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English version

Fire hazard testing  
Part 2: Test methods  
Section 2 — Needle-flame test

**(Includes Amendment A1:1995)**

(IEC 695-2-2:1991 A1:1995)

Essais relatifs aux risques du feu  
Partie 2: Méthodes d'essai  
Section 2 — Essai au brûleur-aiguille  
(inclut l'amendement A1:1995)  
(CEI 695-2-2:1991 + l'amendement A1:1995)

Prüfungen zur Beurteilung der Brandgefahr  
Teil 2: Prüfverfahren  
Hauptabschnitt 2 — Prüfung mit der  
Nadelflamme (enthält Änderung A1:1995)  
(IEC 695-2-2:1991 + Änderung 1:1994)

This European Standard was approved by CENELEC on 1993-12-08, amendment A1 was approved by CENELEC on 1995-09-20. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

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**Foreword**

At the request of CENELEC 72nd Technical Board, HD 444.2.2 S2:1992 (IEC 695-2-2:1991) was submitted to the CENELEC voting procedure for conversion into a European Standard.

The text of the International Standard was approved by CENELEC as EN 60695-2-2 on 8 December 1993.

The following dates were fixed:

- latest date of publication of an identical national standard (dop) 1994-12-15
- latest date of withdrawal of conflicting national standards (dow) —

**Foreword to amendment A1**

The text of amendment 1:1994 to the International Standard IEC 695-2-2:1991, prepared by IEC TC 89, Fire hazard testing, was submitted to the formal vote and was approved by CENELEC as amendment A1 to EN 60695-2-2:1994 on 1995-09-20 without any modification.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-09-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1996-09-01

Annexes designated “normative” are part of the body of the standard. In this standard, Annex A is normative.

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## Introduction

The best method for testing electrotechnical products with regard to fire hazard is to duplicate exactly the conditions occurring in practice. In most instances this is not possible. Accordingly, for practical reasons, the testing of electrotechnical products with regard to fire hazard is best conducted by simulating as closely as possible the actual effects occurring in practice.

Parts of electrotechnical equipment which might be exposed to excessive thermal stress due to electric effects, the deterioration of which might impair the safety of the equipment, shall not be unduly affected by heat and by fire generated within the equipment.

Parts of insulating material or of other combustible material which are liable to propagate flames inside the equipment may be ignited by flames produced by a failing component. Under certain conditions, for example a fault current flowing over a tracking path, overloading of components or parts and bad connections, flames may also occur; such flames may impinge upon combustible parts in the vicinity.

## 1 Scope

This section of IEC 695 specifies a needle-flame test to simulate the effect of small flames which may result from fault conditions within the equipment, in order to assess by a simulation technique the fire hazard.

It is applicable to electrotechnical equipment, its sub-assemblies and components and to solid electrical insulating materials or other combustible materials.

## 2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this section of IEC 695. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this section of IEC 695 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4046:1978, *Paper, board, pulp and related terms — Vocabulary.*

## 3 General description of the test

**3.1** If possible, the specimen should be a complete equipment, sub-assembly or component. If it is necessary to take away parts of an enclosure or to cut off a suitable part to perform the test, care must be taken to ensure that the test conditions are not significantly different from those occurring in normal use with regard to shape, ventilation, effect of thermal stresses and possible flames occurring, or burning or glowing particles falling in the vicinity of the specimen.

If the test cannot be made on the complete specimen, a suitable part may be cut from it.

If the specimen is a suitable part cut from a larger unit, care must be taken to ensure that in this particular case the test flame is not applied incorrectly, for example to an edge created by cutting.

If it is not possible to make the test on a sub-assembly or component within the equipment, the test is made on a separate specimen under the conditions specified in clause 4.

### 3.2 The test is applied to ensure:

- that, under defined conditions, the test flame does not cause ignition of parts, or
- that a combustible part ignited by the test flame under defined conditions has a limited duration of burning or a limited extent of burning, without spreading fire by flames or burning or glowing particles falling from the specimen.

