IEC 60282-1

Edition 7.0 2014-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

AMENDMENT 1
AMENDEMENT 1

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

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

IEC 60282-1:2009-10/AMD1:2014-07(en-fr)

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FOREWORD

This amendment has been prepared by subcommittee 32A: High-voltage Fuses, of IEC technical committee 32: Fuses.

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

FDIS	Report on voting
32A/311/FDIS	32A/312/RVD

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

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the stability 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- withdrawn,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.

1.2 Normative references

Add, after IEC 62271-105:2002, the following reference:

IEC TR 62655:2013, *Tutorial and application guide for high-voltage fuses*

3.1.6
breaking capacity

Replace the existing text of definition 3.1.6 by the following new text:

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

[SOURCE: IEC 60050-441, 441-17-08, modified (modified definition and Notes removed)]

3.1.14
cut-off (current) characteristic;
let-through (current) characteristic

Replace the existing text by the following new text:

curve giving the cut-off current as a function of the r.m.s prospective current, under stated conditions of operation

Note 1: The values of the cut-off currents are the maximum values that can be reached whatever the degree of asymmetry.

[SOURCE: IEC 60050-441, 441-17-14, modified (modified definition and Note to entry)]

3.1.15
recovery voltage

Replace the existing text of definition 3.1.15 by the following new text:

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

Note 1: 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 recovery voltage alone exists.

[SOURCE: IEC 60050-441, 441-17-25, modified (modified definition and Note to entry)]

Add the following new definition:

3.1.22
maximum breaking current
maximum value of prospective current that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour

3.3.2
classes

Replace

"See 9.3.3."

by

"See IEC/TR 62655:2013, 4.2.2."

3.3.4
General-Purpose fuse

Replace the existing definition by the following new defintion:

current-limiting fuse capable of breaking, under specified conditions of use and behaviour, all currents from the rated maximum breaking current down to a low value equal to the current that causes melting of the fuse element in 1 h

4.1 General

Replace the existing text of point b)5) by the following new text:

b) 5) Rated minimum breaking current for Back-Up fuses (4.8.2)

4.2 Rated voltage

Replace the existing title and text of 4.2 by the following new title and text (keep the existing Table 3):

4.2 Rated voltage (U_r)

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

NOTE 1 This rated voltage represents the highest voltage for equipment (see IEC 60038)

NOTE 2 On three-phase solidly earthed systems, fuses may only be used provided that the highest system voltage is less than or equal to their rated voltage. On single phase or non-solidly earthed systems, fuses may only be used provided that the highest system voltage is less than or equal to 87 % of their rated voltage, unless specific testing has been performed (see IEC/TR 62655:2013, 5.1.3).

The rated voltage of a fuse should be selected from the voltages given in Table 3.

4.3 Rated Insulation level (of a fuse base)

Replace the first two paragraphs of 4.3 by the following new text:

"The voltage values (both power frequency and impulse) that characterise the insulation of the fuse-base with regard to its capability of withstanding dielectric stresses (see IEC/TR 62655:2013, 4.5).

Two levels of dielectric withstand are recognised for a fuse-base according to European practice. These are termed "List 1" and "List 2" and relate to different severities of application and corresponding different values of test voltage for the dielectric tests (see IEC/TR 62655:2013, 4.5.2)."

4.6 Rated current of the fuse-link

Replace the existing title and first paragraph of 4.6 by the following new title and text:

4.6 Rated current of the fuse-link (I_r)

The current assigned to the fuse-link that a new clean fuse-link will carry continuously without exceeding specified temperature rises when mounted on a fuse-base specified by the manufacturer and connected to the circuit with certain specified conductor sizes and lengths, at an ambient air temperature of not more than 40 °C (see IEC/TR 62655:2013).

4.7 Temperature-rise limits

Replace the existing Note by the following two new Notes:

NOTE 1 For fuses used in enclosures, see 6.5.3, and IEC/TR 62655:2013, 5.1.1.2 and Annex A.

