

INTERNATIONAL STANDARD



BASIC SAFETY PUBLICATION

Fire hazard testing –

Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance

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IEC 60695-11-5

Edition 2.0 2016-12
REDLINE VERSION

INTERNATIONAL STANDARD



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test arrangement and guidance**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.220.40; 29.020

ISBN 978-2-8322-3695-6

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CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 ~~General description~~ Purpose of the test	10
5 Description of the test apparatus	10
5.1 Burner	10
5.2 Gas supply	10
5.3 Flame	10
5.4 Control valve	11
5.5 Laboratory fumehood/chamber	11
5.6 Layer	11
5.6.1 Specified layer	11
5.6.2 Standardized layer	11
5.7 Timing device	11
6 Test specimen	11
7 ~~Severities~~ Flame application times	12
8 Conditioning and test conditions	12
8.1 Conditioning	12
8.2 Test conditions	12
9 Test procedure	12
9.1 General	12
9.2 Position of test specimen	13
9.3 Application of needle-flame	13
9.4 Number of test specimens	13
10 Observations and measurements	13
11 Evaluation of test results	14
12 Information to be given in the relevant specification	14
13 Test report	14
Annex A (normative) Confirmatory test arrangement	16
A.1 Confirmation of the test flame – Principle	16
A.2 Test apparatus	16
A.2.1 Burner	16
A.2.2 Control valve	16
A.2.3 Copper block	16
A.2.4 Thermocouple	16
A.2.5 Temperature/time indicating/recording devices	16
A.3 Procedure	16
~~Annex B (informative) Access to equipment manufacturers and suppliers~~	~~22~~
Annex B (informative) Example of a product committee specification	22
Annex C (informative) Comparison of results of confirmatory tests using propane and butane as fuel	23
Bibliography	24

Figure 1 – ~~Needle~~ Burner and flame	15
Figure 2 – Test positions	15
Figure A.1 – Copper block	18
Figure A.2 – Confirmatory test arrangement	19
Figure A.3 – Gauge to measure flame height and the distance between burner and copper block (example)	20
Table B.1 – Severities and requirements	22
Table C.1 – Results of the confirmatory test using propane and butane as fuel	23

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

**Part 11-5: Test flames – Needle-flame test method –
Apparatus, confirmatory test arrangement and guidance**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60695-11-5 has been prepared by IEC technical committee 89: Fire hazard testing.

This second edition cancels and replaces the first edition published in 2004. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The scope has been broadened to allow this test method to also simulate the effects of small flames from outside the equipment;
- b) Propane and butane gas are the specified fuel source with a minimum purity of 95 %;
- c) A new concept has been added which allows the burner to be moved during the test to avoid dripping material from falling onto the tip of the burner tube;
- d) The burner tube material is now a referenced source;
- e) The reference for the copper block material has changed – the ISO publication (ISO 1337) has been withdrawn with no replacement. A new callout is now used;
- f) Informative Annex C and a bibliography have been added.

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

FDIS	Report on voting
89/1346/FDIS	89/1351/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.

It has the status of a basic safety publication in accordance with IEC Guide 104 and ISO/IEC Guide 51.

A list of all the parts in the IEC 60695 series, under the general title *Fire hazard testing*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

IMPORTANT – The “colour inside” logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this publication using a colour printer.

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 effects⁷. This ~~can result in~~ deterioration~~of~~ that might impair the safety of the equipment⁷. ~~Such parts~~ should not be unduly affected by heat~~and or~~ 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.

This part of IEC 60695 ~~should~~ is intended to be used to measure and describe the properties of materials, products or assemblies in response to heat and flame under controlled laboratory conditions and ~~should~~ is not intended to be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. This standard may involve hazardous materials, operations and equipment.

It does not purport to address all of the safety problems associated with its use.

It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

FIRE HAZARD TESTING –

Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance

1 Scope

This part of IEC 60695 specifies a needle-flame test to simulate the effect of a small flame which may result from fault conditions, in order to assess the fire hazard by a simulation technique. The results of this test may be used as elements of a fire hazard assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

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

This basic safety publication is intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the relevant publications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60695-4:2012, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:1999, *Safety aspects – Guidelines for their inclusion in standards*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ISO 4046-4:2002 2016, *Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

ISO/IEC 13943:2000 2008, *Fire safety – Vocabulary*

ASTM-B187, *Standard specification for copper, bus bar, rod, and shapes and general purpose rod, bar, and shapes*

3 Terms and definitions

For the purposes of this document, the terms and definitions ~~of ISO/IEC 13943~~ given in ISO 13943:2008, IEC 60695-4:2012 and ISO 4046:2002, as well as the following, apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

combustible, adj.

capable of being ignited and burned

[SOURCE: ISO 13943:2008, 4.43]

3.2

draught-free environment

space in which the results of experiments are not significantly affected by the local air speed

Note 1 to entry: A qualitative example is a space in which a wax candle flame remains essentially undisturbed. Quantitative examples are small-scale fire tests in which a maximum air speed of $0,1 \text{ m} \times \text{s}^{-1}$ or $0,2 \text{ m} \times \text{s}^{-1}$ is sometimes specified.