**NOTE** To investigate the fire hazard which may be created by the specimen, it may be necessary to make preliminary tests with other sources of ignition, flames not being normally the primary source of ignition within electrical equipment. In such cases, the height and duration of flames are of importance for determining the application and severity of the test flame.

**3.3** As this test assesses the effects on the specimen of a small flame such as may arise from other ignited components, the relevant specification is required to specify the duration of flame application and the criteria for acceptance.

## 4 Description of test apparatus

**4.1** The burner to produce the test flame consists of a tube, which is at least 35 mm long and has a bore of  $0.5 \text{ mm} \pm 0.1 \text{ mm}$  and an outer diameter not exceeding 0.9 mm. A hypodermic needle, the tapered end of which is cut off, may be used for the test.

The burner is supplied with butane gas having a purity of at least 95 %; there must be no air admitted to the burner tube.

**NOTE** Propane gas may be used to supply the burner, butane gas being however the standard reference.

With the axis of the burner in the vertical position, the gas supply is adjusted without artificial air supply so that the length of the flame is  $12 \text{ mm} \pm 1 \text{ mm}$ , when viewed in subdued light against a dark background (see Figure 1). In the event of dispute or when required by the relevant specification, the flame should be confirmed using the apparatus and the procedure detailed in Annex A. The test time for the temperature to increase from  $100 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$  to  $700 \text{ }^\circ\text{C} \pm 3 \text{ }^\circ\text{C}$  shall be  $23,5 \text{ s} \pm 1,0 \text{ s}$ .

NOTE Specification of the flame by prescribing gas flow rate instead of height is under consideration.

**4.2** To evaluate the possibility of spread of fire, for example by burning or glowing particles falling from the specimen, a layer of the material or components normally surrounding or situated underneath the specimen is placed underneath the specimen at a distance equal to the distance between the specimen and the surrounding material or components when the specimen is mounted as in normal use.

If the specimen is a sub-assembly or a component of the equipment and is tested separately, a piece of flat smooth white pinewood board, approximately 10 mm thick covered in close contact with a single layer of wrapping tissue, is positioned at a distance of  $200 \text{ mm} \pm 5 \text{ mm}$  below the place where the needle flame is applied to the specimen, unless otherwise specified in the relevant specification. The white pinewood board or wrapping tissue may be replaced by other materials if they have been verified as equally suitable for the purpose.

If the specimen is a complete free-standing equipment, it is placed in its normal position of use on the tissue-covered pinewood board extending for 100 mm outside the base of the appliance in all directions.

If the specimen is a complete wall-mounted equipment, it is fixed in its normal position of use  $200 \text{ mm} \pm 5 \text{ mm}$  above the tissue covered pinewood board.

Means to fix the specimen and the burner in position may be necessary.

NOTE Wrapping tissue as specified in 6.86 of ISO 4046: A soft and strong, lightweight wrapping paper of grammage generally between  $12 \text{ g/m}^2$  and  $30 \text{ g/m}^2$ , primarily intended for protective packaging of delicate articles and for gift wrapping.

## 5 Severities

Preferred values of duration of application ( $t_a$ ) of test flame are:

5 s, 10 s, 20 s, 30 s, 60 s, 120 s (+ 0 s – 1 s)

If required by the relevant specification, other severities may be used. However, repeated applications are not recommended.

NOTE The duration of application of the test flame should be chosen in relation to the characteristics of the specimen and should be taken into consideration during the preparation of the relevant specification. Repeated applications are used in some specifications. The advisability of these procedures is under consideration.

## 6 Preconditioning

If not otherwise specified in the relevant specification, the specimen, the white pinewood board and the tissue paper are stored for 24 h in an atmosphere having a temperature between  $15 \text{ }^\circ\text{C}$  and  $35 \text{ }^\circ\text{C}$  and a relative humidity between 45 % and 75 % before starting the test.

