
Specification for

**Switchgear and controlgear for voltages up to
and including 1000 V a.c. and 1200 V d.c.**

Part 1. Circuit-breakers

Spécification de l'appareillage de connexion et de commande pour
les tensions inférieures et égales à 1000 V en courant alternatif
et 1200 V en courant continu

Partie 1. Disjoncteurs

Spezifikation für Verteilungsschaltgeräte für Spannungen bis und
einschließlich 1000 V Wechselstrom und 1200 V Gleichstrom

Teil 1. Leistungsschalter

Foreword

This revision of this British Standard has been prepared under the authority of the Power Electrical Engineering Standards Committee. It is identical with Publication 157 'Low-voltage switchgear and controlgear' Part 1 'Circuit-breakers' published by the International Electrotechnical Commission, as amended by IEC Publication 157-1A. Since this revision also specifies moulded case circuit-breakers, BS 3871 'Miniature and moulded case circuit-breakers' Part 2 'Moulded case circuit-breakers for a.c. and d.c. circuits' is withdrawn.

Because the text of an IEC Publication has been copied it includes some minor material not appropriate to a British Standard.

For the purposes of this British Standard, the texts of IEC 157-1 and 157-1A given in this publication should be modified as follows.

Terminology. The words 'British Standard' should replace 'Recommendation' wherever it appears.

Cross-references. The references to other IEC Publications should be replaced by references to British Standards as follows.

Reference to IEC Publication

IEC Publication 85 'Recommendations for the classification of materials for the insulation of electrical machinery and apparatus in relation to their thermal stability in service'

IEC Publication 144 'Degrees of protection of enclosures for low-voltage switchgear and controlgear'

IEC Publication 269 'Low-voltage fuses'
Part 1 'General requirements'

Part 2 'Supplementary requirements for fuses for industrial applications'

Part 3 'Supplementary requirements for fuses for domestic and similar applications'

IEC Publication 292 'Low-voltage motor starters'

Part 1 'Direct-on-line (full voltage) a.c. starters'

IEC Publication 337 'Control switches (low-voltage switching devices for control and auxiliary circuits, including contactor relays)'

Part 1 'General requirements'

Text changes

IEC reference	Text to be amended	
1.1	Delete fourth paragraph	
4.4.1	Two British Standard values of rated control supply voltage, 50 V d.c. and 240 V a.c. are to be added to those of Table III	
IEC reference	Original IEC text	Text to be substituted
1.1	used as sdirect-on-line	used as direct-on-line

Appropriate British Standard

BS 2757 'Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service'

BS 5420 'Degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.'*

BS 88 'Cartridge fuses of voltage ratings up to 660 volts'
Part 1 'Performance and dimensions of fuse links'
Part 2 'Supplementary requirements for fuses of standardized dimensions and performance for industrial purposes'

BS 1361 'Cartridge fuses for a.c. circuits in domestic and similar premises' and BS 1362 'General purpose fuse links for domestic and similar purposes (primarily for use in plugs)'

BS 4941 'Motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c.'

Part 1 'Direct-on-line (full voltage) a.c. starters'

BS 4794 'Control switches (switching devices including contactor relays, for control and auxiliary circuits for voltages up to and including 1000 V a.c. and 1200 V d.c.)'

Part 1 'General requirements'

*In course of preparation

Amendment No. 1
published and effective from 31 March 1988
to BS 4752 : Part 1 : 1977

**Specification for switchgear and
controlgear for voltages up to and
including 1000 V a.c. and 1200 V d.c.**
Part 1. Circuit-breakers

Revised text

NOTE. This amendment is based on IEC Publication 157-1B : 1979 and incorporates CENELEC Harmonization Document HD 418. HD 418 modifies the requirements of IEC Publications 157-1 and 157-1A, with which BS 4752 : Part 1 ceases to be identical, and of IEC Publication 157-1B.