[SOURCE: ISO 13943:2008, 4.70]

3.3

fire

(general) process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, glowing or a combination thereof

Note 1 to entry: In the English language the term "fire" is used to designate three concepts, two of which, **fire** (3.4) and **fire** (3.5), relate to specific types of self-supporting combustion with different meanings and two of them are designated using two different terms in both French and German.

[SOURCE: ISO 13943:2008, 4.96]

3.4

fire

(controlled) self-supporting combustion that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[SOURCE: ISO 13943:2008, 4.97]

3.5

fire

(uncontrolled) self-supporting combustion that has not been deliberately arranged to provide useful effects and is not limited in its extent in time and space

[SOURCE: ISO 13943:2008, 4.98]

3.6

fire hazard

physical object or condition with a potential for an undesirable consequence from fire (3.1)

[SOURCE: ISO 13943:2008, 4.112]

3.7**fire risk**

probability of a fire (3.3) combined with a quantified measure of its consequence

Note 1 to entry: It is often calculated as the product of probability and consequence.

[SOURCE: ISO 13943:2008, 4.124]

3.8**flame, noun**

rapid, self-sustaining, sub-sonic propagation of combustion in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2008, 4.133]

3.9**glowing, noun**

luminosity caused by heat

cf. incandescence

[SOURCE: ISO 13943:2008, 4.168]

3.10**glowing combustion**

combustion of a material in the solid phase without flame but with emission of light from the combustion zone

cf. incandescence

[SOURCE: ISO 13943:2008, 4.169]

3.11**ignition**

sustained ignition (deprecated)
(general) initiation of combustion

[SOURCE: ISO 13943:2008, 4.187]

3.12**ignition**

sustained ignition (deprecated)
(flaming combustion) initiation of sustained flame

[SOURCE: ISO 13943:2008, 4.188]

3.13**wrapping tissue**

soft and strong, lightweight wrapping paper of grammage generally between 12 g/m² and 30 g/m², primarily intended for protective packaging of delicate articles and for gift wrapping

Note 1 to entry: In French, the word “mousseline” includes both white tissue and “bulle corde”, which is unbleached or coloured tissue.

[SOURCE: ISO 4046-4:2016, 4.215]

4 ~~General description~~ Purpose of the test

Warning

~~Precautions shall 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.~~

The test is performed to determine that, under defined conditions, the test flame ~~either~~ does not cause ignition of parts or ~~if it does, that a~~ combustible parts ignited by the test flame ~~has~~ have a limited duration of burning or a limited extent of burning, without spreading fire by flames or burning or glowing particles falling from the test specimen.

~~This test determines the effects on the test specimen of a small flame such as may arise from other ignited components and the relevant product specification shall specify the duration of flame application and the criteria for acceptance.~~

The test flame, applied to the test specimen, imitates a flame that might arise from a component that is close to the test specimen in the real application. Such a flame might have occurred, for example, because of an electrical fault.

The relevant product specification shall specify, if applicable, the duration of the test flame application and the acceptance criteria.

5 Description of the test apparatus

5.1 Burner

The burner to produce the test flame shall consist of a tube at least 35 mm long with a bore of $0,5 \text{ mm} \pm 0,1 \text{ mm}$ and an outer diameter not exceeding 0,9 mm.

NOTE The tubing specified in ISO 9626:2016 [1]¹ (0,8 mm normal walled or thin walled) meets these requirements ~~in this standard for an internal diameter of $0,5 \text{ mm} \pm 0,1 \text{ mm}$ and an outside diameter no greater than 0,9 mm.~~

5.2 Gas supply

The burner is supplied with ~~either~~ propane or butane gas having a purity ~~of at least~~ not less than 95 %.

5.3 Flame

With the axis of the burner in the vertical position, ~~ignite~~ the gas supply ~~is~~ and adjusted ~~so that the length~~ the gas flow rate to ensure that the overall height of the flame is $12 \text{ mm} \pm 1 \text{ mm}$, when viewed in subdued light against a dark background (see Figure 1), and that the flame is symmetrical. Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium. There shall be no air admitted to the burner tube.

The flame shall be confirmed using the apparatus and procedure detailed in Annex A. ~~The test time for the temperature to increase from $100 \text{ }^{\circ}\text{C} \pm 5 \text{ }^{\circ}\text{C}$ to $700 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$ shall be $23,5 \text{ s} \pm 1,0 \text{ s}$.~~

¹ Numbers in square brackets refer to the bibliography.

5.4 Control valve

A control valve is required to set the gas flow rate to ensure that the overall height of the flame is within the required tolerances.

