IEC 60282-2

Edition 3.0 2008-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

High-voltage fuses –
Part 2: Expulsion fuses

Fusibles à haute tension –
Partie 2: Coupe-circuit à expulsion

IEC 60282-2:2008

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CONTENTS

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HIGH-VOLTAGE FUSES –

Part 2: Expulsion fuses

FOREWORD

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International Standard IEC 60282-2 has been prepared by subcommittee 32A: High-voltage fuses, of IEC technical committee 32: Fuses.

This third edition cancels and replaces the second edition, published in 1995, and constitutes a technical revision.

The main changes with regard to the previous edition concern the following:

– Class C has been eliminated;
– TRV values have been reviewed and, where appropriate, harmonized with IEC 62271-100:2001, its amendment 1 (2002) and amendment 2 (2006);
– tests for non-ceramic insulators have been included;
– a lightning surge impulse withstand test for fuse-links has been included;
– an homogeneous series has been redefined.

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

FDIS	Report on voting
32A/261/FDIS	32A/264/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 the parts in the 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- withdrawn,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 2: Expulsion fuses

1 Scope

This part of IEC 60282 specifies requirements for expulsion 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.

Expulsion fuses are fuses in which the arc is extinguished by the expulsion effects of the gases produced by the arc.

Expulsion fuses are classified according to the TRV (transient recovery voltage) capability in classes A and B.

This standard covers only the performance of fuses, each one comprising a specified combination of fuse-base, fuse-carrier and fuse-link which have been tested in accordance with this standard; successful performance of other combinations cannot be implied from this standard.

This standard may also be used for non-expulsion fuses in which the interruption process waits for natural current zero to clear the circuit.

NOTE 1 See Clause 5 and Clause 12 for specific information regarding the selection of fuse class.

NOTE 2 Fuses required for the protection of capacitors and for transformer circuit applications are subject to additional requirements (see IEC 60549 [1][1] or IEC 60787 [2]).

NOTE 3 This standard does not cover load-switching nor fault-making capabilities. Information regarding requirements related to switching capabilities may be found in IEC 60265-1 [3].

NOTE 4 This standard does not cover aspects related to the level of noise, nor the emission of hot gases inherent to some types of expulsion fuses during the process of interruption of fault currents.

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 coordination – Part 1: Definitions, principles and rules*

IEC 60694:1996, *Common clauses for high-voltage switchgear and controlgear standards*[2]

Amendment 1 (2000)
Amendment 2 (2001)

IEC 60815:1986, *Guide for the selection of insulators in respect of polluted conditions*

IEC 60898-1:2002, *Electric accessories – Circuit-breakers for overcurrent protection for household and similar installations – Part 1: Circuit-breakers for a.c. operation*

IEC 61109:1992, *Composite insulators for a.c. overhead lines with a nominal voltage greater than 1 000 V – Definitions, test methods and acceptance criteria*

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1 References in square brackets refer to the bibliography.

2 IEC 60694, together with its 2 amendments, have since been withdrawn and replaced by IEC 62271-1:2007[4].

IEC 61952:2002, *Insulators for overhead lines – Composite line post insulators for alternative current with a nominal voltage > 1 000 V*

IEC 62271-100:2001, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers*

Amendment 1 (2002)
Amendment 2 (2006)

3 Terms and definitions

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

NOTE Certain terms, are taken from IEC 60050-151 [5][3] and IEC 60050- 441 [6], as indicated by the reference numbers in brackets.

3.1 Electrical characteristics

3.1.1
rated value
quantity value assigned, generally by the manufacturer, for a specified operating condition of a component, device or equipment

[IEV 151-04-03,modified]

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

[IEV 441-18-35]

3.1.2
rating
set of rated values and operating conditions

[IEV 151-04-04]

[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 each pole of the switching device or the fuse were replaced by a conductor of negligible impedance

NOTE The method to be used to evaluate and to express the prospective current is to be specified in the relevant publications.

[IEV 441-17-01]

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, e.g. 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

[3] The terms cited from IEC 60050-151 are from the first edition (1978). A second edition which cancels and replaces the first edition, was published in 2001.

NOTE Specifications concerning the instant of the initiation of the breaking process are to be found in the relevant publications. For mechanical switching devices or fuses, it is usually defined as the moment of initiation of the arc during the breaking process.

[IEV 441-17-06]

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

NOTE 1 The voltage to be stated and the conditions to be prescribed are dealt with in the relevant publications.

NOTE 2 For switching devices, the breaking capacity may be termed according to the kind of current included in the prescribed conditions, e.g. line-charging breaking capacity, cable charging breaking capacity, single capacitor bank breaking capacity, etc.

