of testing, but only with the consent of the manufacturer. Tests on a.c. rated contactors shall be made at a frequency of between 45 Hz and 62 Hz where the rated frequency of the equipment is 50 Hz or 60 Hz; for lower or higher rated frequencies, a tolerance of ± 20% shall apply.

The test shall be made over a period of time sufficient for the temperature-rise to reach a steady-state value, but not exceeding 8 h. In practice, this condition is reached when the variation does not exceed 1 °C per hour.

Note. – In practice, to shorten the test, the current may be increased during the first part of the test, it being reduced to the specified test current afterwards.

At the end of the test, the temperature-rise of the different parts of the main circuit shall not exceed the values specified in Table VI.

Depending on the value of the rated thermal current, one of the following procedures shall be adopted:

For values of test current up to and including 400 A:

a) The connections shall be single-core, PVC insulated, copper cables or wires with cross-section areas as given in Table VII.

b) In the case of multi-pole contactors, tested with a.c., the test may be carried out with single-phase current with all poles connected in series, provided magnetic effects can be neglected.

c) The connections shall be in free air, and spaced at approximately the distance existing between the terminals.

d) For single-phase or multi-phase tests, the minimum length of any temporary connection from a contactor terminal to another terminal, or to the test supply, or to a star point shall be:

- 1 m for cross-sections up to and including 35 mm² (or AWG 2);
- 2 m for cross-sections larger than 35 mm² (or AWG 2).

Insert here existing Table VII (page 45)

For values of test current higher than 400 A but not exceeding 800 A:

a) The connections shall be single-core, PVC insulated, copper cables with cross-section areas as given in Table VIII, or the equivalent copper bars given in Table VIII as recommended by the manufacturer.

b) In the case of multi-pole contactors, tested with a.c., the test may be carried out with single-phase current, with all poles connected in series, provided magnetic effects can be neglected.

c) Cables or copper bars shall be spaced at approximately the distance between terminals. Copper bars shall be finished matt black. Multiple parallel cables per terminal shall be bunched together and arranged with approximately 10 mm air space between each other. Multiple copper bars per terminal shall be spaced at a distance approximately equal to the bar thickness. If the sizes stated for the bars are not suitable for the terminals, or are not available, other bars having approximately the same cross-section and approximately the same or smaller cooling surface, may be used. Cables or copper bars shall not be interleaved.

d) For single-phase or multi-phase tests, the minimum length of any temporary connection from a contactor terminal to another terminal or to the test supply shall be 2 m. The minimum length to a star point may be reduced to 1.2 m.

For values of test current higher than 800 A but not exceeding 3 150 A:

a) The connections shall be copper bars of the sizes stated in Table VIII unless the contactor is designed only for cable connection. In this case, the size and arrangement of the cables shall be as specified by the manufacturer.

b) In the case of multi-pole contactors, tested with a.c., the test may be carried out with single-phase current with all poles connected in series, provided magnetic effects can be neglected.

c) Copper bars shall be spaced at approximately the distance between terminals. Copper bars shall be finished matt black. Multiple copper bars per terminal shall be spaced at a distance approximately equal to the bar thickness. If the sizes stated for the bars are not suitable for the terminals, or are not available, other bars having approximately the same cross-section and approximately the same or smaller cooling surfaces, may be used. Copper bars shall not be interleaved.

d) For single-phase or multi-phase tests, the minimum length of any temporary connection from a contactor terminal to another terminal or to the test supply shall be 3 m but this can be reduced to 2 m, provided that the temperature-rise at the supply end of the connection is not more than 5 °C below the temperature-rise in the middle of the connection length. The minimum length to star point shall be 2 m.

For values of test current higher than 3 150 A:

Agreement shall be reached between manufacturer and user on all relevant items of the test, such as: type of supply, number of phases and frequency (where applicable), cross-sections of test connections, etc. This information shall form part of the test report.

Note. – In all cases, the use of single-phase a.c. current for testing multi-pole contactors is only permissible if magnetic effects are small enough to be neglected. This requires careful consideration especially for currents above 400 A.

