

CONFIRMED
DECEMBER 2007

Specification for

Fuses for voltages exceeding 1000 V a.c. —

Part 2: Expulsion fuses

UDC 621.316.923

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

Co-operating organizations

The Electrical Industry Standards Committee under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Admiralty*	Electric Light Fittings Association
Air Ministry*	Electrical Contractors' Association
Association of Consulting Engineers	(Incorporated)
(Incorporated)*	Electrical Contractors' Association of Scotland
Association of Supervising Electrical	Engineering Equipment Users' Association*
Engineers	General Post Office*
British Electrical and Allied Industries	Independent Cable Makers' Association
Research Association*	Institution of Electrical Engineers
British Electrical and Allied Manufacturers'	Ministry of Fuel and Power*
Association*	Ministry of Labour and National Service
British Electrical Development Association	(Factory Department)*
British Railways, The British Transport	Ministry of Supply*
Commission*	Ministry of Works
Central Electricity Authority and Area	National Physical Laboratory*
Boards*	North of Scotland Hydro-Electric Board*
Cable Makers' Association*	Oil Companies Materials Committee*
Crown Agents for Oversea Governments and	Public Transport Association (Incorporated)
Administrations*	Radio Industry Council
Electric Lamp Manufacturers' Association	War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of the standard.

Association of Mining Electrical and	London Transport Executive, The British
Mechanical Engineers	Transport Commission
Engineer Surveyors' Association	National Coal Board
High Commission of India	South of Scotland Electricity Board
Lloyd's Register of Shipping	

This British Standard, having been approved by the Electrical Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 30 January 1956

© BSI 02-2000

The following BSI references relate to the work on this standard:—
Committee reference ELE/10/6
Draft for comment
CR(ELE) 7650

ISBN 0 580 02513 6

Amendments issued since publication

Amd. No.	Date of issue	Comments
2633	October 1956	
3625	January 1960	
3755	May 1960	
5872	July 1966	
611	October 1970	
1885	January 1976	Indicated by a sideline in the margin

Contents

	Page
Co-operating organizations	Inside front cover
Foreword	iii
Section 1. General	
1 Scope	1
2 Basis of specification	1
3 Definitions	2
Section 2. Rating	
4 Voltage-rating	6
5 Current-rating	6
6 Breaking-capacity ratings	7
Section 3. Marking	
7 Fuse-links	9
8 Current-limiting impedances	10
Section 4. Service conditions	
9 Service conditions	10
Section 5. Operation in service	
10 General requirements	10
11 Liquids	11
12 Time/current characteristics	11
13 Cut-off current characteristic (for current-limiting fuses only)	11
14 Temperature-rise limits at rated current	11
Section 6. Construction	
15 Components	12
16 Contacts	12
17 Fuse-links	12
18 Fuse-carriers and fuse-mounts	13
19 Current-limiting impedances	13
Section 7. Type tests	
20 General	13
21 Test for temperature-rise	13
22 High-voltage test: wet test for outdoor fuses	14
23 Impulse-voltage tests	15
24 Oil-penetration test for oil-tight cartridge fuse-links	16
25 Sealing test for liquid fuse-links	16
26 Weatherproof test for powder-filled cartridge-fuses for outdoor use	17
27 Tests for breaking-capacity	17
28 Criteria of failure in tests for breaking-capacity	19
Section 8. Routine tests	
29 General	21
Appendix A Notes on terms in the standard relating to performance of fuses	23
Appendix B Selection of fuses	24
Appendix C Calculation of short-circuit fault-currents	27
Appendix D Measurement of prospective current and cut-off current	27
Appendix E Measurement of power-factor	28