NOTE 2 Therefore where the term "oil" is used in this standard, any appropriate insulating liquid is covered. Appropriate insulating liquids are those approved by the fuse manufacturer.

Table 6 – Limits of temperature and temperature rise for components and materials

Replace Footnote f with the following new footnote:

f Special consideration should be given with regard to vaporisation and oxidation when low-flash-point oil is used. The given temperature value may be exceeded for transformer-type applications and/or if synthetic or other suitable insulating liquids are used (see 7.7.3 and IEC 60076-7).

4.8.1 Rated maximum breaking current

Replace the existing title of 4.8.1 by the following new title and remove the first paragraph:

4.8.1 Rated maximum breaking current (I_1)

Table 9 – Standard values of rated TRV – Series I

Replace Table 9 with the following new Table:

Rated voltage	Basic parameters		Derived values			
	Peak voltage	Time coordinate	Time delay [a]	Voltage coordinate [b]	Time coordinate [c]	Rate of rise
U_r	u_c	t_3	t_d	u'	t'	u_c/t_3
kV	kV	µs	µs	kV	µs	kV/µs
3,6	6,2	40	6	2,06	19,4	0,154
7,2	12,4	52	7,8	4,1	25	0,238
12	20,6	60	9	6,9	29	0,345
17,5	30	72	10,8	10	35	0,415
24	41	88	13,2	13,8	42,5	0,47
36	62	108	16,2	20,6	52	0,57
40,5	69	115	17,2	23	55,5	0,60
52	89	132	19.8	29,5	63.8	0,68
72,5	124	168	8,4	41,5	64	0,74

[a] $t_d = 0,15\ t_3$ for $U_r \leq 52$ kV
and $t_d = 0,05\ t_3$ for $U_r > 52$ kV

[b] $u' = 1/3\ u_c$ with $u_c = 1,4 \times 1,5 \sqrt{2/3}\ \ U_r$

[c] $t' = (0,15 + 1/3)\ t_3$ for $U_r \leq 52$ kV
and $t' = (0,05 + 1/3)\ t_3$ for $U_r > 52$ kV

Figure 4 – Various stages of the striker travel

Replace AB in the key with the following:

AB Further travel during which the specified energy shall be delivered

Table 11 – Mechanical characteristics of strikers

Replace footnote b with the following new footnote:

b Duration of travel is defined as the time from commencement of arcing to the time when travel OB is reached. The minimum arcing withstand time of 100 ms (4.15.3) is sufficient to cover this 50 ms plus an additional time of 50 ms to allow for the switching device operating time.

5.1.1 General

Replace the third paragraph of 5.1.1 with the following new text:

"No tests have been specified to prove the performance of the fuse in the range of currents below that specified in the breaking tests in 6.6 with respect to its capability to withstand the current of every possible time/current combination without deterioration leading to either premature operation or failure (see IEC TR 62655:2013)."

5.1.2 Standard conditions of use

Replace the existing text of 5.1.2 by the following new text:

Testing specified in this standard is intended to demonstrate the suitability of a fuse for use under the following conditions:

- the a.c. component of current is not higher than the rated maximum breaking current;
- the a.c. component of a current that the fuse is intended to interrupt is not lower than:
  - the rated minimum breaking current for a Back-Up fuse;
  - the current that causes melting in 1 h for a General-Purpose fuse;
  - the rated current for a Full-Range fuse;

- the surrounding temperature is not higher than the maximum application temperature (MAT) in the case of a Full-Range fuse that has an assigned MAT (with no low current restriction);
- the highest system voltage is not greater than the rated voltage of the fuse-link, if used in a three-phase solidly earthed neutral system or low impedance- or low resistance-earthed neutral system;
- the highest system voltage is not greater than 87 % of the rated voltage of the fuse-link, if used in a three-phase isolated neutral system or a resonant earthed system, because a double earth fault (with one fault on the supply side and one fault on the load side of a fuse on another phase) can occur;

  NOTE 1 A higher maximum system voltage than 87 % of the rated voltage of the fuse-link is acceptable when additional or alternative tests have been performed on the fuse (see IEC/TR 62655:2013, 5.1.3.3).