TABLE VIII

Standard test conductors for rated conventional thermal currents higher than 400 A

Value of rated thermal current (A)	Range of rated thermal current (A)	Test connection			
		Cables		Copper bars	
		Quantity	Cross-sections (mm²)	Quantity	Dimensions (mm)
500	400– 500	2	150 (16)	2	30 × 5 (15)
630	500– 630	2	185 (18)	2	40 × 5 (15)
800	630– 800	2	240 (21)	2	50 × 5 (17)
1 000	800–1 000		–	2	60 × 5 (19)
1 250	1 000–1 250		–	2	80 × 5 (20)
1 600	1 250–1 600		–	2	100 × 5 (23)
2 000	1 600–2 000		–	3	100 × 5 (20)
2 500	2 000–2 500		–	4	100 × 5 (21)
3 150	2 500–3 150		–	3	100 × 10 (23)

Notes *1.* – Value of current shall be greater than the first value and less than or equal to the second value.

2. – Bars are assumed to be arranged with their long faces vertical. Arrangements with long faces horizontal may be used if specified by the manufacturer.

3. – Values in brackets are estimated temperature-rises of the test conductors given for reference.

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8.2.3.3 *Value of the test voltage*

In the second line of Item a) of this clause, replace "Table VIII" *by* "Table IX", *and renumber existing Table VIII by* "TABLE IX".

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8.2.7 *Verification of mechanical endurance*

After Clause 8.2.7.4, insert the following new clauses:

8.2.7.5 *Statistical analysis of test results*

The mechanical endurance of a design of a contactor is assigned by the manufacturer, verified by a statistical analysis of test results.

For contactors which are produced in small quantities, the mechanical endurance test may be a special test (see Item *f)* of Clause 8.1.1) and the tests described in Clauses 8.2.7.5.1 and 8.2.7.5.2 do not apply.

However, for contactors which are produced in small quantities and which also differ from a basic design only by detailed variations (i. e. without any significant variation) without notable influence on characteristics, the manufacturer may assign mechanical endurance on the basis of experience with similar designs, analysis, properties of materials, etc., and on the basis of the analysis of test results on large quantity production of the same basic design contactors.

After this assignment, a type test shall be performed. The type test is one or the other of the two described below, selected by the manufacturer as most suitable in each case, for example according to the quantities of planned production or according to the rated thermal current.

Note. – This test is not intended to be a lot-by-lot or production acceptance test for application by the user.

8.2.7.5.1 *Single 8 type test*

Eight contactors shall be tested up to the assigned mechanical endurance.

If the number of failures does not exceed two, the type test is considered passed.

8.2.7.5.2 *Double 3 type test*

Three contactors shall be tested up to the assigned mechanical endurance.

The type test is considered passed if there is no failure, and failed if there is more than one failure. Should there be one failure, then three additional contactors are tested up to assigned mechanical endurance, and providing there is no additional failure, the test is considered passed. The test is failed if at any time there is a total of two or more failures.

Explanatory note. – The single 8 test and the double 3 test are both given in IEC Publication 410, Sampling Plans and Procedures for Inspection by Attributes (see Tables X-D-2 and X-C-2).
These two tests were chosen with the objectives of basing them on testing a limited number of contactors and on essentially the same statistical characteristics (acceptance quality level: 10%).

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8.2.8 *Verification of the ability to withstand overload currents*

Replace "Under consideration" *by the following:*

For the test, the contactor shall be mounted, wired and operated as specified in Clause 8.2.2.

All poles of the contactor are simultaneously subjected to one test with the overload withstand current and duration values stated in Clause 4.3.5.3. The test is performed at any convenient voltage and it starts with the contactor at room temperature.

After the test, the contactor shall be substantially in the same condition as before the test. Furthermore, it shall fulfil the operating conditions specified in Clause 8.2.6 and withstand the dielectric test voltages in accordance with Clause 8.2.3.3, applied only as in Clause 8.2.3.2.1.

Notes 1. – The I^2t value (Joule integral) calculated from this test cannot be used to estimate the performance of the contactor under short-circuit conditions.

2. – For convenience of testing, the manufacturer may reduce the test duration, in order to suit the available value of the test current provided that the above value of I^2t (Joule integral) is maintained.