[IEV 441-17-08]

3.1.7
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]

3.1.8
arcing time
interval of time between the instant of the initiation of the arc in a pole or a fuse and the instant of final arc extinction in that pole or that fuse

[IEV 441-17-37]

3.1.9
operating time
total clearing time
sum of the pre-arcing time and the arcing time

[IEV 441-18-22]

3.1.10
Joule integral
I^2t

integral of the square of the current over a given time interval: $I^2t = \int_{t_0}^{t_1} i^2 tdt$

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 numerical value of the operating I^2t expressed in A^2.s.

[IEV 441-18-23]

3.1.11
virtual time
value of the 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 in the scope of this standard are the values of the pre-arcing time.

3.1.12
time-current characteristic
curve giving the time, e.g. pre-arcing time or operating time, as a function of the prospective current under stated conditions of operation

[IEV 441-17-13]

3.1.13
recovery voltage
voltage which appears across the terminals of a pole of a switching device or 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]

3.1.14
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 switching device. It includes the voltage shift of the neutral of a polyphase circuit.

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

[IEV 441-17-26]

3.1.15
power-frequency recovery voltage
recovery voltage after the transient voltage phenomena have subsided

[IEV 441-17-27]

3.1.16
prospective transient recovery voltage (of a circuit)
the transient recovery voltage following the breaking of the prospective symmetrical current by an ideal switching device

NOTE The definition assumes that the switching device or 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, e.g. 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]

3.2 Fuses and their component parts (see Figure 1)

3.2.1
fuse
device that by the fusing of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted by breaking the current when this exceeds a given value for a sufficient time. The fuse comprises all the parts that form the complete device

[IEV 441-18-01]

3.2.2
terminal (as a component)
conductive part of a device, electric circuit or electric network, provided for connecting that device, electric circuit or electric network to one or more external conductors

NOTE The term "terminal" is also used for a connection point in circuit theory

[IEV 151-12-12]

3.2.3
fuse-base
fuse-mount
fixed part of a fuse provided with contacts and terminals

[IEV 441-18-02]

3.2.4
fuse-base contact
contact piece of a fuse-base designed to engage with a corresponding part of the fuse

[IEV 441-18-03]

3.2.5
fuse-carrier
movable part of a fuse designed to carry a fuse-link

[IEV 441-18-13]

3.2.6
fuse-carrier contact
contact piece of a fuse-carrier designed to engage with a corresponding part of the fuse

[IEV 441-18-05]

3.2.7
fuse-holder
combination of a fuse-base with its fuse-carrier

[IEV 441-18-14]

3.2.8
fuse-link
part of a fuse (including the fuse-element(s)) intended to be replaced after the fuse has operated

[IEV 441-18-09]

3.2.9
fuse-link contact
contact piece of a fuse-link designed to engage with a corresponding part of the fuse

[IEV 441-18-04]

3.2.10
fuse-element
part of the fuse-link designed to melt under the action of current exceeding some definite value for a definite period of time

[IEV 441-18-08]

3.2.11
renewable fuse-link
fuse-link that, after operation, may be restored for service by a refill-unit

[IEV 441-18-16]

3.2.12
refill unit
set of replacement parts intended to restore a fuse-link to its original condition after an operation

[IEV 441-18-15]

3.3 Additional terms

3.3.1
expulsion fuse
fuse in which operation is accomplished by expulsion of gases produced by the arc

[IEV 441-18-11]

3.3.2
drop-out fuses
fuse in which the fuse-carrier automatically drops into a position providing an isolating distance after the fuse has operated

[IEV 441-18-07]

3.3.3
homogeneous series (of fuse-link)
series of fuse-links, deviating from each other only in such characteristics that, for a given test, the testing of one or a reduced number of particular fuse-link(s) of that series may be taken as representative for all the fuse-links of the homogeneous series.

NOTE The relevant publications specify the characteristics by which the fuse-links of a homogeneous series may deviate, the particular fuse-links to be tested and the specific test concerned.

[IEV 441-18-34]

NOTE See also 8.6.1.2, 8.6.1.4 and 8.6.3.1.

3.3.4

isolating distance (for a fuse)
shortest distance between the fuse-base contacts or any conductive parts connected thereto, measured on a fuse:

a) for a drop-out fuse, with the fuse-carrier in drop-out position;

b) for fuses that are not drop-out fuses, with the fuse-link or the renewable fuse-link removed.

[IEV 441-18-06, modified]

3.3.5
speed designation of fuse-links (for expulsion fuses)
designation, expressed by letters such as K or T associated with the ratio between the values of the pre-arcing currents at two specified values of pre-arcing times

NOTE 1 K or T are letters typically used for speed designation.

NOTE 2 Pre-arcing times are usually declared for 0,1 s and 300 s (or 600 s).

NOTE 3 Fuse-links are typically designated by their rated current followed by their speed designation, e.g. a 125 K fuse-link is a 125 A rated fuse-link of speed designation type K.