5.5 Laboratory fumehood/chamber

The laboratory fumehood/chamber shall have an inside volume of at least 0,5 m³. The chamber shall provide a draught-free environment, whilst allowing normal thermal circulation of air past the test specimen. The chamber shall permit observation of the test in progress. The inside surfaces of the walls shall be of a dark colour. ~~In case of dispute, the recorded light level shall be less than 20 lx using a light meter, facing towards the rear of the chamber and positioned in place of the test specimen.~~

For safety and convenience, it is desirable that this ~~enclosure~~ fumehood/chamber (which can be completely closed) be fitted with an extraction device, such as an exhaust fan, to remove products of combustion, which may be toxic. The extraction device, ~~if used~~, shall be turned off during the test and turned on immediately after the timing measurements have been made. A positive closing damper may be needed.

NOTE Placing a mirror in the chamber, to provide a rear view of the test specimen, has been found to be useful.

5.6 Layer

5.6.1 Specified layer

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

5.6.2 Standardized layer

If the test specimen is a sub-assembly or a component of the equipment and is tested separately, ~~such that surrounding materials and distances are unknown~~, a piece of flat smooth wooden board, approximately 10 mm thick covered in close contact with a single layer of wrapping tissue (3.13), ~~is~~ shall be positioned at a distance of 200 mm ± 5 mm below the place where the needle-flame is applied to the test specimen, ~~unless otherwise specified in the relevant specification. Wrapping tissue as specified in 4.215 of ISO 4046-4 is a soft and strong, lightweight wrapping tissue 12 g/m² to 30 g/m².~~

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

If the test specimen is a complete wall-mounted equipment, it ~~is~~ shall be fixed in its normal position of use 200 mm ± 5 mm above the tissue covered wooden board.

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

5.7 Timing device

The timing device shall have a ~~tolerance~~ resolution of not more than 0,5 s.

6 Test specimen

If possible, the test specimen shall 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 shall be taken to ensure that the test conditions are not significantly different from those occurring in normal use with regard to shape, ventilation conditions, effect of thermal stresses and possible flames occurring, or burning or glowing particles falling in the vicinity of the test specimen.

If the test specimen is a suitable part cut from a larger unit, care shall 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 conduct the test on a sub-assembly or component within the equipment, the test is conducted on a test specimen removed from the equipment.

7 Severities Flame application times

Preferred values of the duration of application (t_a) of the test flame are as follows:

5 s, 10 s, 15 s, 20 s, 30 s, 60 s, 120 s.

The tolerance for all values is ${}^0_{-1}$ s.

NOTE The duration of application of the test flame should be chosen in relation to the characteristics of the end product.

NOTE See Annex C for an example of a classification system for the needle-flame test.

8 Conditioning and test conditions

8.1 Conditioning

If not otherwise specified in the relevant specification, the test specimen, ~~the wooden board~~ and the tissue ~~paper~~ ~~-covered~~ **wooden board** shall be conditioned for not less than 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 % before starting the test. **Once removed from the conditioning atmosphere, the test specimens shall be tested within 1 h (see ISO 291).**

8.2 Test conditions

Unless otherwise specified, all test specimens shall be tested under standard atmospheric conditions for testing as follows:

- temperature: 15 °C to 35 °C; and
- relative humidity: ≤ 75 %.

9 Test procedure

9.1 General

Warning

Precautions shall 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; and
- toxic residues.

9.2 Position of test specimen

Unless otherwise specified in the relevant specification, the test specimen ~~is~~ shall be arranged in a position of normal use such that ignition is most likely to occur during the test. The means to fix the test 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.

9.3 Application of needle-flame

The test flame ~~is~~ shall be applied to that part of the surface of the test specimen which is most likely to be affected by flames resulting from normal use or from fault conditions. Examples of flame test positions are shown in Figures 2a and 2b.

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

With the central axis of the burner tube vertical, place the burner remote from the test specimen, set the burner (see 5.1) to produce a standardized 12 mm nominal test flame, conforming to 5.3. Wait for a minimum of 5 min to allow the burner conditions to reach equilibrium. Rotate the burner so that the burner tube is positioned at an angle of $45 \pm 5^\circ$ from the vertical (see Figure 1) throughout the duration of the test.

The test flame ~~is~~ shall be positioned so that the tip of the flame is in contact with the surface of the test specimen. ~~The test flame is removed after the specified time.~~

~~If the test specimen drips molten or flaming material during the application of the flame, the burner may be tilted up to 45° from the vertical to prevent material from dripping into the burner tube while maintaining an $8 \text{ mm} \pm 1 \text{ mm}$ spacing between the center of the top of the burner and the remaining portion of the test specimen, ignoring any strings of molten material.~~

If the test specimen is located vertically above the test flame, a spacing of $8 \text{ mm} \pm 1 \text{ mm}$ shall be maintained between the center of the top of the burner and the remaining portion of the test specimen during the test, ignoring any strings of molten material. If the test specimen is located horizontally from the test flame, a spacing of $5 \text{ mm} \pm 1 \text{ mm}$ shall be maintained between the center of the top of the burner and the remaining portion of the test specimen during the test (see Figure 1).