	Page
Appendix F Measurement of recovery-voltage	29
Appendix G Example of data to be included in a report of type-tests for breaking-capacity	29
Appendix H Insulation co-ordination	30
Appendix J Correction factors for atmospheric conditions during impulse-voltage tests, and for air density during wet withstand voltage tests	31
Appendix K Virtual time	31
Figure 1 — Test-circuits and voltages	34
Figure 2 — Test for current-limiting fuses	35
Figure 3 — Determination of recovery-voltage	36
Figure 4 — Prospective current oscillogram	37
Figure 5 — Oscillogram for large prospective current	37
Figure 6 — Examples of discrimination	38
Figure 7 — Oscillogram for computation of power factor	39
Figure 8 — Air-density correction-factor	40
Figure 9 — Correction-factor for humidity	41
Figure 10 — Virtual time curves	42
Figure 11 — Determination of virtual time	43
Figure 12 — Dimensions for reference TA1 fuse-links. Voltage 3.3 kV. For use in air	44
Figure 13 — Dimensions for reference TA2 fuse-links. Voltage 3.3 kV. For use in air	45
Figure 14 — Dimensions for Reference TA3 fuse-links. Voltage 6.6/11 kV. For use in air	46
Figure 15 — Dimensions of Ferrule-type fuse links for use in air or oil	47
Table 1 — Current-ratings for fuses other than voltage-transformer fuses	7
Table 2 — Current-ratings for fuses primarily used for the protection of voltage-transformers	7
Table 3 — Standard 3-phase breaking-capacity ratings for fuses other than voltage-transformer fuses	8
Table 4 — Standard 3-phase breaking-capacity ratings for voltage-transformer fuses	9
Table 5 — Temporary test-connections for temperature-rise test	14
Table 6 — Power-frequency test-voltages for wet test on outdoor fuses	15
Table 7 — Impulse-voltage tests for electrically exposed fuses	16
Table 8 — Voltage settings in peak kV and r.m.s. kV of sphere-gap for checking transient voltage of fuse operation	20
Table 9 — Test-voltages in tests of longer duration than one minute	22
Table 10	25

Foreword

This standard makes reference to the following British Standards:

BS 116, *Oil circuit-breakers for alternating current systems*.

BS 148, *Insulating oil (low viscosity type) for transformers and switchgear*.

BS 923, *Impulse-voltage testing*.

BS 2782, *Methods of testing plastics*.

This British Standard has been prepared to meet the need for a standard for fuses for a.c. circuits above 1 000 volts, which is the upper limit of voltage for fuses covered by BS 88. It is expected that additions to the standard will become necessary as knowledge increases and, in particular, it is hoped to standardize dimensions to some extent when adequate experience has been gained with fuses in accordance with this standard. Some time must necessarily elapse before every such fuse can be supplied and certified to comply with the standard in all respects; in the meantime therefore its application should be subject to agreement between the contracting parties.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 48, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1 Scope

This British Standard relates to fuses for use indoors or outdoors on alternating current systems having line-to-line voltages above 1 000 volts at a frequency of 50 cycles per second, and with breaking-capacities corresponding to three-phase values from 25 MVA to 750 MVA for power fuses and from 50 MVA to 2 500 MVA for voltage-transformer fuses (or equivalent values for other systems).

In general, these fuses are suitable for short-circuit protection only, leaving other devices for protection against over-currents.

The requirements of this standard apply to fuses for use in air and to fuses for use immersed in oil.

This standard relates only to expulsion fuses.

Where fuses depend for their correct operation as fuses on the movement of some component to provide an insulating gap, this feature is considered as part of the fuse operation and comes within the scope of this standard.

On the other hand, there are fuse-links that contain tripping devices for initiating the opening of a switch. These fuse-links are required to comply with this standard, but the satisfactory operation of the equipment operated by the tripping devices is outside the scope of the standard.

The range of breaking-capacity ratings of 25 MVA to 750 MVA covers the usual applications of high-voltage fuses for power-system and voltage-transformer protection. It is recognized, however, that voltage-transformer fuses may also be required for use on systems having short-circuit capacities in excess of 750 MVA. Where such fuses are designed to operate in series with current-limiting impedances, the values of which are more than 100 times the impedance of the system, their performance is practically unaffected by the short-circuit current of the system, hence they may be safely used, with the appropriate impedance, on circuits having greater short-circuit capacities than 750 MVA. Voltage-transformer fuses without current-limiting impedances for use on systems with short-circuit currents greater than those corresponding to 750 MVA may be deemed to comply with this standard provided that all the requirements other than the tests set out in Clauses 27 and 28 are met; in such cases tests for breaking-capacity should be the subject of agreement between purchaser and manufacturer.

2 Basis of specification

a) *General.* This standard is based on single-phase and polyphase service conditions. Fuses complying with it are suitable for operating under a variety of conditions where the recovery-voltage across any fuse may be any voltage not exceeding its voltage-rating. Conditions i) and ii) below are examples in which a three-phase group of fuses can break two phases of the circuit and leave the third intact, and so may impose a recovery-voltage equal to the voltage-rating of the fuse across each of the two fuses that have operated.