AMD 5158
March 1988

Front and back covers

On the front and back covers delete three times 'IEC 157-1 : 1973' and 'IEC 157-1A : 1976'.

On the front cover, beneath the Part title, insert the following:

'(Implementation of CENELEC HD 418)'

AMD 5158
March 1988

Foreword

Delete the foreword entirely and substitute the following.

Foreword

This revision of BS 4752 : Part 1 has been prepared under the authority of the Power Electrical Engineering Standards Committee. It is related to Publication 157-1 published by the International Electrotechnical Commission (IEC), as amended by Publications 157-1A : 1976 and 157-1B : 1979. BS 4752 : Part 1 is in agreement with Harmonization Document HD 418, published by the European Committee for Electrotechnical Standardization (CENELEC). HD 418 is based on IEC Publications 157-1, 157-1A and 157-1B, but contains modifications to the following clauses: 7.1.3.2, 7.1.4, 7.2.1, 7.7.1.4, 7.7.2.3.2.2 and 8.2.4.5.

Terminology and conventions. Parts of the text of IEC Publications 157-1, 157-1A and 157-1B have been used for reprographic purposes. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following. Wherever the word 'recommendation' appears, it should be read as 'Part of BS 4752'.

Cross-references

International standards

IEC 144 : 1963

IEC 337

IEC 337-1 : 1970

IEC 417 : 1973

IEC 439

(now reissued as
IEC 439-1 : 1985)

Corresponding British Standards

BS 5420 : 1977 Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.

BS 4794 Control switches (switching devices, including contactor relays, for control and auxiliary circuits for voltages up to and including 1000 V a.c. and 1200 V d.c.)

Part 1 : 1979 General requirements

BS 6217 : 1981 Guide to graphical symbols for use on electrical equipment.

BS 5486 Low voltage switchgear and controlgear assemblies

Part 1 : 1986 Specification for type-tested and partially type-tested assemblies
(Identical)

IEC 439-2 : 1975	Part 2 : 1978 Particular requirements for busbar trunking systems (busways)
IEC 447 : 1974	BS 6013 : 1980 Specification for standard direction of movement for actuators which control the operation of electrical apparatus
The Technical Committee has reviewed the provisions of the following international standards, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.	
International standards	Related British Standards
IEC 85 : 1984	BS 2757 : 1956 Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service
IEC 269	BS 88 Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c.
IEC 269-1 : 1968	Part 1 : 1975 General requirements
IEC 269-2 : 1973	Part 2 : 1975 Supplementary requirements for fuses of standardized dimensions and performance for industrial purposes
IEC 269-3 : 1973	BS 1361 : 1971 Cartridge fuses for a.c. circuits in domestic and similar premises
	BS 1362 : 1973 General purpose fuse links for domestic and similar purposes (primarily for use in plugs)
IEC 292	BS 4941 Specification for motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c.
IEC 292-1 : 1969	Part 1 : 1979 Direct-on-line (full voltage) a.c. starters'

AMD 5158
March 1988

Contents

After the reference to clause 9 delete 'Figures A and 1 to 6' and substitute 'Figures 1 to 8'.

At the end of the title for appendix D insert 'associated in the same circuit'.

AMD 5158
March 1988

Clause 1.1 Scope

In paragraph 3, line 1, delete 'ued as sdirect-on-line' and substitute 'used as direct-on-line'.

Delete paragraph 4 entirely and substitute the following:

'*Note 1.*— The requirements for circuit-breakers intended to be accessible to and operated by unskilled people on domestic and similar installations are contained in IEC Publication 157-2 (under consideration).

Note 2.— Particular requirements for circuit-breakers which are also intended to provide earth-leakage protection are under consideration.'

In the existing note to clause 1.1, after 'Note' insert '3'.

AMD 5158
March 1988

Clause 2.2.8 Pole (of a circuit-breaker)

Delete paragraph 1 entirely and substitute:

'The portion of a circuit-breaker associated exclusively with one electrically separated conducting path of its main circuit, provided with contacts intended to connect and disconnect the main circuit itself, and excluding those portions which provide a means for mounting and operating all poles together.'