## 7 Initial measurements

The specimen shall be examined visually and, when specified in the relevant specification, the physical and electrical parameters measured.

## 8 Test procedure

### WARNING NOTE

Precautions must be taken to safeguard the health of the personnel conducting tests against:

- the risks of explosion or fire;
- the inhalation of smoke and/or toxic products;
- toxic residues.

**8.1** The room or compartment in which the test is made shall have adequate dimensions to ensure that the test is carried out in a substantially draught-free atmosphere and with an adequate supply of air.

**8.2** Unless otherwise specified in the relevant specification, the specimen is arranged in its most unfavourable position of normal use. The means to fix the specimen shall not influence the effect of the test flame or the propagation of flames in a way other than that occurring under normal conditions of use.

**8.3** During the adjustment of the test flame, any influence of heat or radiation on the specimen shall be avoided. If required by the relevant specification or in the event of dispute, the flame shall be confirmed.

**8.4** The test flame is applied to that part of the surface of the specimen which is likely to be affected by flames resulting from normal use or from fault conditions, or from any source of ignition accidentally applied.

In order that the test flame may be applied in the most unfavourable way, the tube of the burner may be bent.

The point of application and the duration of application of the test flame shall be specified in the relevant specification.

Once the test flame has been positioned so that at least the tip of the flame is in contact with the surface of the specimen, the burner must not be moved. The test flame is removed after the specified time. For examples of test positions, see Figure 1.

**8.5** Unless otherwise specified in the relevant specification, the test is made on three specimens.

**8.6** When required by the relevant specification, the test is made at more than one point on the same specimen, in which case care must be taken to ensure that any deterioration caused by previous tests will not affect the result of the test to be made.

## 9 Observations and measurements

**9.1** During the test, the specimen, the parts surrounding the specimen and the layer placed below it shall be observed.

**9.2** In the case of ignition of the specimen or of the parts surrounding it or of the layer placed below it, the duration of burning ( $t_b$ ) is measured and reported.

Duration of burning denotes the time interval from the moment the test flame is removed until the flames have extinguished or the glowing of the specimen or of parts in its vicinity or of the layer used for the test is no longer visible.

**9.3** If specified in the relevant specification, the extent of burning is measured after the specimen has been allowed to cool down to approximately room temperature and has been cleaned by means of a clean dry cloth.

Extent of burning denotes the distance measured between the centre of the area where the test flame is applied and the most distant trace of burning.

Trace of burning denotes the destroyed area of the surface of the specimen affected by burning, including charred areas.

When determining the trace of burning, changes in colour, soot formation, distortion of shape due to heat, melting and scorching of the surface are ignored.

**9.4** Characteristics of burning shall be observed.

**9.5** The specimen shall be examined visually for physical damage and the mechanical/electrical parameters measured as specified in the relevant specification.

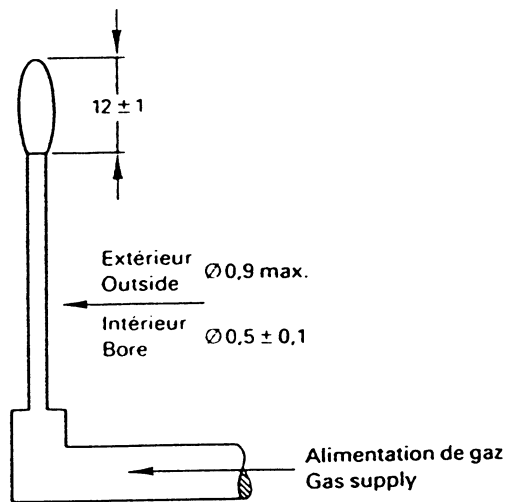
## 10 Evaluation of test results

Unless otherwise prescribed in the relevant specification, the specimen is considered to have satisfactorily withstood the needle-flame test if one of the following situations applies:

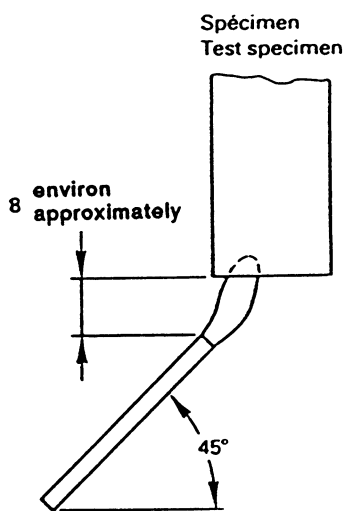
- a) There is no flame and no glowing of the specimen and no ignition of the wrapping tissue or scorching of the pinewood board when these are used.
- b) Flames or glowing of the specimen, the surroundings and the layer below extinguish within 30 s after the removal of the needle-flame, that is  $t_b < 30$  s, the surrounding parts and the layer below have not burnt away completely and there has been no ignition of the wrapping tissue nor scorching of the pinewood board when these have been used.

## 11 Information to be given in the relevant specification

- a) any preconditioning, if required (clause 6);
- b) number of specimens, if not three (see 8.5);
- c) position of the specimen (see 8.2);
- d) surface to be tested and the point of application (see 8.4 and 8.6);
- e) the underlying layer to be used to evaluate the effect of flaming drops (see 4.2);
- f) level of severity:
  - the duration of application of the test flame ( $t_a$ ) (see 3.3 and clause 5);
- g) requirements (clauses 9 and 10):
  - the permissible duration and extent of burning, considering the design and arrangements of the various parts, and shields and barriers inside the equipment;
  - whether the criteria specified are sufficient to check compliance with the safety requirements, or whether further criteria should be introduced;
- h) initial measurements (clause 7);
- i) any deterioration of mechanical/electrical properties allowed (see 9.5).

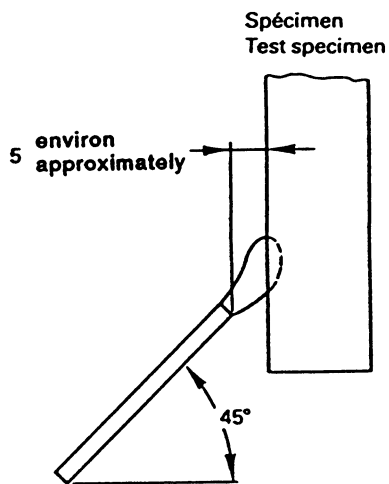


a) **Réglage de la flamme**  
**Flame adjustment**



b) **Position d'essai (exemple)**  
**Test position (example)**

*Dimensions en millimètres*



c) **Position d'essai (exemple)**  
**Test position (example)**

CEI-IEC 31491

*Dimensions in millimetres*

**Figure 1 — Needle burner**



## Annex A (normative)

### Subsidiary test method for confirming the flame

This subsidiary test method for confirming the flame is used where required by the relevant specification or in case of dispute.

#### A.1 Confirmation

##### A.1.1 Principle

The time for the temperature of the copper block, described in Figure A.1 to increase from 100 °C to 700 °C shall be  $23,5 \pm 1,0$  s, when the flame test arrangement of Figure A.2 is used.

##### A.1.2 Procedure

An example of a suitable jig for the adjustment of flame height is given in Figure A.3. The jig shall be constructed such that it does not rest on the end of the burner tube nor disturb the root of the burner flame.

Set up the arrangement according to Figure A.2 in a draught-free environment, ensuring leak-free gas connections.

Temporarily remove the burner away from the block to ensure no influence of the flame on the block during the preliminary adjustment of the gas flow rate.

Ignite the gas and adjust the gas flow rate to give a flame height of  $12 \text{ mm} \pm 1 \text{ mm}$  when viewed in subdued light against a dark background.

Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium and then readjust the flame height, if necessary.

With the temperature/time indicating/recording devices operational, re-position the burner under the block.