- the highest system voltage is not greater than 87 % of the rated voltage of the fuse-link, if used on a single-phase system;

  NOTE 2 A higher maximum system voltage than 87 % of the rated voltage of the fuse-link is acceptable when additional or alternative tests have been performed on the fuse (see IEC/TR 62655:2013, 5.1.3.3).

- the prospective transient recovery voltage is within the limits represented by the tests specified in 6.6.1.2;
- the frequency is between 48 Hz and 62 Hz;
- the power factor is not lower than specified in Table 13;
- the prospective TRV wave, while passing through the delay line and not recrossing it, does not exceed the reference line with the parameters specified in 6.6.1.2.

NOTE 3 As regards the prospective TRV characteristics, the time coordinate t_3 is not significant for the behaviour of fuses (except for those fuses which cause high arc-voltage peaks immediately after arc initiation; see 6.6.1.2.2).

It is considered that fuses will be capable of breaking correctly any value of prospective current, irrespective of the possible d.c. component, provided that the preceding requirements have been met.

6.5.3 Measurement of power dissipation

Replace the first paragraph of 6.5.3 by the following new paragraph:

"Fuses intended for use in enclosures may require derating (see IEC/TR 62655:2013, 5.1.1.2 and Annex A). To facilitate this derating, measurement of the power dissipation shall be made as follows."

7.7 Oil-tightness tests

Replace the existing title and text of 7.7 by the following new title and text:

7.7 Insulating liquid-tightness tests

7.7.1 General

Two test sequences are specified to demonstrate the liquid-tightness capability of fuses for applications involving fuses that are intended for use submerged in an insulating liquid. The first (7.7.2) is intended for applications in which the primary source of heat in an enclosure is the fuse itself (for example switchgear). The second method (7.7.3) is intended for applications in which other equipment (for example transformer windings) produce the majority of the heat in the enclosure. The test requirements are based on historical testing procedures that have produced good service experience.

Mineral oil has traditionally been used for this testing, but it is recognized that other insulating liquids, for example silicon fluid, and natural and synthetic esters, can be used in these applications. Experience has shown that if the tests are conducted with traditional insulating oil, the results will generally be valid for all insulating liquids that are inert as regards to the fuse sealing system. The manufacturer shall specify what liquids are appropriate for the test and the test report shall state the liquid used for the testing.

If several current ratings differing only in their fuse elements are to be evaluated, testing the fuse-link that has the highest power dissipation is sufficient.

For tests that specify a current, a tolerance from −5 % to +0 % is to be used.

NOTE Attention is drawn to the implementation of appropriate precautions when operating liquids near their ignition temperature.

7.7.2 Liquid-tightness tests for switchgear type applications

Fuse-links of current-limiting fuses designed to be used immersed in insulating liquid, and where the primary source of heat is the fuse itself, shall be tested as follows.

The fuse-link shall be immersed in insulating liquid under a pressure of 700 hPa ± 10 % (above atmospheric pressure).

A current equal to the maximum permissible continuous current of the fuse-link I_{encl} at 80 °C (see IEC/TR 62655:2013, Annex A) shall be passed through it, and the temperature of the liquid shall be raised to between 75 °C and 85 °C. This shall be achieved in 2 h to 4 h. The temperature shall be maintained within this range for a further test period of 2 h with the fuse carrying current. Supplementary heating and/or cooling of the liquid and/or its container is normally required to attain and/or maintain the required liquid temperature.

If a fuse-link tested according to Annex E is assigned a maximum application temperature (MAT) higher than 85 ºC, then the insulating liquid temperature shall, instead, be raised to a temperature at least equal to the fuse-link's assigned MAT. The current passed through the fuse-link shall be the maximum permissible continuous current I_{encl} for this temperature (see IEC/TR 62655:2013, Annex A).