The test flame is removed after the specified flame application time (t_a) (see Clause 7).

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

9.4 Number of test specimens

Unless otherwise specified in the relevant specification, the test is performed on three test specimens.

10 Observations and measurements

In the case of ignition of the test specimen and/or the specified layer and/or the surrounding parts, the duration of burning (t_b) is measured and reported. Ignition of the specified layer shall be observed and noted. The duration of burning denotes the time interval from the moment the test flame is removed from the test specimen, until the last flames have extinguished and the glowing combustion of the test specimen, the specified layer and/or the surrounding parts is no longer visible.

11 Evaluation of test results

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

- a) There is no ignition of the specified layer ~~or wrapping tissue~~ and, **after the removal of the needle-flame**, there is no flame and no glowing of the test specimen.
- b) Flames or glowing of the test specimen and the surrounding parts extinguish within 30 s after the removal of the needle-flame, that is $t_b < 30$ s. Also, the surrounding parts have not burnt away completely and there has been no ignition of the specified layer ~~or wrapping tissue~~.

12 Information to be given in the relevant specification

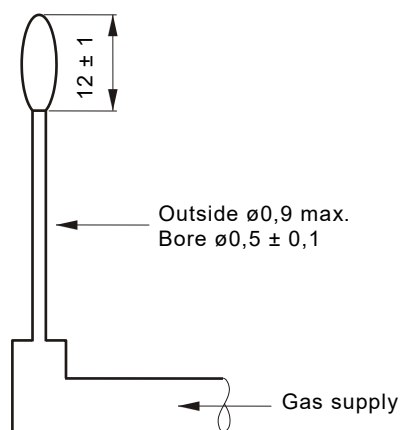
The relevant specification shall indicate the following details:

- a) any conditioning, if different from that specified in Clause 8;
- b) the number of test specimens, if different from that specified in 9.4;
- c) the position of the test specimen (see 9.2);
- d) the surface to be tested and the point of application (see 9.3);
- e) the specified layer to be used to evaluate the effect of burning or glowing particles falling from the test specimen (see 5.6);
- ~~f) level of severity:~~
- f) the duration of application of the test flame (t_a) (see Clause 7);
- g) the permissible duration and extent of burning, considering the design and arrangements of the various parts, shields and barriers inside the equipment;
- h) whether the criteria specified are sufficient to check compliance with the safety requirements, or whether further criteria should be introduced;
- i) any requirements if different from those given in Clauses 10 and 11.

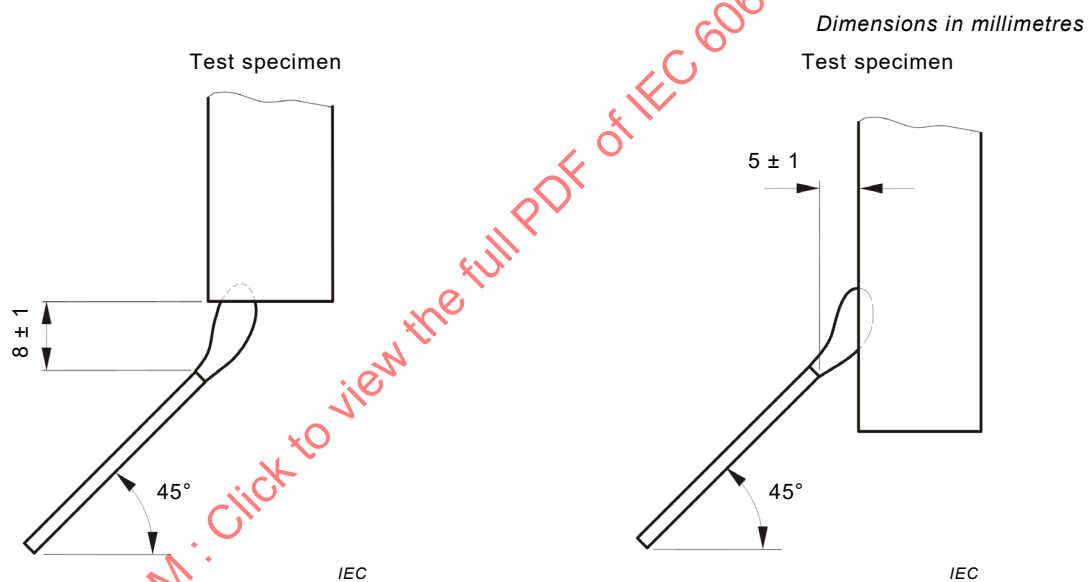
13 Test report

The test report shall include the following information:

- a) the type and description of the test specimen (see Clause 6);
- b) the method of preparation (see Clause 6);
- c) any conditioning of the test specimens (see Clause 8);
- d) the number of test specimens (see 9.4);
- ~~e) level of severity:~~
- e) the duration of application of the test flame (t_a) (see Clauses 7 and 12);
- f) the surface tested and the point of application of the needle-flame (see 9.3);
- g) the specified layer used to evaluate the effect of burning or glowing particles falling from the test specimen (see 5.6);
- h) whether the test flame has been applied at more than one point on the same test specimen, (see 9.3); and
- i) the test results (see Clauses 10 and 11).