Make three determinations of the time for the temperature of the block to increase from  $100 \text{ °C} \pm 2 \text{ °C}$  to  $700 \text{ °C} \pm 3 \text{ °C}$ . Allow the block to cool naturally in air to below 50 °C between determinations.

If the copper block has not been used before, make a preliminary run to condition the block surface. Discard the result.

**A.1.3** Calculate the mean time in seconds as the result.

**A.1.4** The flame is confirmed if the result is within the range  $23,5 \text{ s} \pm 1,0$  s.

#### A.2 Test apparatus

##### A.2.1 Burner

The burner shall be in accordance with clause 4.

##### A.2.2 Control valve

One control valve is required to set the gas flow rate.

##### A.2.3 Copper block

4 mm diameter, of mass  $0,58 \text{ g} \pm 0,01 \text{ g}$  in the fully machined but undrilled state, see Figure A.1.

##### A.2.4 Thermocouple

Sheathed fine wire type K (NiCr/NiAl), outer sheath diameter 0,5 mm, suitable for longterm operation at  $> 1\ 050 \text{ °C}$ .

The preferred method of fastening thermocouple to block is by compressing the copper around the thermocouple, see Figure A.2.

##### A.2.5 Temperature indicating, recording and timing devices

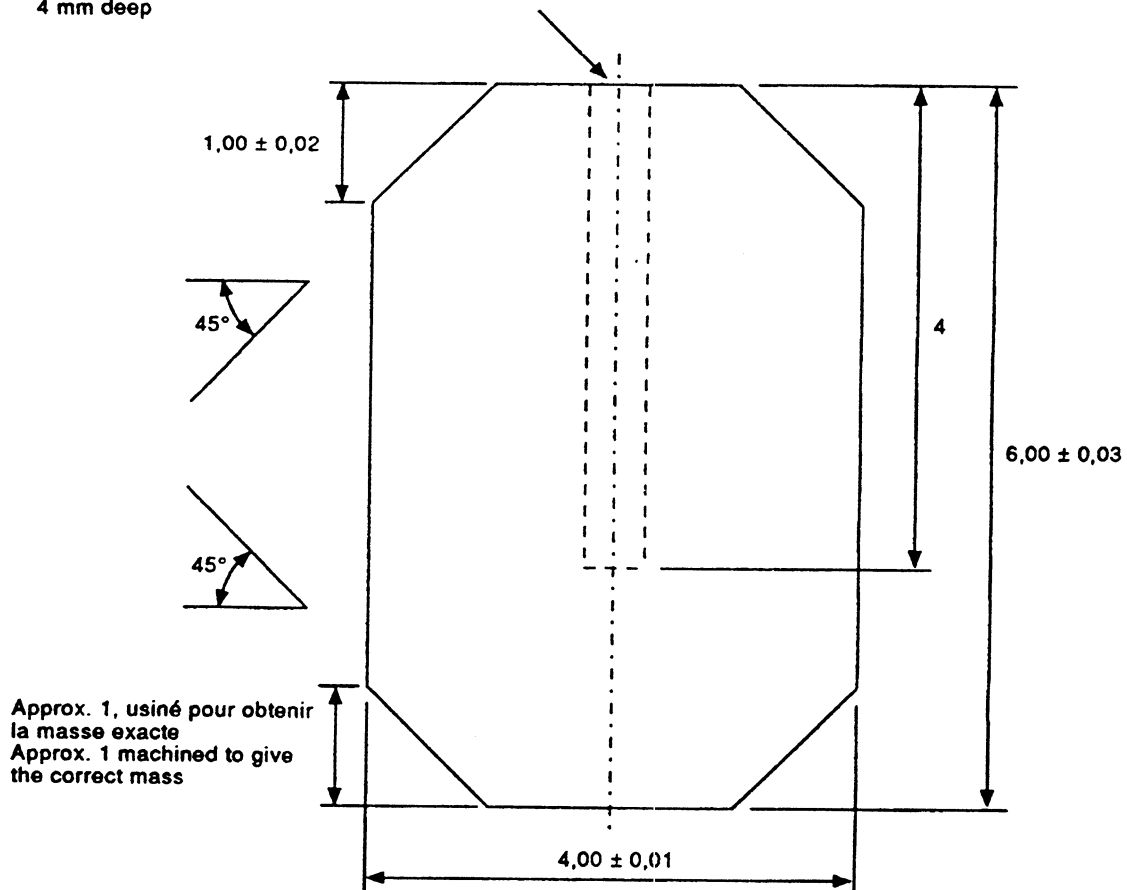
Appropriate for the measurement of the time for the block to heat up from  $100 \text{ °C} \pm 2 \text{ °C}$  to  $700 \text{ °C} \pm 3 \text{ °C}$  with a time uncertainty of 0,1 s.