The current shall be switched off, any supplementary heating discontinued and the liquid cooled, or allowed to cool, to a temperature between 15 °C and 30 °C over any convenient period of time.

This cycle shall be carried out six times and the tank pressure then relieved. The fuse-link shall then be removed from the liquid, cleaned externally and opened for inspection of the arc-quenching medium, which shall show no sign of ingress of liquid. See Figure 12 for a representation of the test sequence.

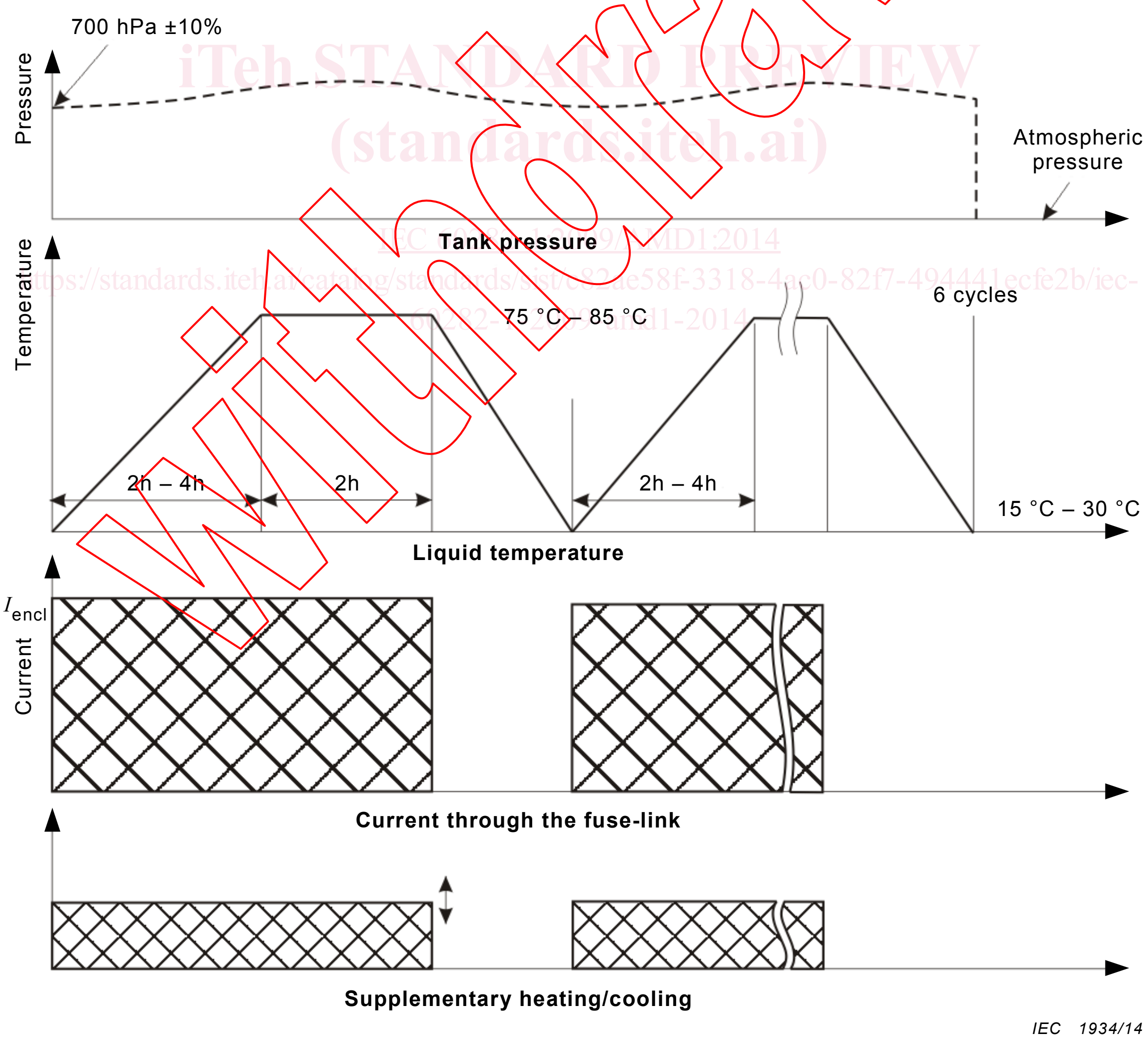

Figure 12 – Test sequence for switchgear type applications

7.7.3 Liquid-tightness tests for transformer type applications

7.7.3.1 General

If a fuse-link is intended for application in a liquid-filled distribution transformer tank, a test temperature of 115 °C or 140 °C shall be assigned (115 °C for European practice and 140 °C for North American practice). A fuse tested to 7.7.3 does not have to be tested to 7.7.2 to demonstrate liquid-tightness. For high temperature applications, where the heat source is not a transformer winding, the most appropriate temperature (115 °C or 140 °C) should be chosen.

During the cycling tests detailed in 7.7.3, the fuse-link rate of temperature change should be no more than 0,5 °C/min and steps should be taken to avoid thermal shock.

The manufacturer shall provide information concerning the assigned temperature (115 °C or 140 °C).

7.7.3.2 Thermal cycle test in liquid