- i) The operation of fuses on a three-phase fault where the neutral of the source of supply is not connected to the fault.
- ii) The operation of fuses on a single-phase line-to-line fault on a three-phase system, if the load is not connected to the supply neutral, since under these conditions the fuse in the healthy line is connected to the fault *via* the load.

In view of the above conditions, breaking-capacity tests made on a three-phase basis should have a recovery-voltage across each phase not less than the line-to-line voltage [see Sub-clause 27 l) and Figure 1(a)]. The use of a three-phase 3-wire test circuit with one fuse of a three-phase group of fuses replaced by a link of negligible impedance enables this condition to be achieved. The same circuit may be used to test fuses intended for single-phase duty, two at a time. The test circuit severity on one of the fuses shall comply with the circuit conditions prescribed in Sub-clause 27 g) and for current-limiting fuses also with Figure 2.

Single-phase tests of one fuse of a three-phase group of fuses, or of fuses for single-phase systems shall also comply with the requirements of Sub-clause 27 g). Fuses complying with this standard are suitable for service on single-phase or two-phase systems where the line-to-line voltage is the same as that of a three-phase system for which they have been tested (see Clause 10).

b) *Breaking-capacity rating*. For the purpose of this standard the breaking-capacity rating of a fuse is expressed as a prospective current at its voltage-rating. When recording the results obtained during breaking-capacity type-tests the prospective current and the recovery-voltage shall be stated. When a fuse exhibits current-limiting characteristics the current broken will be less than the peak current associated with the prospective current. In this case, when assessing the performance of the fuse, it will be deemed to have broken the prospective current.

c) *MVA rating*. For the practical convenience of specifying MVA breaking-capacity ratings for fuses and for comparing a given rating with the MVA value for a short-circuit at a given point in a supply network, the breaking-capacity rating in kilo-amperes assigned to a fuse is converted into an MVA rating by multiplying the former by its voltage-rating in kilovolts and by the phase-factor.

Thus the value of single-phase MVA is the product of single-phase r.m.s. kilo-amperes and the voltage-rating in kilovolts, and the value of three-phase MVA is obtained by multiplying the single-phase r.m.s. kilo-amperes by the voltage-rating in kilovolts and by $\sqrt{3}$ (not by 3).

d) *Severity of duty*. The specification standardizes criteria of severity of duty under which type-tests are made and ratings are assigned. It is recognized that the severity of duty imposed on a fuse may also depend on the form of restriking-voltage, but, since present knowledge is insufficient to enable restriking-voltage characteristics to be standardized, only those factors which control the amplitude of the restriking-voltage have been included. It is generally agreed that the restriking-voltage characteristics obtainable in testing stations are more onerous than those obtained under normal service conditions. The permissible peak value of the transient voltage which may be produced by the fuse is specified [see Sub-clause 28 a) ix)].

3 Definitions

For the purposes of this British Standard the following definitions shall apply:—

3.1

fuse

a device for protecting a circuit against damage from an excessive current flowing in it, by opening the circuit on the melting of a fuse-element by such excessive current. The fuse consists of all the parts that form the complete device, including any current-limiting impedance association therewith

3.2

fuse-element

the part of a fuse which is designed to melt and thus open a circuit

in some designs the fuse-element includes other attachments which are renewed when the fuse is re-wired

3.3

cartridge

a “totally-enclosing” fuse-element container, consisting of insulating material; generally tubular, with its ends enclosed by caps of metal or other material. The term “totally-enclosing” is deemed not to exclude the use of devices in connection with indicating or pressure-release

3.4

cartridge-fuse

a fuse in which the fuse-element is enclosed in a cartridge

3.5

oil-tight cartridge-fuse

a cartridge-fuse which excludes oil from the interior of the cartridge when totally immersed in oil, and in which the oil plays no part in arc extinction

3.6

powder-filled cartridge-fuse

a cartridge-fuse in which the fuse-element is enclosed in a cartridge containing an arc-quenching powder

3.7**liquid-fuse**

a fuse in which the fuse-element is enclosed in an insulating container filled to an appropriate level with an arc-quenching liquid

3.8**oil-tank fuse**

a fuse in which the fuse-link is totally immersed in an oil tank, the oil acting as the arc-extinguishing medium

3.9**expulsion-fuse**

a fuse in which the length of break is increased by expulsion of part or all of the fuse-element and/or in which arc-quenching is assisted by the movement of vapour from the container. The vapour may be generated wholly by the volatilization of the fuse-element or partly by the effect of heat on a solid substance carried either by the fuse-link or by the inner wall of the container