AMD 5158
March 1988

Clause 2.5.9 Short-time withstand current

After the paragraph which ends 'and behaviour', insert the following:

Note. — Account has to be taken both of the I^2t let-through and also of the electro-mechanical effects associated with the peak current.'

AMD 5158
March 1988

Clause 2.5.21 Take-over current

Delete the existing paragraph entirely and substitute the following:

'The value of current corresponding to the intersection of the characteristics of operation of two over-current protecting devices (either I^2t or homogeneous time-current characteristic curves).

Note. — When a circuit-breaker is associated with a back-up device (fuse or another circuit-breaker) generally intended for protecting it from short-circuits exceeding its breaking capacity, one should distinguish:

- a) the take-over current I_{B} : the maximum over-current value beyond which the back-up device will necessarily operate the take-over current may also be defined as the back-up limit of current);
- b) the selectivity limit of current I_{S} : the maximum over-current value at which the circuit-breaker will operate alone (see Figures 7 and 8).'

AMD 5158
March 1988

New clause 2.5.26 Joule integral (I^2t)

After clause 2.5.25, insert the following new definitions:

2.5.26 Joule integral (I^2t)

The integral of the square of the current over a given time interval:

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

Note. — This definition is that of the International Electrotechnical Vocabulary (I.E.V.) (441-07-14) without the notes.

2.5.26.1 I^2t characteristic of a circuit-breaker

A curve giving the values of I^2t related to break times (generally minimum or maximum values of I^2t) as a function of the prospective current under stated conditions of operation.

Note. — Normally it is sufficient to quote maximum and minimum values of I^2t at rated breaking capacity.

2.5.26.2 I^2t zone of a circuit-breaker

The zone contained between the minimum I^2t and the maximum I^2t characteristics.'

AMD 5158
March 1988

Clause 4.1 Summary of characteristics

In line 4, delete 'Rated quantities' and substitute 'Rated values'.

AMD 5158
March 1988

Clause 4.3 Rated quantities

In the title, and at two places in the text, delete 'rated quantities' and substitute 'rated values'.

AMD 5158
March 1988

Clause 4.3.2.1 Rated thermal current

Delete the clause entirely and substitute the following two new clauses 4.3.2.1 and 4.3.2.2, renumbering the existing 4.3.2.2 as 4.3.2.3.

4.3.2.1 *Rated conventional thermal current*

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

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

2. — An unenclosed circuit-breaker is a circuit-breaker supplied by the manufacturer without an enclosure or a circuit-breaker supplied by the manufacturer with an enclosure forming an integral part of the circuit-breaker.

4.3.2.2 *Rated enclosed thermal current*

The rated enclosed thermal current (I_{the}) of a circuit-breaker is the maximum current stated by the manufacturer that the circuit-breaker 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 enclosure 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 Sub-clause 4.2 of IEC Publication 439 is in effect the "rated service thermal current".)

AMD 5158
March 1988

Table III Standard values of the rated control supply voltage, if different from that of the main circuit

In the column 'D.C. V' between '48,' and '110', insert '50,'.

In the column 'Single-phase a.c. V', after '220' insert ',240.'

Clause 7.1.3.2 Earth terminal

Delete the text entirely and substitute the following:

‘The chassis, frameworks and the fixed parts of the metal enclosures of equipment shall be interconnected electrically and connected to a terminal which enables them to be earthed.

NOTE. – This requirement can be met by the normal structural parts providing adequate electrical continuity.

When an earth terminal is provided, it shall be readily accessible, and so placed that the earth connection of the equipment is maintained when the cover or other removable parts are removed.

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

The earth terminal shall be suitably protected against corrosion.

The earth terminal shall be permanently and indelibly marked with either the sign $\perp$ (IEC 417-5017a) or the sign  (IEC 417-5019a).’