Dimensions in millimetres

IEC

Figure 1 – Needle Burner and flame**Figure 2a – Test position (horizontal example)****Figure 2b – Test position (vertical example)****Figure 2 – Test positions**

Annex A (normative)

Confirmatory test arrangement

A.1 Confirmation of the test flame – Principle

The time for the temperature of the copper block, described in Figure A.1, to increase from $100\text{ °C} \pm 5\text{ °C}$ to $700\text{ °C} \pm 3\text{ °C}$ shall be $23,5\text{ s} \pm 1,0\text{ s}$, when the flame confirmatory test arrangement of Figure A.2 is used.

The flame shall be confirmed in accordance with this Annex A every time the gas supply is changed or replaced.

NOTE Detailed background information for the confirmation of a test flame can be found in IEC 60695-11-40 [2].

A.2 Test apparatus

A.2.1 Burner

The burner shall be in accordance with 5.1.

A.2.2 Control valve

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

A.2.3 Copper block

The copper block material shall be specified as: Cu-ETP UNS C11000 (see ASTM-B187). The diameter of the copper block shall be $4\text{ mm} \pm 0,01\text{ mm}$ with a mass of $0,58\text{ g} \pm 0,01\text{ g}$ in the fully machined and polished but undrilled state, see Figure A.1.

A.2.4 Thermocouple

The thermocouple shall be a sheathed fine wire type K (NiCr/NiAl) with an outer sheath diameter of 0,5 mm.

The preferred method of fastening the thermocouple to the copper block is by compressing the copper around the thermocouple, after first ensuring that the thermocouple is inserted to the full depth of the hole as shown in Figure A.2.

A.2.5 Temperature/time indicating/recording-and-timing devices

These devices shall be appropriate for the measurement of the time for the copper block to heat up from $100\text{ °C} \pm 5\text{ °C}$ to $700\text{ °C} \pm 3\text{ °C}$ ~~with a time uncertainty of 0,1 s~~. The timing device shall have a tolerance of not more than 0,5 s.

A.3 Procedure

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

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

- Temporarily remove the burner away from the copper block to ensure no influence of the flame on the copper block during the preliminary adjustment of the gas flow rate.
- With the axis of the burner in the vertical position, ignite the gas supply and adjust the gas flow rate to ~~give a flame~~ ensure that the overall height of the flame is $12 \text{ mm} \pm 1 \text{ mm}$, when viewed in subdued light against a dark background, and that the flame is symmetrical.

~~NOTE 1 In case of dispute, a light level of 20 lux should be used.~~

- Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium and ~~then readjust~~ measure the flame height, ~~if necessary to determine that~~ ensure that the height is within the required limits.
- With the temperature/time indicating/recording devices operational, reposition the burner under the copper block.
- Conduct three determinations of the time for the temperature of the copper block to increase from $100 \text{ }^{\circ}\text{C} \pm 5 \text{ }^{\circ}\text{C}$ to $700 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$. Allow the copper block to cool naturally in air to below $50 \text{ }^{\circ}\text{C}$ between determinations.

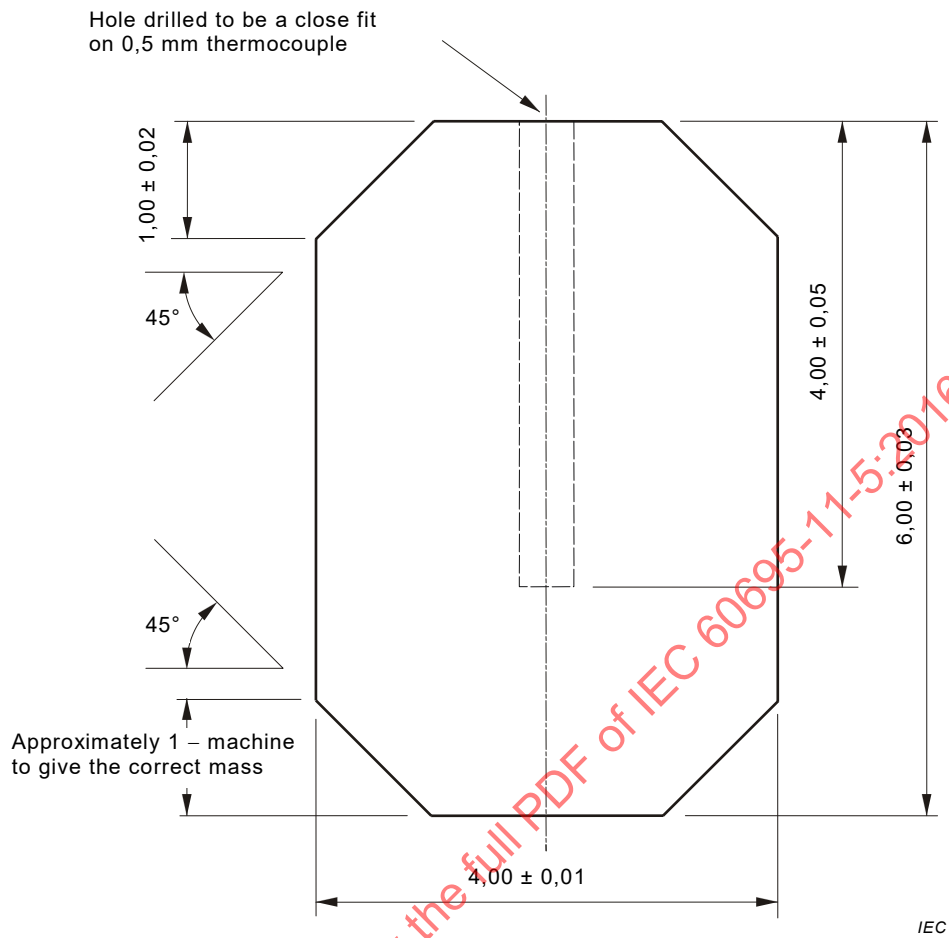
~~NOTE 2~~ At temperatures above $700 \text{ }^{\circ}\text{C}$, the thermocouple can be easily damaged, therefore it is advisable to remove the burner immediately after reaching $700 \text{ }^{\circ}\text{C}$.