B – Appendix C

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Replace the title of Appendix C and "Under consideration" *by the following:*

PROTECTION OF A CONTACTOR BY A SHORT-CIRCUIT PROTECTIVE DEVICE

C1. Scope

This appendix deals with the protection of a contactor by a short-circuit protective device (see Clause 4.6 of this standard). Examples of protective devices are fuses (see IEC Publication 269-1, Low-voltage Fuses, Part 1: General Requirements) and circuit-breakers (see IEC Publication 157-1, Low-voltage Switchgear and Controlgear, Part 1: Circuit-breakers).

This appendix does not deal with overload protection or with the co-ordination between a short-circuit protective device and an overload relay which may be part of the circuit in which the contactor is used. Guidance for such a co-ordination can be found in IEC Publication 292-1A, First supplement to IEC Publication 292-1: Low-voltage Motor Starters, Part 1: Direct-on-line (Full Voltage) A.C. Starters.

C2. Object

The object of this appendix is to state:

- the general requirements for protection;
- the different types of protection and the corresponding additional conditions;
- the types and characteristics of the short-circuit protective device;
- the tests intended to verify that the conditions of the protection have been met.

Note. – For simplification purposes, "short-circuit protective devices" are referred to as "SCPD" in the rest of this appendix.

C3. General requirements for protection

It is the responsibility of the manufacturer of the contactor to recommend a suitable SCPD.

C3.1 The SCPD shall be located on the supply side of the contactor, and have a short-circuit breaking capacity not less than the short-circuit prospective current at its location.

Notes 1. – In some particular cases, the breaking capacity of the SCPD contactor combination may be taken into account.

2. – The use of a SCPD having a breaking capacity less than the prospective short-circuit current at the point where it is installed is permitted if another protective device having the necessary breaking capacity is installed on the supply side. In this case, the test shall be made with the actual arrangement of the contactor.

C3.2 For all values of short-circuit current for which the short-circuit protection is suitable, the contactor shall behave in such a manner that the external manifestations (such as emission of flames or hot gases) do not extend beyond a safety perimeter stated by the manufacturer of the contactor, and the SCPD shall operate in accordance with the relevant IEC specification.

C4. Types of protection and corresponding additional conditions

For currents within the range of operation of the SCPD, the overcurrent through the contactor during the breaking time of the SCPD may cause damage to the contactor itself. According to the amount of damage acceptable, two types of protection are considered as standard:

Type "a" – Any kind of damage to the contactor itself (the enclosure, if any, remaining externally undamaged) is allowed and, after inspection, the contactor may need replacement of some parts such as contacts, arc-chambers, or may need replacement as a whole. Inspection includes, *inter alia,* a dielectric test (see Clause 8.2.3).

Type "c" – No damage shall occur to the contactor, beyond that referred to in the last paragraph of this clause.

For both types of protection, light contact burning is allowed and welding of contacts is accepted (in which case, the contacts may require replacement); depending on the SCPD utilized, the probability of such an occurrence may be larger or smaller. Applications requiring a practically negligible risk of welding contacts are subject to agreement between manufacturer and user and are not covered by this appendix. It shall be possible to establish the presence of welded contacts by simple verification, for example, an inspection after the removal of the arc-chutes.

Note. – In some countries, the type of protection "a" is not accepted.

C5. Types and characteristics of the SCPD

For a given contactor, the contactor manufacturer shall state the precise type or types and characteristics of the SCPD to be used in order to achieve a given type of protection, and the maximum prospective short-circuit current, at a stated rated operational voltage, for which the corresponding combination is suitable.

Note. – A given combination of a contactor and a SCPD may comply with more than one type of protection for different values of the maximum prospective short-circuit current.

Any estimate of performance of a contactor when combined with a SCPD different from that tested shall be based on comparison of the data given by the manufacturer of the SCPD which is to be compared (in particular with respect to the peak let-through current and Joule integral under the particular operating conditions anticipated).

C6. Verification of the conditions of protection

The verification of the general conditions of protection under Clause C3 shall be as follows:

- For Clause C3.1, the requirement shall be verified by reference to the results of breaking capacity tests carried out on the SCPD in accordance with the relevant specification.
- For Clause C3.2, the type of protection may be verified by the tests specified in Clauses C6.1 to C6.3. Such tests are special tests.