The fuse-link shall be immersed in insulating liquid and the liquid temperature reduced to –30 °C (+0 °C, –5 °C). One complete cycle consists of raising the liquid temperature to 115 °C (+5 °C, –0 °C) or 140 °C (+5 °C, –0 °C), and back to –30 °C. When the liquid reaches 115 °C or 140 °C, current equal to the maximum permissible continuous current of the fuse-link I_{encl} for 115 °C or 140 °C (see IEC/TR 62655:2013, Annex A) shall be passed through the fuse for 2 h. During the 2 h period, the liquid temperature shall be maintained at 115 °C /140 °C (+5 °C, –0 °C). The time from one temperature extreme to the other shall be any convenient value as limited by the rate of temperature change specified in 7.7.3.1. The cycle may be interrupted for any convenient period of time when the liquid temperature is at 20 °C (+10 °C, –10 °C). There shall be a holding period at –30 °C (+0 °C, –5 °C) of at least two hours. Current through the fuse may be used as supplementary heating during the heating part of the cycle.

See Figure 13 for a representation of the test sequence.

This cycle shall be carried out ten times with five fuse-links of the design to be evaluated. The fuse-links shall be removed from the insulating liquid, cleaned externally and opened for inspection of the arc-quenching medium, which shall show no sign of ingress of liquid. It should be noted that more than one fuse-link can be tested in the same liquid filled tank simultaneously, and on the last cycle, the fuse-link temperature need only be reduced to room temperature.