- If the copper block has not been used before, conduct a preliminary run to condition the copper block surface. Discard the result.
- Calculate the mean time in seconds as the result.
- The flame is confirmed if the result is within the range $23,5 \text{ s} \pm 1,0 \text{ s}$.

~~The flame shall be confirmed in accordance with this Annex A every time the gas supply is changed or replaced.~~

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Dimensions in millimetres



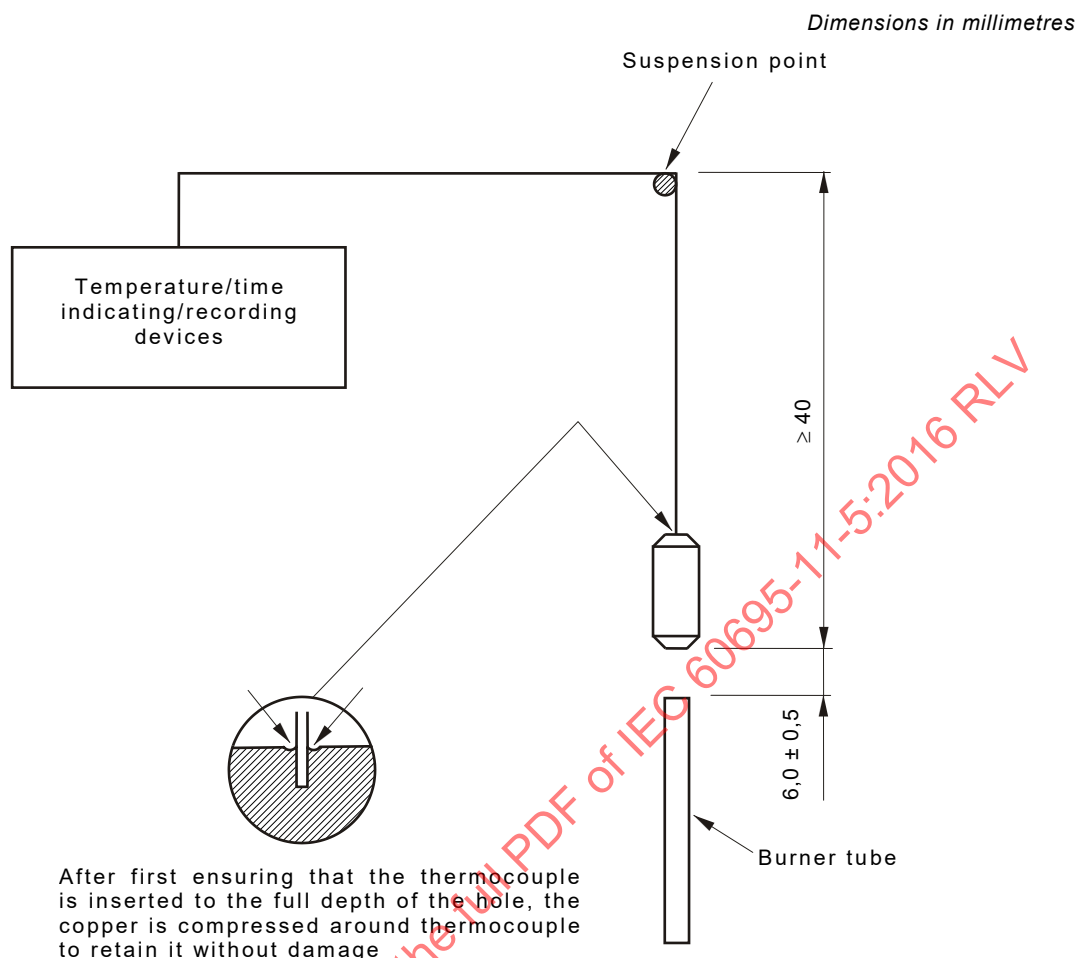
Copper block polished all over

Tolerance: $\pm 0,1$, ± 30 min (angular), unless otherwise stated

Material: high conductive electrolytic copper Cu-ETP UNS C 11000 (see ASTM-B187)

Weight Mass: 0,58 g $\pm$ 0,01 g before drilling

Figure A.1 – Copper block



IEC

The mode of suspension of the copper block shall be such that the block remains essentially stationary during the test.