3.3.6
interchangeability of fuse-links
compatibility of dimensions and pre-arcing time-current characteristics between different manufacturer's expulsion fuse-links, permitting use of such fuse-links in fuse-carriers of alternative manufacturers, without significant alteration of the pre-arcing time-current characteristics

NOTE It should be noted that the protective and interrupting performance provided by the combination of the selected fuse-link and the selected fuse-carrier can only be assured by performance test on the specific combination.

3.3.7
distribution fuse-cutout
drop-out fuse comprising a fuse-base, a fuse-carrier lined with arc-quenching material, and a fuse-link having a flexible tail, and a small diameter arc-quenching tube surrounding the fuse-element

3.3.8
open-link cutout
expulsion-fuse that does not employ a fuse-carrier and, in which the fuse-base directly receives an open-link fuse-link or a disconnecting blade

3.3.9
open-link fuse-link
replaceable part or assembly comprising the fuse-element and fuse tube, together with the parts necessary to confine and aid in extinguishing the arc and the parts to connect it directly into the fuse clips of the open-link cutout fuse-base

4 Service conditions

4.1 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 total solar radiation does not exceed 1 kW/m^2:

- for indoor installations, the preferred values of minimum ambient air temperature are –5 °C, –15 °C and –25 °C;
- for outdoor installations, the preferred values of minimum ambient air temperature are –10 °C, –25 °C, –30 °C and –40 °C.

NOTE 1 Attention is drawn to the fact that the time-current characteristics may be influenced by changes in ambient temperature.

b) The pollution level as classified in Clause 3 of IEC 60815 does not exceed the pollution level II – Medium according to Table 1 of IEC 60815.

c) For indoor installations, only normal condensation is present.

d) For outdoor installations, the wind pressure does not exceed 700 Pa (corresponding to 34 m/s wind speed).

e) The altitude does not exceed 1 000 m.

NOTE 2 When fuses are required for use above 1 000 m, the rated insulation levels to be specified should be determined by multiplying the standard insulation levels given in Tables 4 and 5 by the appropriate correction factors given in Table 1, or reducing overvoltages by using appropriate overvoltage limiting devices.

NOTE 3 The rated current of the equipment or the temperature rise specified in Table 12 can be corrected for altitudes exceeding 1 000 m by using 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.

4.2 Special service conditions

By agreement between manufacturer and user, high-voltage fuses may be used under conditions different from the conditions given in 4.1.

For any special service condition, the manufacturer shall be consulted.

5 Classification and designation

5.1 Classification

For a given rating, two classes of expulsion fuses are defined according to their ability to comply with the TRV requirements of the following tables for test duties 1, 2, 3 and 4 (see Annex A for guidance on correct application):

a) Class A – Table 8;

b) Class B – Table 9.

NOTE 1 These classes are approximately in line with the TRV requirements in the following standards:

- Class A: IEC 60282-2 (1970) [7][4]: (Class 2 fuses), and IEEE C37.41 (distribution class fuse-cutouts) [8];

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[4] First edition now withdrawn and replaced by more recent editions.

– Class B: IEC 60282-2 (1970): (Class 1 fuses), and IEEE C37.41 (power class fuses).

NOTE 2 Parameters used to define TRV are described in Figures 6 and 7.

5.2 Fuse-link speed designation

Certain types of fuse-link are designated as, e.g. "type T" or "type K", according to their compliance with specific pre-arcing time-current characteristics.

Such designation may assist in allowing interchangeability (see 3.3.8) between alternative manufacturer's fuse-links for use in distribution fuse-cutouts.

a) Designation type K: high-speed fuse-links with pre-arcing time-current characteristics in accordance with Table 10.

b) Designation type T: low-speed fuse-links with pre-arcing time-current characteristics in accordance with Table 11.

6 Ratings

6.1 General

The ratings of the fuse and its classification according to 5.1 are based on the defined working conditions for which it is designed and constructed. These ratings are as follows:

a) Fuse (complete)
   - Rated voltage (see 6.2);
   - Rated current (see 6.3);
   - Rated frequency (see 6.4);
   - Rated breaking capacity (see 6.5);
   - Rated insulation level (see 6.6).

b) Fuse-base
   - Rated voltage (see 6.2);
   - Rated current (see 6.3);
   - Rated insulation level (see 6.6).

c) Fuse-carrier
   - Rated voltage (see 6.2);
   - Rated current (see 6.3);
   - Rated frequency (see 6.4);
   - Rated breaking capacity (see 6.5).

d) Fuse-link
   - Rated voltage (see 6.2);
   - Rated current (see 6.3).

6.2 Rated voltage

A voltage used in the designation of the fuse, fuse-base, fuse-carrier, or fuse-link from which the test conditions are determined.

The rated voltage shall be selected from the voltages given in Table 3.

NOTE This rated voltage is equal to the highest voltage for the equipment.

Two series of highest voltages for equipment are given in Table 3; one for 50 Hz and 60 Hz systems (series I), and the other for 60 Hz systems (series II – North American practice). It is recommended that only one of these series should be used in any one country.