3.10**current-limiting fuse**

a fuse which by its mode of operation at the initiation of arcing limits the current by cut-off (see Definition 3.23, Appendix A and Figure 5)

3.11**tripping-fuse**

a fuse that contains an auxiliary device for the purpose of tripping other apparatus such as a switch

3.12**voltage-transformer fuse**

a fuse for use in the primary circuit of a voltage-transformer

NOTE A current-limiting impedance (usually resistance) may be used in series with a voltage-transformer fuse. In certain types of voltage-transformer fuse the current-limiting impedance is inherent in the high resistance of the fuse-element. Alternatively, or in addition, the fuse may be of the current-limiting type.

3.13**fuse-link**

that part of a fuse which comprises a fuse-element and a cartridge or other container, if any, and is either capable of being attached to fuse-contacts or is fitted with fuse-contacts as an integral part

3.14**fuse-contact**

a contact suitable for engaging with a fixed contact, and capable of having a fuse-link attached to it or of forming an integral part of a fuse-link

3.15**fuse-carrier**

a removable holder serving to carry a fuse-link and fitted with fuse-contacts, if necessary, for this purpose. A cartridge or other container of a fuse-element, if suitable, may form a fuse-carrier or part of a fuse-carrier

3.16**fixed contact**

a contact suitable for engaging with a fuse-contact, and connected to a terminal to which the circuit conductor is connected

3.17**fuse-mount**

an assembly comprising a base, insulators and fixed contacts

3.18**fusing-current**

the r.m.s. current which will melt the fuse-element in any specified time from the commencement of current flow

3.19

minimum fusing-current

the minimum r.m.s. current at which a fuse-element in a fuse will melt

3.20

current-rating

the r.m.s. current stated by the manufacturer to be the current that the fuse will carry continuously without deterioration, in accordance with the relevant clauses of this standard

3.21

voltage-rating

the voltage stated by the manufacturer to be the highest declared r.m.s. voltage allowable between the conductors of a circuit in which the fuse or the group of fuses may be used

3.22

prospective current

the r.m.s. value of the alternating component of the current that flows in the circuit due to the applied voltage when the fuse including its series current-limiting impedance (if any) is replaced by a link of negligible impedance, but without any other circuit change

3.23

cut-off

if the melting of a fuse-element prevents the current through the fuse from reaching the otherwise attainable maximum (the peak of the first major loop), the fuse is said to “cut off”, and the instantaneous maximum current attained is called the cut-off current

NOTE 1 In an a.c. circuit the numerical value of the cut-off current may be greater than the numerical value of the prospective current. (See Definition 3.22 and Appendix D.)

NOTE 2 A fuse only exhibits cut-off at prospective currents greater than a particular value; this value varies with different fuses and may be at a prospective current greater than the breaking-capacity rating.

3.24

breaking-capacity rating

the prospective current that can be broken by a fuse at its voltage-rating under prescribed conditions. For practical convenience it may be stated in rated MVA

3.25

recovery-voltage

the normal-frequency r.m.s. voltage that appears across the terminals of a fuse after final arc-extinction

3.26

restriking-voltage

the high-frequency transient voltage that exists across the fuse terminals at, or in close proximity to, each zero current pause during the arcing-time; the important characteristics are its amplitude and its rate-of-rise (expressed in volts per micro-second) at the time of final arc-extinction

3.27

arc-voltage

the voltage that exists across the fuse terminals during the arcing-time

NOTE The maximum value of the arc-voltage may exceed the peak value of the recovery-voltage.

3.28

loop

that part of an alternating wave which extends from one zero to the next

NOTE 1 Successive loops may have different durations and amplitudes in the period immediately following the initiation of current.

NOTE 2 For the purpose of indicating the number of current zeros during the arcing-time, arcing-times may be referred to as including a stated number of loops.

3.29

pre-arcing-time

the time between the commencement of a fusing-current and the instant when a break occurs in the fuse-element

3.30**arcing-time**

the time between the end of the pre-arcing-time and the instant when the circuit is broken and the current becomes permanently zero

3.31**total operating-time**

the sum of the pre-arcing-time and the arcing-time (See Definitions 3.29 and 3.30.)