New clause 7.1.4 Actuator (operating handle)

After clause 7.1.3, insert the following:

‘7.1.4. *Actuator (operating handle)*

The actuator of the equipment shall be insulated from live parts for the rated insulation voltage. Additionally:

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

The direction of the movement of the actuator shall comply with the requirements of IEC Publication 447.

NOTE. – The latter publication was accepted as CENELEC Harmonization Document HD 331.’

Clause 7.2.1 Mechanical details

After paragraph 3, which ends ‘the apparatus.’, insert the following new paragraph 4:

‘When an enclosure is so designed as to allow the covers to be opened without the use of tools, means shall be provided to prevent loss of the fastening devices.’

Clause 7.7.1.4 Dependent power closing (pneumatic)

Delete paragraph 1 entirely and substitute the following:

‘A compressed-air closing mechanism supplied from an external source shall be capable of securing the closing of the circuit-breaker in any condition between no-load and its rated making capacity, when the air pressure measured immediately before the closing operation remains between the limiting values $P_{\min}$ and $P_{\max}$ of the rated supply pressure.’

AMD 5158
March 1988

Clause 7.7.2.3.2 Inverse time-delay operation

In paragraph 1, delete the last sentence, beginning 'The values'.

After paragraph 1, insert the following new paragraph 2:

- 'The values of A , B and T shall be as given in Table VIII, except:
- when a three-pole or a four-pole over-current opening release operates on one pole only (e.g. particular case of neutral pole), the maximum current indicated in column B shall be increased by 20 %;
 - when a three-pole over-current opening release operates on two poles only, the maximum current indicated in column B shall be increased by 10 %.'

AMD 5158
March 1988

Table VIII Characteristics of the opening operation of inverse time-delay over-current opening releases when energized on all poles

At the foot of the table, delete the unnumbered note beginning 'When a three-pole'.

AMD 5158
March 1988

Clause 8.2.2.1 Ambient air temperature

Delete the text of the clause entirely and substitute the following:

'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 circuit-breaker 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.'

AMD 5158
March 1988

Clause 8.2.2.2 Temperature-rise tests of the main circuit

Delete the text of the clause entirely and substitute the following:

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

Circuit-breakers having an integral enclosure and circuit-breakers only intended for use with a special type of enclosure shall be tested in their enclosure for the rated conventional thermal current test. No opening 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 $\pm 5\%$, 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 circuit-breakers 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 circuit-breakers shall be made at a frequency of between 45 Hz and 62 Hz where the rated frequency of the circuit-breaker is 50 Hz or 60 Hz; for lower or higher rated frequencies, a tolerance of $\pm 20\%$ 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 degree Celsius 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 V.

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 IX.
- b) In the case of multi-pole circuit-breakers, 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 circuit-breaker 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;
 - 2 m for cross-sections larger than 35 mm² (or AWG 2).

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 new Table X, or the equivalent copper bars given in Table X as recommended by the manufacturer.
- b) In the case of multi-pole circuit-breakers, 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, it is allowed to use other bars having approximately the same cross-section and approximately the same or smaller cooling surface. 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 circuit-breaker 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 3150 A:

- a) The connections shall be copper bars of the sizes stated in Table X unless the circuit-breaker 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 circuit-breakers, 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, it is allowed to use other bars having approximately the same cross-section and approximately the same or smaller cooling surfaces. Copper bars shall not be interleaved.
- d) For single-phase or multi-phase tests, the minimum length of any temporary connection from a circuit-breaker terminal to another circuit-breaker 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 a star point shall be 2 m.

For values of test current higher than 3150 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-phase circuit-breakers is only permissible if magnetic effects are small enough to be neglected. This requires careful consideration especially for currents above 400 A.”.

Table X Standard test connections for test currents higher than 400 A but not exceeding 1600 A (1)

Delete the existing title and table entirely and substitute the attached new table under the title 'Standard test conductors for rated conventional thermal currents higher than 400 A'.