C6.1 *Condition of the contactor*

The contactor and its associated SCPD shall be mounted complete on their own supports or on equivalent supports. If the contactor and/or the SCPD are intended to be enclosed, they shall be tested in the same type of enclosure as that in which they will be installed.

The connections to the main circuit shall be similar to those intended to be used when the contactor and its SCPD are in service. The magnet coil of the contactor shall be supplied by an independent source; such a source shall deliver the same kind of current and the same voltage as those specified for service conditions.

All the tests shall be performed starting from the cold state on a contactor in a new and clean condition.

The safety perimeter referred to in Clause C3.2 is constituted:

- if the contactor is in a metal enclosure: by that enclosure;
- if the contactor is in an insulating enclosure: by a metal foil covering that enclosure;
- if there is no enclosure: by a wire mesh situated at the safety perimeter stated by the manufacturer of the contactor.

During the test, surgical cotton wool is to be placed at all openings, handles, flanges, joints of the enclosure in order to detect harmful emission of flame beyond the safety perimeter.

In all cases, the safety perimeter defined above shall be connected directly to the neutral point of the supply source or to a substantially inductive artificial neutral permitting a prospective fault current of at least 100 A.

C6.2 *Test current and test circuit*

The following two kinds of test currents shall be applied with the corresponding test circuit of Clause C6.2.3.

C6.2.1 *Test current "q"*

The test current "q", determined as the prospective short-circuit current at the test location, shall be not less than the prospective short-circuit current associated with the type of protection referred to.

C6.2.2 *Test current "r"*

The test current "r", determined as the prospective short-circuit current at the test location, is a conventional short-circuit current equal to thirty times the maximum operational current for utilization category AC-3.

Note. – The permissible voltage drop during the starting period is effectively limited by the need to ensure correct starting of the motor. And consequently this also limits the minimum value of the prospective short-circuit current. Thirty times the rated operational current represents such a minimum value, based on average practical conditions.

C6.2.3 *Test circuit*

The test circuit, the supply voltage, the power-factor and the recovery voltage shall be in accordance with IEC Publication 157-1 (Clauses 8.2.4.5, 8.2.4.6 and 8.2.4.7) for three-phase tests. The rated voltage to be considered for the test is the rated operational voltage stated for the combination and for the type of protection referred to.

C6.3 *Test procedure and results to be obtained*

C6.3.1 *General*

The coil shall be connected to a separate source giving the rated control supply voltage of the contactor and delivering the same kind of current and the same voltage as those specified for service conditions.

Note. – Although it represents only a small percentage of practical applications (control supply voltage not altered by the faults), this requirement is meant to facilitate comparative tests.

C6.3.2 *Description of the tests*

One breaking operation of the SCPD shall be performed with the contactor closed prior to the test, and one breaking operation of the SCPD shall be performed by closing the contactor on to the short-circuit.

C6.3.3 *Execution of the tests*

A contactor in a new and clean condition shall be used. The rest time between two operations shall be long enough to bring back all the components to the room temperature.

There shall be no ignition of the cotton wool or any other manifestation of a fire hazard.

For type "a" protection, the contactor shall be inspected after each operation and parts or the whole contactor replaced as necessary.

For type "c" protection, the only action on the contactor after each operation shall consist of separating or exchanging the welded contacts if necessary.

In all cases, it is necessary to inspect the SCPD, to reset the release of the circuit-breaker and, in the case of fuses, to replace all fuse-elements.

C6.3.4 *Results to be obtained* (see also Clause C4)

For all types of protection, the general requirements given in Clause C3.2 shall be fulfilled. The enclosure (or the wire mesh constituting the safety perimeter) shall not be damaged externally; that implies, in particular, that the door, covers, etc., of the enclosure remain closed.

Furthermore, for type "c" protection, there shall be neither prolonged arcing nor flashover between poles and frame. Furthermore, after the completion of the tests, the contactors shall satisfy the dielectric tests according to Item *a)* of Clause 8.2.3.2.1 of this publication, but with a test voltage of two times the rated insulation voltage only.