##### A.2.6 Fuel gas

Butane with a purity of at least 95 %.

If the purity of the butane fuel gas is less than 95 %, the flame shall be confirmed in accordance with this normative annex every time the gas supply is changed or replaced.

Trou de 4 mm de profondeur foré pour  
 enserrer étroitement le thermocouple de 0,5 mm  
 Hole drilled to be a close fit on 0,5 mm thermocouple  
 4 mm deep



CEI-IEC 27164

*Dimensions en millimètres**Dimensions in millimetres*

**Matériau: Cuivre (électrolytique) de haute conductivité,  
 poli sur toute sa surface**

**Masse avant perçage: 0,58 g ± 0,01 g**

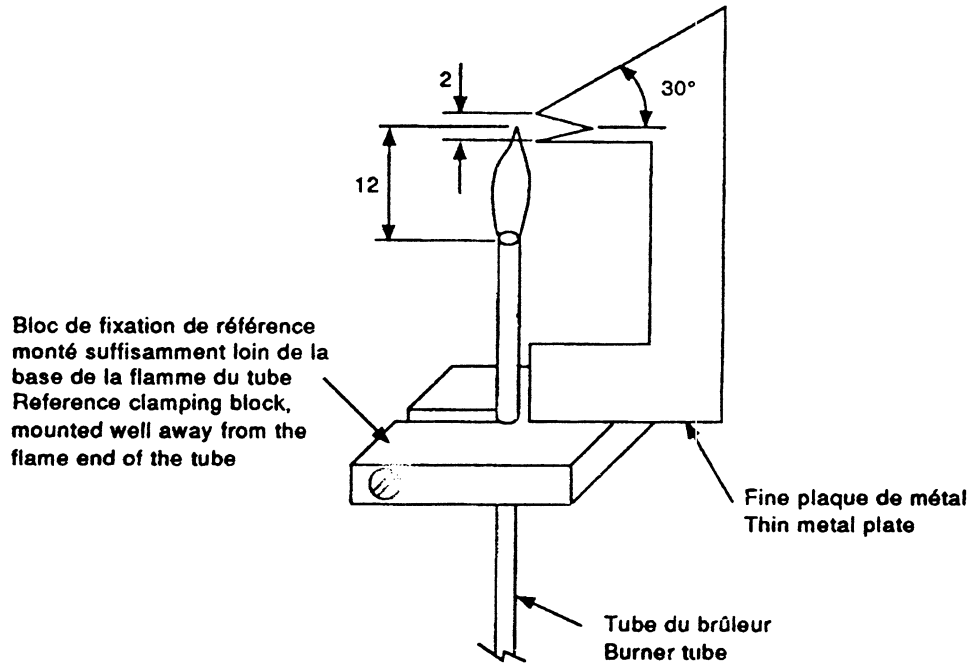
**Material: High-conductivity (electrolytic) copper  
 polish all external surfaces**

**Mass before drilling: 0,58 g ± 0,01 g**

**Figure A.1 — Copper block polish external surfaces**







CEI-IEC 273/94

*Dimensions en millimètres*

*Dimensions in millimetres*

Figure A.3 — Example of height jig