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

Value of rated conventional thermal current (A)	Range of rated conventional thermal current (A)	Test connection			
		Cables		Copper bars	
		Quantity	Cross-sections in mm ²	Quantity	Dimensions in 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.

AMD 5158
March 1988

Clause 8.2.4.3 Standard tests

After paragraph 4, which ends 'is permissible', insert the following new paragraph 5:

'The maximum value of I^2t (see clause 2.5.26) noted during these tests shall be recorded on the test report.

Note. — The maximum value of I^2t recorded during the tests may not be the maximum possible value for the prescribed conditions. Additional tests are necessary for determining this maximum value.'

AMD 5158
March 1988

Clause 8.2.4.5 Test circuit for the verification of short-circuit making and breaking capacities

Delete paragraph 7 beginning 'When tests' and substitute the following:

'When the tests are made with a current less than the rated short-circuit breaking capacity, the additional impedance shall be inserted on the load side of the circuit-breaker between it and the short-circuit. In any case, the diagram of the test circuit shall appear in the test report.'

AMD 5158
March 1988

Clause 9.5.1 Verification of the take-over current

In paragraph 1, line 2, delete '(see Figure A)' and substitute '(see Figures 7 and 8)'.

AMD 5158
March 1988

New clause 10 Additional requirements for four-pole circuit-breakers

After Clause 9.5.5, insert the following new clause:

10.1 The fourth pole shall only be intended for connecting the neutral, and shall be clearly marked to that effect by the letter N.

10.2 The fourth pole shall operate together with the other poles.

10.3 The fourth pole may be fitted with an over-current release.

10.4 For a circuit-breaker having a value of rated thermal current not exceeding 200 A, the thermal rating of all four poles shall be identical.

For higher thermal current ratings, the fourth pole may have a rating not less than 50 % of that of each of the other poles but not less than 200 A.

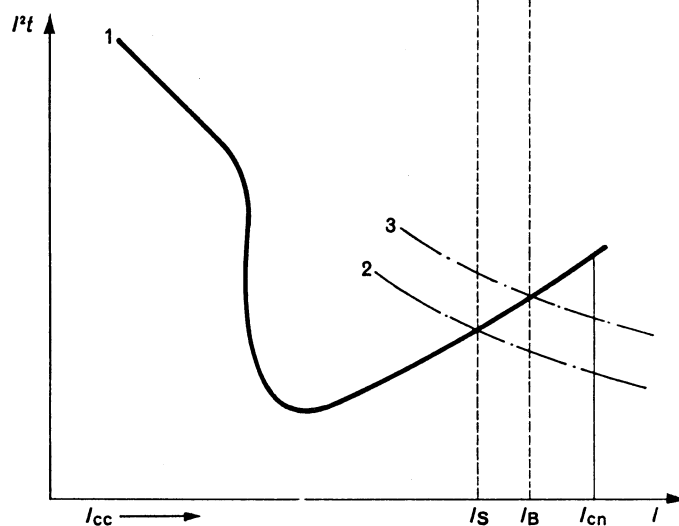
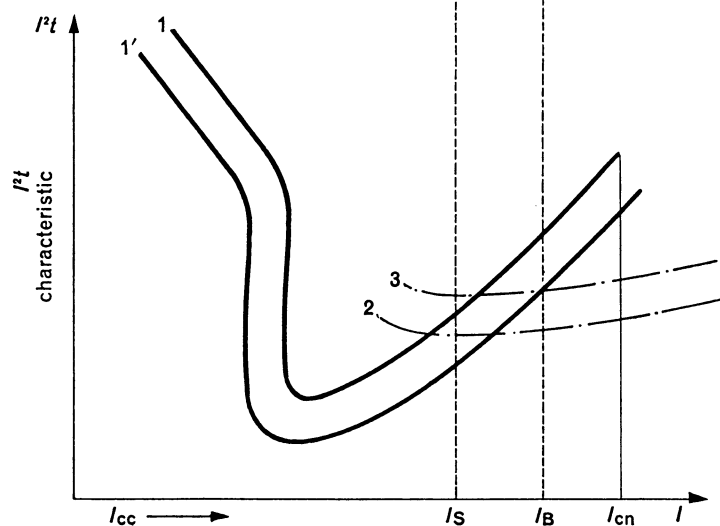
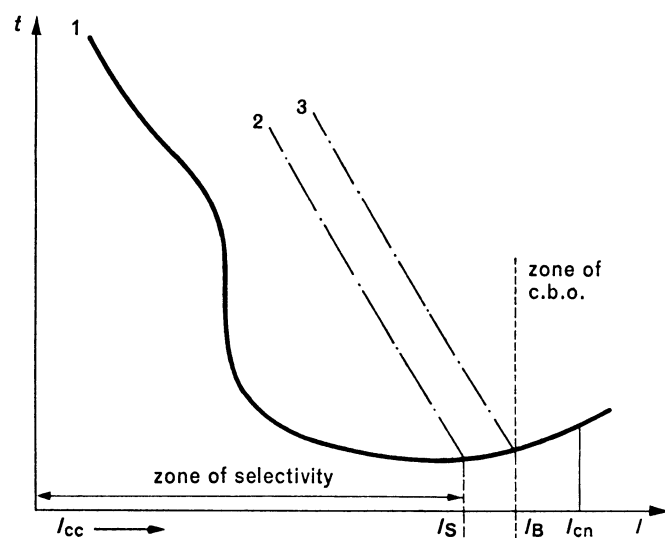
10.5 A temperature rise test in accordance with Clause 8.2.2 shall first be made on the three poles which incorporate over-current releases.