Figure A.2 – Confirmatory test arrangement

Dimensions in millimetres

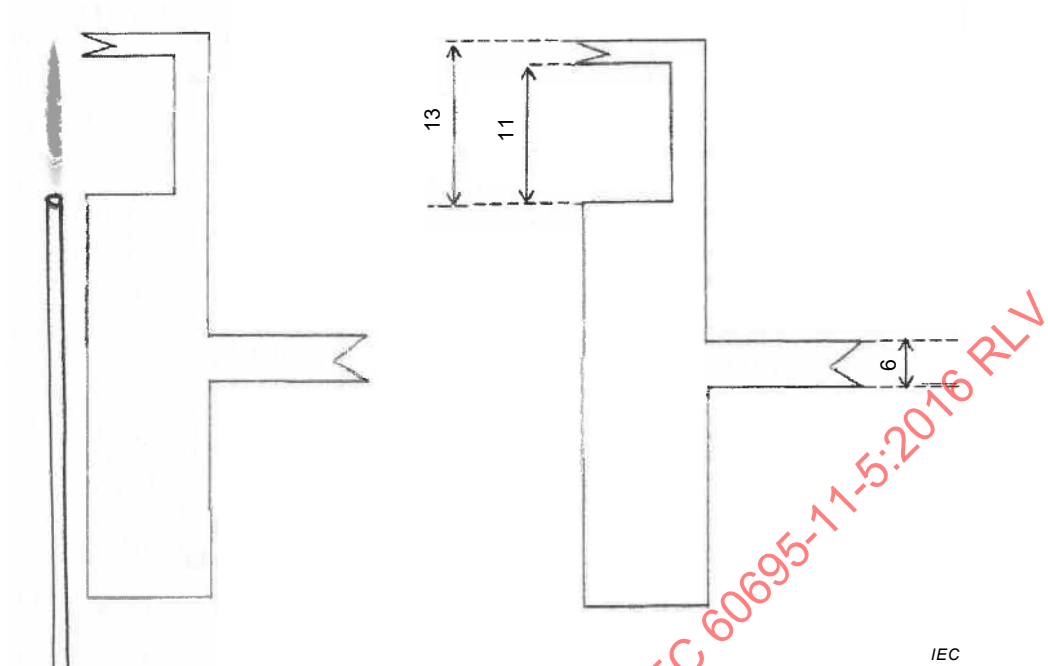


Figure A.3 – Gauge to measure flame height and the distance between burner and copper block (example)

Annex B
(informative)

Access to equipment manufacturers and suppliers

An up-to-date list of equipment manufacturers and suppliers is maintained by the Secretary of IEC technical committee 89. The address details can be found on the IEC website: <http://www.iec.ch>

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Annex B (informative)

Example of a product committee specification

The IEC references the IEC 60695-11-5 Needle-flame test method in 4.38, *Passive flammability*, of IEC 60384-1:2015, *Fixed capacitors for use in electronic equipment – Part 1: General specification* [3]. The test procedure specifies in Table 7 of IEC 60384-1:2015 that the test flame exposure time and the maximum burning time are dependent upon both the volume of the part under test and the specified category of the capacitor. For example, a capacitor with an assigned category of passive flammability of code C and a volume greater than 1 750 mm³ would be subjected to a 30 s flame application time and should not burn for more than 30 s after the test flame has been removed.

The criteria in Table 7 of IEC 60384-1:2015 are as follows (Table B.1):

Table B.1 – Severities and requirements

Category of flammability	Severities Flame exposure time, in seconds, for capacitor volume ranges				Maximum burning time
	Volume ≤ 250 mm ³	250 mm ³ < Volume ≤ 500 mm ³	500 mm ³ < Volume ≤ 1 750 mm ³	Volume > 1 750 mm ³	
A	15	30	60	120	3
B	10	20	30	60	10
C	5	10	20	30	30

Annex C (informative)

Comparison of results of confirmatory tests using propane and butane as fuel

This Annex shows the results of the comparison of confirmatory tests using propane and butane as the fuel for producing the test flame.

The results (Table C.1) show that either fuel, propane or butane, is suitable to produce a test flame that complies with Annex A of this standard.

