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INTERNATIONAL STANDARD

NORME INTERNATIONALE

High-voltage fuses –
Part 1: Current-limiting fuses

Fusibles à haute tension –
Partie 1: Fusibles limiteurs de courant

IEC 60282-1:2009

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Part 1: Current-limiting fuses

FOREWORD

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International Standard IEC 60282-1 has been prepared by subcommittee 32A: High-voltage fuses, of IEC technical committee 32: Fuses.

This seventh edition cancels and replaces the sixth edition published in 2005. The changes introduced by this new edition are only editorial.

The text of this standard is based on the following documents:

FDIS	Report on voting
32A/274/FDIS	32A/277/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 60282 series, under the general title *High-voltage fuses,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

HIGH-VOLTAGE FUSES –

Part 1: Current-limiting fuses

1 General

1.1 Scope

This part of IEC 60282 applies to all types of high-voltage current-limiting fuses designed for use outdoors or indoors on alternating current systems of 50 Hz and 60 Hz and of rated voltages exceeding 1 000 V.

Some fuses are provided with fuse-links equipped with an indicating device or a striker. These fuses come within the scope of this standard, but the correct operation of the striker in combination with the tripping mechanism of the switching device is outside the scope of this standard; see IEC 62271-105.

1.2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60060-1:1989, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60071-1:2006, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60265-1:1998, *High-voltage switches – Part 1: Switches for rated voltages above 1 kV and less than 52 kV*

IEC 60549:1976, *High-voltage fuses for the external protection of shunt power capacitors*

IEC 60644:1979, *Specification for high-voltage fuse-links for motor circuit applications*

IEC/TR 60787:2007, *Application guide for the selection of high-voltage current-limiting fuse-links for transformer circuits*

IEC 62271-105:2002, *High-voltage switchgear and controlgear – Part 105: Alternating current switch-fuse combinations*

ISO 148-2, *Metallic materials – Charpy pendulum impact test – Part 2: Verification of test machines*

ISO 179 (all parts), *Plastics – Determination of Charpy impact properties*

2 Normal and special service conditions

2.1 Normal service conditions

Fuses complying with this standard are designed to be used under the following conditions.

a) The maximum ambient air temperature is 40 °C and its mean measured over a period of 24 h does not exceed 35 °C.

The minimum ambient air temperature is –25 °C.

NOTE 1 The time-current characteristics of fuses will be modified at the minimum and maximum temperatures.

b) The altitude does not exceed 1 000 m.

NOTE 2 The rated voltages and insulation levels specified in this standard apply to fuses intended for use at altitudes not exceeding 1 000 m. When fuses incorporating external insulation are required for use at altitudes above 1 000 m, one or other of the following procedures should be adopted.

a) The test voltages for insulating parts in air should be determined by multiplying the standard test voltages given in Tables 4 and 5 by the appropriate correction factor given in column (2) of Table 1.

b) The fuses may be selected with a rated voltage which, when multiplied by the appropriate correction factor given in column (3) of Table 1 is not lower than the highest voltage of the system.

For altitudes between 1 000 m and 1 500 m and between 1 500 m and 3 000 m, the correction factors can be obtained by linear interpolation between the values in Table 1.

Table 1 – Altitude correction factors – Test voltage and rated voltage

Maximum altitude m (1)	Correction factor for test voltages referred to sea-level (2)	Correction factor for rated voltages (3)
1 000	1,0	1,0
1 500	1,05	0,95
3 000	1,25	0,80

Where the dielectric characteristics are identical at any altitude, no special precautions need to be taken.

NOTE 3 The rated current or the temperature rise specified in this standard can be corrected for altitudes exceeding 1 000 m by using the appropriate factors given in Table 2, columns (2) and (3) respectively. Use one correction factor from columns (2) or (3), but not both, for any one application.

For altitudes between 1 000 m and 1 500 m and between 1 500 m and 3 000 m, the correction factors can be obtained by linear interpolation between the values in Table 2.

Table 2 – Altitude correction factors – Rated current and temperature rise

Maximum altitude m (1)	Correction factor for rated current (2)	Correction factor for temperature rise (3)
1 000	1,0	1,0
1 500	0,99	0,98
3 000	0,96	0,92

c) The ambient air is not excessively (or abnormally) polluted by dust, smoke, corrosive or flammable gases, vapour or salt.

d) For indoor installations, the conditions of humidity are under consideration but, in the meantime, the following figures can be used as a guidance:

– the average value of the relative humidity, measured during a period of 24 h, does not exceed 95 %;

– the average value of the vapour pressure, for a period of 24 h, does not exceed 22 hPa;

– the average value of the relative humidity, for a period of one month, does not exceed 90 %;

– the average value of the water vapour pressure, for a period of one month, does not exceed 18 hPa.

For these conditions, condensation may occasionally occur.

NOTE 4 Condensation can be expected where sudden temperature changes occur in periods of high humidity.

NOTE 5 To withstand the effects of high humidity and occasional condensation, such as breakdown of insulation or corrosion of metallic parts, indoor fuses designed for such conditions and tested accordingly or outdoor fuses may be used.

NOTE 6 Condensation may be prevented by special design of the building or housing, by suitable ventilation and heating of the station or by the use of dehumidifying equipment.

e) Vibrations due to causes external to fuses or earth tremors are negligible.

In addition, for outdoor installations,

f) account should be taken of the presence of condensation or rain and rapid temperature changes;

g) the wind pressure does not exceed 700 Pa (corresponding to 34 m/s wind speed);

h) the solar radiation does not exceed 1,1 kW/m^2.

2.2 Other service conditions

Fuse-links intended for use at surrounding temperatures (see 3.3.11) above 40 °C are covered in this standard in Annex E.