For a circuit-breaker having a value of rated thermal current not exceeding 200 A, a separate and additional test shall be made by passing the test current through the fourth pole and its adjacent pole.

For higher thermal current ratings, the method of testing shall be the subject of a separate agreement between manufacturer and user.

10.6 For short-circuit tests in accordance with Clause 8.2.4, the neutral point on the load side of the circuit-breaker on test shall be bonded back to the neutral of the supply (or to its artificial neutral) (see Figure 1).

10.7 An additional short-circuit test in accordance with Clause 8.2.4 shall be made on the fourth pole and its adjacent pole at rated breaking capacity, using the circuit shown in Figure 2.'



- I_{ce} = Prospective short-circuit current;
- I_{en} = Rated short-circuit breaking capacity (see Clause 4.3.5.2);
- I_S = Selectivity limit of current (see new Clause 2.5.21b));
- I_B = Take-over current (see new Clause 2.5.21a));
- I^2t = The integral of the square of the current extended over the break-time;
- 1 = Upper limit of the operating range of the circuit-breaker;
- 1' = Lower limit of the operating range of the circuit-breaker;
- 2 = Pre-arcing characteristic of the fuse;
- 3 = Operating characteristic of the fuse;

Zone of c.b.o. = zone of certain back-up operation.

FIG. 8. — General case of circuit-breakers with break-time less than 20 ms (in particular current-limiting circuit-breakers).

Appendix D Co-ordination of circuit-breakers with separate fuses associated in the same circuit

Delete the existing text entirely and substitute the following:

‘Introduction

With integrally-fused circuit-breakers, the circuit-breaker manufacturer is responsible for ensuring the correct co-ordination of the circuit-breaker with its fuses. But circuit-breakers are frequently connected in series with separate fuses, for reasons such as the method of power distribution adopted for the installation, or because the breaking capacity of the circuit-breaker alone may be insufficient for the proposed application. In such instances, the fuses may be mounted in locations remote from the circuit-breaker. Moreover, the fuse or fuses may be protecting a main feeder supplying a number of circuit-breakers or just an individual circuit-breaker.

Note. — Generally, fuses are located on the supply side of the circuit-breaker in such an association. However, specific installation rules may authorize to locate them on the load side of the circuit-breaker. As regards co-ordination, problems are the same in both cases.