3.32**virtual time of a period of operation of a fuse**

the time for which a steady current equal to the prospective current would have to flow in a fuse to produce the same quantity of energy as would be produced if the actual current during the period of operation considered flowed in the fuse for the actual period (see Clause 12)

this time is calculated from the formula:

$$t_v = \frac{\int i^2 dt}{I_p^2}$$

in which

i is the instantaneous value of current,

I_p is the prospective current, and

t_v is the virtual time of the period of operation under consideration.

3.33**operation**

the process in a fuse between the beginning of the pre-arcing-time and the end of the arcing-time

3.34**type-test**

a test of one article intended to show that all articles of the same kind and made to the same specification would pass an identical test

3.35**routine test**

a test of every article made to the same specification

3.36**insulation co-ordination**

the process of correlating the insulation strengths of electrical equipment with anticipated over-voltages and with the characteristics of protective devices (see Appendix H). It consists of the steps taken to prevent damage to electrical equipment due to over-voltages, and to localize flashovers (as far as economically practicable) to points where they will not cause damage

3.37**insulation level of apparatus**

the level that determines the dielectric strength of apparatus, and which is expressed for impulse-tested apparatus by a peak impulse value (impulse withstand voltage with full 1/50 microsec wave) and for non-impulse-tested apparatus by a power-frequency r.m.s. voltage value (power-frequency withstand voltage) which the apparatus should withstand under specified test conditions

3.38**electrically exposed installation**

an installation in which the apparatus is subject to over-voltages of atmospheric origin

NOTE 1 Such installations are usually connected to overhead transmission lines, either directly or through a short length of cable.

NOTE 2 Apparatus may be required for installations which are partly exposed to over-voltages of atmospheric origin, that is, exposed to voltages of magnitude less than for an exposed installation. Such installations are usually connected to overhead transmission lines through two-winding transformers, or a longer length of cable, which reduce the amplitude of incoming over-voltages. These cases require special consideration. The apparatus will be chosen from the appropriate exposed or non-exposed insulation class, as a special class of insulation is not proposed for this case.

3.39

electrically non-exposed installation

an installation in which the apparatus is not subject to over-voltages of atmospheric origin

NOTE Such installations are usually connected to cable networks.

3.40

effectively earthed system

one in which during a line-to-earth fault the maximum voltage to earth of the other two lines expressed as a percentage of the line-to-line voltage does not exceed 80 per cent

NOTE 1 A value not exceeding 80 per cent is obtained when for all switching conditions and unlimited supply the ratio of the zero-sequence reactance to the positive-sequence reactance is less than three, and the ratio of the zero-sequence resistance to the positive-sequence reactance is less than unity.

NOTE 2 A system in which all the transformers have star connected windings with all neutrals solidly (directly) earthed (i.e. the multiple earthed system) is regarded as effectively earthed. If only a limited number of transformers are so earthed, the system will not necessarily be effectively earthed.

3.41

non-effectively earthed system

one in which, during a line-to-earth fault, the maximum voltage to earth of the sound lines exceeds 80 per cent of the line-to-line voltage

Section 2. Rating

4 Voltage-rating

The following are the standard voltage-ratings for fuses:

3.3 kV	33 kV
6.6 kV	66 kV
11 kV	

Non-preferred voltage-ratings for fuses are as follows:

2.2 kV	110 kV
22 kV	132 kV
88 kV	

5 Current-rating

Fuses shall have one of the values of current-rating given in Table 1 or Table 2. Some fuses of the higher current-ratings may not be available in all types or in all the breaking-capacity ratings in Table 3 or Table 4.

Table 1 — Current-ratings for fuses other than voltage-transformer fuses

Amperes
5
10
15
20
25
30
40
50
60
75
100
150
200

NOTE It is recognized that fuses with current-ratings other than those specified in Table 1 and Table 2 are in present use, and that some time may elapse before all fuses can be made and supplied to the above ratings.

Table 2 — Current-ratings for fuses primarily used for the protection of voltage-transformers

Amperes
0.5
1
2
3

NOTE 1 It is recognized that fuses with current-ratings other than those specified in Table 1 and Table 2 are in present use, and that some time may elapse before all fuses can be made and supplied to the above ratings.

NOTE 2 It is recognized that the current-ratings of the fuse and of the current-limiting impedance may not be the same. Where a fuse is used in series with a current-limiting impedance, the current-rating of the combination is that of the component with the smaller current-rating.

6 Breaking-capacity ratings

Fuses shall have one of the breaking-capacity ratings specified in Table 3 or Table 4.