2.3 Special service conditions

By agreement between the manufacturer and the user, high-voltage fuses may be used under conditions different from the normal service conditions given in 2.1. For any special service condition, the manufacturer shall be consulted.

2.4 Environmental behaviour

Fuses complying with this standard are inert devices during normal service. It is also a requirement of 5.1.3 that no significant external emission takes place. Therefore, they are regarded as environmentally safe devices in service and operation.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Electrical characteristics

3.1.1
rated value
value of a quantity used for specification purposes, established for a specified set of operating conditions of a component, device, equipment, or system

NOTE Examples of rated values usually stated for fuses, voltage, current and breaking current.

[IEV 441-18-35 modified]

3.1.2
rating
set of rated values and operating conditions

[IEV 441-18-36]

3.1.3
prospective current (of a circuit and with respect to a fuse)
current that would flow in the circuit if the fuse were replaced by a conductor of negligible impedance

NOTE For the method to evaluate and to express the prospective current, see 6.6.2.1 and 6.6.2.2.

[IEV 441-17-01, modified]

3.1.4
prospective peak current
peak value of a prospective current during the transient period following initiation

NOTE The definition assumes that the current is made by an ideal switching device, i.e. with instantaneous transition from infinite to zero impedance. For circuits where the current can follow several different paths, for example polyphase circuits, it further assumes that the current is made simultaneously in all poles, even if only the current in one pole is considered.

[IEV 441-17-02]

3.1.5
prospective breaking current
prospective current evaluated at a time corresponding to the instant of the initiation of the breaking process

NOTE For the fuses, this instant is usually defined as the moment of the initiation of the arc during the breaking process. Conventions relating to the instant of the initiation of the arc are given in 6.6.2.3.

[IEV 441-17-06]

3.1.6
breaking capacity
value of prospective current that a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[IEV 441-17-08, modified]

3.1.7
cut-off current
let-through current
maximum instantaneous value of current attained during the breaking operation of a fuse

NOTE This concept is of particular importance when the fuse operates in such a manner that the prospective peak current of the circuit is not reached.

[IEV 441-17-12, modified]

3.1.8
pre-arcing time
melting time
interval of time between the beginning of a current large enough to cause a break in the fuse element(s) and the instant when an arc is initiated

[IEV 441-18-21]

3.1.9
arcing time
interval of time between the instant of the initiation of the arc in a fuse and the instant of final arc extinction in that fuse

[IEV 441-17-37, modified]

3.1.10
operating time
total clearing time
sum of the pre-arcing time and the arcing time

[IEV 441-18-22]

3.1.11
Joule integral
I^2t
integral of the square of the current over a given time interval $t_0 - t_1$

$$I^2t = \int_{t_0}^{t_1} i^2 \mathrm{d}t$$

NOTE 1 The pre-arcing I^2t is the I^2t integral extended over the pre-arcing time of the fuse.

NOTE 2 The operating I^2t is the I^2t integral extended over the operating time of the fuse.

NOTE 3 The energy in joules liberated in 1 Ω of resistance in a circuit protected by a fuse is equal to the value of the operating I^2t expressed in $A^2 \times s$.

[IEV 441-18-23 modified]

3.1.12
virtual time
value of Joule integral divided by the square of the value of the prospective current

NOTE The values of virtual times usually stated for a fuse-link are the values of pre-arcing time and of operating time.

[IEV 441-18-37 modified]

3.1.13
time-current characteristic
curve giving the time, for example pre-arcing time or operating time, as a function of the prospective current under stated conditions of operation

[IEV 441-17-13]

3.1.14
cut-off (current) characteristic
let-through (current) characteristic
curve giving the cut-off current as a function of the prospective current, under stated conditions of operation

NOTE In the case of a.c., the values of the cut-off currents are the maximum values which can be reached whatever the degree of asymmetry. In the case of d.c., the values of the cut-off current are the maximum values reached related to the time-constant as specified.

[IEV 441-17-14]

3.1.15
recovery voltage
voltage which appears across the terminals of a fuse after the breaking of the current

NOTE This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which the power frequency or the steady-state recovery voltage alone exists.

[IEV 441-17-25, modified]

3.1.16
transient recovery voltage
TRV
recovery voltage during the time in which it has a significant transient character

NOTE 1 The transient recovery voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and the fuse. It includes the voltage shift of the neutral point of a polyphase circuit.

NOTE 2 The transient recovery voltage in three-phase circuits is, unless otherwise stated, that across the first fuse to clear, because this voltage is generally higher than that which appears across each of the other two fuses.

[IEV 441-17-26, modified]

3.1.17
power-frequency recovery voltage
recovery voltage after the transient voltage phenomena have subsided

[IEV 441-17-27]

3.1.18
prospective transient recovery voltage (of a circuit)
transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

NOTE The definition assumes that the fuse, for which the prospective transient recovery voltage is sought, is replaced by an ideal switching device, i.e. having instantaneous transition from zero to infinite impedance at the very instant of zero current, i.e. at the "natural" zero. For circuits where the current can follow several different paths, for example a polyphase circuit, the definition further assumes that the breaking of the current by the ideal switching device takes place only in the pole considered.

[IEV 441-17-29, modified]

3.1.19
switching voltage
maximum instantaneous value of voltage which appears across the terminals of a fuse during its operation

NOTE The switching voltage may be the arc voltage or may occur during the time of transient recovery voltage.

[IEV 441-18-31]

3.1.20
minimum breaking current
minimum value of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

[IEV 441-18-29]

3.1.21
power dissipation (in a fuse-link)
power released in a fuse-link carrying a stated value of current under prescribed conditions of use and behaviour

NOTE Prescribed conditions of use and behaviour usually include a constant r.m.s. value of current until steady temperature conditions are reached.

[IEV 441-18-38]