For such applications, the user or specifying authority may have to decide, on the basis of a desk study alone, how best the optimum level of co-ordination may be achieved. This appendix is therefore intended to give guidance on this decision, and also to give guidance on the type of information the circuit-breaker manufacturer should make available to the prospective user.

Note. — The term “co-ordination” includes consideration of discrimination (i.e. selective operation) as well as consideration of back-up protection (see new Clause 2.5.21).

Guidance is also given on test requirements, should such tests be deemed essential for the proposed application. But for the vast majority of applications, expensive and complicated testing may not be considered necessary. This may be for a variety of practical considerations, such as the prospective short-circuit current being less than or only marginally in excess of the breaking capacity of the circuit-breaker alone.

D1. Scope

This appendix deals with requirements for the co-ordination of circuit-breakers with separate fuses associated in the same circuit.

D2. Object

The object of this appendix is to state:

- the general requirements for the co-ordination of a circuit-breaker with its associated fuse or fuses;
- the methods and the tests (if deemed necessary) intended to verify that the conditions for co-ordination have been met.

D3. General requirements for co-ordination of a circuit-breaker with its associated fuse or fuses

D3.1 General considerations

Ideally, the co-ordination should be such that the circuit-breaker alone will operate at all values of over-current up to the limit of its rated breaking capacity.

In practice, the following considerations apply:

- a) If the value of the prospective fault current at the point of installation is less than the rated breaking capacity of the circuit-breaker, it may be assumed that the fuse or fuses are only in the circuit for considerations other than those of back-up protection. If the value of the take-over current I_B (see definition 2.5.21) is too low, there is a risk of unnecessary loss of selectivity (i.e. selective operation).
- b) If the value of the prospective fault current at the point of installation exceeds the rated breaking capacity of the circuit-breaker, the fuse or fuses shall be so selected as to ensure compliance with the requirements of Clauses D3.2 and D3.3.

D3.2 Take-over current

The take-over current I_B (see definition 2.5.21) shall be not greater than the breaking capacity of the circuit-breaker alone.

D3.3 Behaviour of the circuit-breaker in association with its fuses

For all values of over-current up to and including the breaking capacity assigned to the combination:

- a) The making operation of the circuit-breaker as well as the breaking operation of the combination shall not give rise to external manifestations (such as emission of flames) projected beyond the limits stated by the manufacturer (see Clause 9.2.2a)).
- b) There shall be no flashover between poles or between poles and frame, nor welding of contacts (see Clause 9.2.2b)).

Note. — See also Clauses D5.2 and D5.3.

D4. Type and characteristics of the associated fuses

On request, the manufacturer of the circuit-breaker shall state, in accordance with the relevant IEC publications (Publications 269-1 and 269-2 or 269-3), the type and the characteristics of the fuses to be used with the circuit-breaker, and the maximum prospective short-circuit current for which the combination is suitable at the stated rated operational voltage.

Whenever possible, the fuses shall be located on the supply side of the circuit-breaker. If the fuses are located on the load side, it is essential that the connections between the circuit-breaker and the fuses be so designed as to minimize any risk of short circuit.

D5. Methods for verification of the co-ordination

D5.1 Determination of the take-over current

Compliance with the requirements of Clause D3.2 shall be verified by comparing the operating characteristics of the circuit-breaker and of the fuse.

If the circuit-breaker is fitted with adjustable over-current opening releases, the operating characteristics to be used shall be those corresponding to the minimum current setting. If the circuit-breaker can be fitted with instantaneous over-current opening releases, the operating characteristics to be used shall be those corresponding to the circuit-breaker fitted with such releases.

D5.2 Verification of the behaviour of the circuit-breaker/fuse combination under short-circuit conditions

- a) Full compliance with the requirements of Clause D3.3 can be verified only by tests in accordance with Clause D5.3. In this case, all the conditions for the test shall be as specified in Clause 8.2