**Table 3 — Standard 3-phase breaking-capacity ratings
for fuses other than voltage-transformer fuses**

1	2	3
Standard voltage-rating	Standard 3-phase breaking-capacity rating	Standard 3-phase breaking-current corresponding to MVA in Col. 2
kV	MVA	kA
2.2 ^a	25 ^a 50 ^a 75 ^a 100 ^a	6.57 ^a 13.1 ^a 19.7 ^a 26.3 ^a
3.3	25 50 75 100 150	4.38 8.76 13.1 17.5 26.3
6.6	50 75 100 150 250	4.38 6.57 8.76 13.1 21.9
11	50 75 100 150 250	2.63 3.94 5.25 7.88 13.1
22 ^a	75 ^a 100 ^a 150 ^a 250 ^a 350 ^a 500 ^a	1.97 ^a 2.63 ^a 3.94 ^a 6.57 ^a 9.2 ^a 13.1 ^a
33	75 ^a 100 ^a 150 ^a 250 350 500	1.31 ^a 1.75 ^a 2.63 ^a 4.38 6.13 8.76
66	250 ^a 350 ^a 500 750	2.19 ^a 3.06 ^a 4.38 6.57
NOTE It is recognized that fuses are made for voltages up to 132 kV, but this standard does not contain any recommendations regarding the breaking-capacity of fuses for voltages above 66 kV. ^a These are non-preferred ratings.		

**Table 4 — Standard 3-phase breaking-capacity ratings
for voltage-transformer fuses**

1	2	3
Standard voltage-rating	Standard 3-phase breaking-capacity rating	Standard 3-phase breaking-current corresponding to MVA in Col. 2
kV	MVA	kA
2.2 ^a	75 ^a 100 ^a 150 ^a	19.7 ^a 26.3 ^a 39.4 ^a
3.3	50 75 150 250 ^a	8.76 13.1 26.3 43.8 ^a
6.6	150 250 500 ^a	13.1 21.9 43.8 ^a
11	150 250 500 750 ^a	7.88 13.1 26.3 39.4 ^a
22 ^a	250 ^a 500 ^a 750 ^a 1 500 ^a	6.57 ^a 13.1 ^a 19.7 ^a 39.4 ^a
33	500 750 1 500	8.76 13.1 26.3
66	750 ^a 1 500 2 500	6.57 ^a 13.1 21.9
NOTE It is recognized that fuses are made for voltages up to 132 kV, but this standard does not contain any recommendations regarding the breaking-capacity of fuses for voltages above 66 kV. ^a The are non-preferred ratings.		

Section 3. Marking

7 Fuse-links

All fuse-links shall be indelibly marked with:

- a) Current-rating (see Clause 5).

Where unwired fuses are sent out by the manufacturer, the maximum permissible current-rating of the fuse-element shall be clearly stated by the manufacturer, and a blank space shall be left on the fuse for filling in the current-rating of fuse-element used. Fuse-elements for re-wireable fuses shall be marked with their current-rating.

- b) Voltage-rating (see Clause 4).

The fuse-link may be marked with any combination of the voltages for which it is suitable as proved by test.

- c) Manufacturer's identification code.

If the construction of the fuse provides sufficient space, it is desirable to include:

- d) Breaking-capacity at voltage-rating . . . kA. r.m.s.
- e) Value of current-limiting impedance (if any) in ohms — see Note to Definition 3.12.
- f) The number of this British Standard (BS 2692).

8 Current-limiting impedances

All current-limiting impedances separate from the fuse shall be indelibly marked with:

- a) The impedance in ohms.
- b) An indication of the fuse with which the impedance is to be used.
- c) Manufacturer's identification code.

Section 4. Service conditions

9 Service conditions

High-voltage fuses complying with this standard are suitable within the limits of their rating for installation where the conditions are those specified below.

- a) *Voltage*. A voltage available across a fuse after operation not greater than the voltage-rating of the fuse.
- b) *Current*. The carrying of currents from zero current to rated current and the breaking of fusing-currents up to the breaking-capacity rating (see Appendix A).
- c) *Ambient temperature*. Ambient temperature not exceeding 25 °C.
(For other ambient temperatures see Clause 14.)
- d) *Altitude*. An altitude not exceeding 3 300 feet (1 000 metres) above sea-level. When a fuse intended for service at high altitudes is tested near sea-level the limits of temperature-rise given in Clause 14 shall be reduced one per cent for each 1 000 feet above sea-level at which the fuse is intended to work in service. The correction shall not be applied to altitudes below 3 300 feet (1 000 metres).
- e) *Atmosphere*. An atmosphere not subject to excessive pollution by smoke, chemical fumes, salt-laden spray, etc. Such pollution occurs in some industrial areas and in some coastal districts.