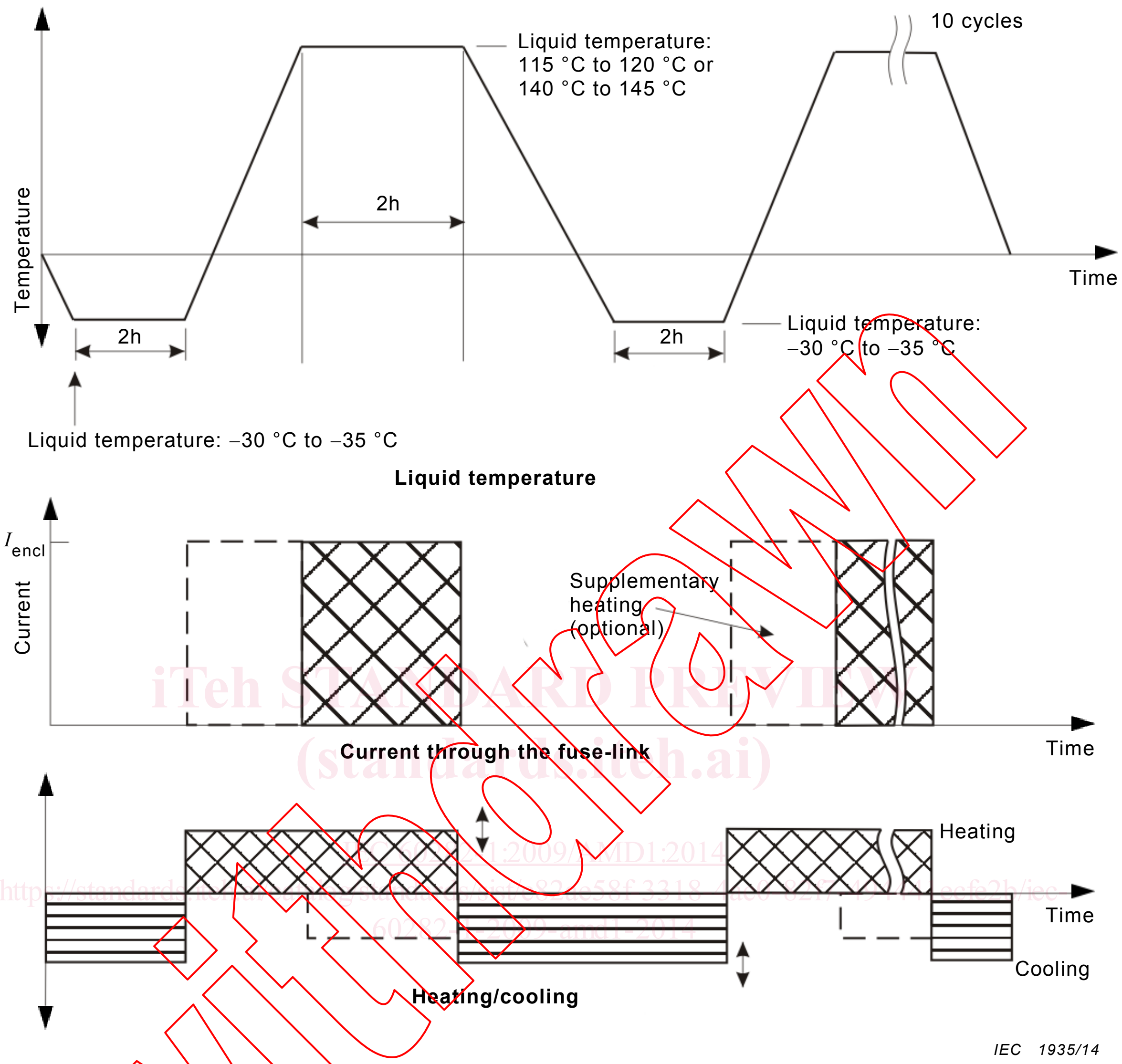

Figure 13 – Test sequence for combined test for transformer type applications

7.7.3.3 Alternative tests

If it is not convenient to perform the testing as specified in 7.7.3.2 it may be split into two parts with series a) performed before series b) as follows:

a) Test in air

With the fuse-link in air, its temperature is reduced to –30 °C (+0 °C, –5 °C). One complete cycle consists of raising the fuse-link temperature to 115 °C (+5 °C, –0 °C) or 140 °C (+5 °C, –0 °C), and back to –30 °C (+0 °C, –5 °C). The time for each thermal cycle from one temperature extreme to the other shall be any convenient value, as limited by the rate of temperature change specified in 7.7.3.1, with a holding period at each temperature extreme of at least two hours. The cycle may be interrupted for any convenient period of time when the fuse-link temperature is at 20 °C (+10 °C, –10 °C). Current through the fuse(s) may be used as a supplemental heat source during the heating cycle. See Figure 14 for a representation of the test sequence.