NOTE For installation of fuses which emit flame see Sub-clauses 17 a) and 28 a) v).

Section 5. Operation in service

10 General requirements

- a) A fuse shall be capable of satisfactorily opening the circuit or circuits protected by it under conditions that produce any value of fusing-current not exceeding its breaking-capacity rating at voltages not exceeding its voltage-rating. The behaviour of the fuse shall be satisfactory irrespective of the degree of current asymmetry.
- b) When performing operation a) above, a fuse shall not show undue distress as defined below. Any emission shall not cause breakdown or significant electrical leakage to earth or between poles nor shall it cause damage to associated apparatus and it shall neither in quantity nor direction be a source of danger to an operator.
- c) Operation of an oil-tank fuse shall not cause emission of flame from the containing tank and provision shall be made to ensure that any gas or oil emitted from the tank is conducted harmlessly away. The construction shall be such that gases cannot collect at any point where ignition can be caused during or after operation of the fuse or by normal operation of the associated apparatus. Carbonization of the oil during the operation shall not be such as to cause breakdown or significant electrical leakage.
- d) Operation of a powder-filled cartridge-fuse shall not cause emission of flame or powder.
- e) Fuses for use in the tank of a voltage-transformer shall not cause flame, oil or gas emission from the tank during their operation. The construction of the tank shall be such that gases cannot collect at any point where ignition can be caused during or after operation of the fuse or by normal operation of the associated apparatus. Carbonization of the oil during operation shall not be such as to cause breakdown or significant electrical leakage.

f) After the operation described in Sub-clause a) above, a fuse, and current-limiting impedance, if any, shall, without reconditioning, be capable of withstanding its rated voltage without dielectric breakdown, and the fuse-contacts, fuse-carrier and fuse-mount, when fitted with a new fuse-element or fuse-link, shall be capable of carrying rated current at rated voltage without a temperature-rise in excess of that allowable under Clause 14. All parts of the fuse shall be essentially in the same condition as before the operation, except that the fuse-element will require renewal and parts which assist in extinguishing the arc may require renewal [see Sub-clause 28 b)]. After such renewals the fuse shall comply with this standard in all respects.

11 Liquids

When fuses are immersed in, or filled with, liquid and are installed in localities subject to low temperatures, an appropriate liquid of low freezing-point should be used. When so required the maker shall give the lower limit of temperature for which the fuse may be used.

12 Time/current characteristics¹⁾

The manufacturer shall, on request, submit characteristic curves of the fuses showing the relation between pre-arcing-time and prospective current. The performance of fuses with respect to current at any particular value of time shall be within ± 20 per cent.

The measurements for determining the curve shall be made with the fuses initially at a temperature between the limits of 15 °C and 25 °C.

Information shall be given for arcing-time. The manufacturer shall give information on virtual time on request (see Definition 3.32).

If required, additional curves may be given based on measurements with the fuses initially at the steady temperature which is attained with rated current flowing.

NOTE See Appendix K.

13 Cut-off current characteristic¹⁾ (For current-limiting fuses only)

The manufacturer shall, on request, submit characteristic curves of the fuses showing the relation between prospective current and maximum cut-off current. The performance of fuses with respect to cut-off current at any particular value of prospective current shall be within ± 20 per cent.

The curve shall be plotted as follows:

abscissae: prospective current
ordinates: maximum cut-off current.

14 Temperature-rise limits at rated current

a) All parts of fuses shall be so designed and proportioned that when they are carrying their rated currents continuously in accordance with the requirements of Clause 21 the temperature-rise of the fuse-contacts and of the terminals, or sweating sockets where used, shall not exceed the following values:

	Centigrade degrees
Fuse-contacts	55
Terminals, or sweating sockets where used, to which the circuit conductor is connected	45

b) All parts of current-limiting impedances for use with fuses shall be so designed and proportioned that when they are carrying their rated currents continuously in accordance with the requirements of Clause 21 the temperature-rise of any part shall not exceed 45 Centigrade degrees.

¹⁾ Standardized methods of presenting the information are under consideration and it is hoped to publish details in due course.