Table C.1 – Results of the confirmatory test using propane and butane as fuel

Fuel		Propane C_3H_8	Butane C_4H_{10}
Date conducted		January 16, 2014	February 27, 2014
Flame height [mm]		12	12
Results Time for increasing the copper block temperature from 100 °C to 700 °C [s]	1 st test	22,3	23,1
	2 nd test	22,4	23,9
	3 rd test	23,2	22,6
	4 th test	23,2	22,8
	5 th test	22,8	23,1

NOTE According to Annex A, the flame is confirmed if the result is within the range $23,5 \text{ s} \pm 1,0 \text{ s}$.

Bibliography

- [1] ISO 9626:~~1994~~ 2016, *Stainless steel needle tubing for the manufacture of medical devices – Requirements and test methods*
- [2] IEC TS 60695-11-40:~~2002~~, *Fire hazard testing – Part 11-40: Test flames – Confirmatory tests – Guidance*
- [3] IEC 60384-1:2016, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*

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Fire hazard testing –

Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance

Essais relatifs aux risques du feu –

**Partie 11-5: Flammes d'essai – Méthode d'essai au brûleur-aiguille –
Appareillage, dispositif d'essai de vérification et lignes directrices**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Purpose of the test	10
5 Description of the test apparatus	10
5.1 Burner.....	10
5.2 Gas supply.....	10
5.3 Flame	10
5.4 Control valve.....	10
5.5 Laboratory fumehood/chamber.....	10
5.6 Layer	11
5.6.1 Specified layer.....	11
5.6.2 Standardized layer.....	11
5.7 Timing device	11
6 Test specimen.....	11
7 Flame application times	11
8 Conditioning and test conditions	12
8.1 Conditioning.....	12
8.2 Test conditions	12
9 Test procedure	12
9.1 General.....	12
9.2 Position of test specimen	12
9.3 Application of needle-flame.....	12
9.4 Number of test specimens.....	13
10 Observations and measurements.....	13
11 Evaluation of test results	13
12 Information to be given in the relevant specification.....	13
13 Test report.....	14
Annex A (normative) Confirmatory test arrangement.....	16
A.1 Confirmation of the test flame – Principle	16
A.2 Test apparatus.....	16
A.2.1 Burner	16
A.2.2 Control valve	16
A.2.3 Copper block	16
A.2.4 Thermocouple.....	16
A.2.5 Temperature/time indicating/recording devices	16
A.3 Procedure	16
Annex B (informative) Example of a product committee specification	21
Annex C (informative) Comparison of results of confirmatory tests using propane and butane as fuel.....	22
Bibliography.....	23

Figure 1 – Burner and flame	14
Figure 2 – Test positions.....	15
Figure A.1 – Copper block	18
Figure A.2 – Confirmatory test arrangement.....	19
Figure A.3 – Gauge to measure flame height and the distance between burner and copper block (example).....	20
Table B.1 – Severities and requirements.....	21
Table C.1 – Results of the confirmatory test using propane and butane as fuel	22

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

**Part 11-5: Test flames – Needle-flame test method –
Apparatus, confirmatory test arrangement and guidance**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60695-11-5 has been prepared by IEC technical committee 89: Fire hazard testing.

This second edition cancels and replaces the first edition published in 2004. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The scope has been broadened to allow this test method to also simulate the effects of small flames from outside the equipment;
- b) Propane and butane gas are the specified fuel source with a minimum purity of 95 %;
- c) A new concept has been added which allows the burner to be moved during the test to avoid dripping material from falling onto the tip of the burner tube;
- d) The burner tube material is now a referenced source;

- e) The reference for the copper block material has changed – the ISO publication (ISO 1337) has been withdrawn with no replacement. A new callout is now used;
- f) Informative Annex C and a bibliography have been added.

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

FDIS	Report on voting
89/1346/FDIS	89/1351/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.

It has the status of a basic safety publication in accordance with IEC Guide 104 and ISO/IEC Guide 51.

A list of all the parts in the IEC 60695 series, under the general title *Fire hazard testing*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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.

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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 might be exposed to excessive thermal stress due to electric effects. This can result in deterioration that might impair the safety of the equipment. Such parts should not be unduly affected by heat or 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.

This part of IEC 60695 is intended to be used to measure and describe the properties of materials, products or assemblies in response to heat and flame under controlled laboratory conditions and is not intended to be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. This standard may involve hazardous materials, operations and equipment.

It does not purport to address all of the safety problems associated with its use.

It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

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FIRE HAZARD TESTING –

Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance

1 Scope

This part of IEC 60695 specifies a needle-flame test to simulate the effect of a small flame which may result from fault conditions, in order to assess the fire hazard by a simulation technique. The results of this test may be used as elements of a fire hazard assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.

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

This basic safety publication is intended for use by technical committees in the preparation of standards in accordance with the principles laid down in IEC Guide 104 and ISO/IEC Guide 51.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications. The requirements, test methods or test conditions of this basic safety publication will not apply unless specifically referred to or included in the relevant publications.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60695-4:2012, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

ISO 291, *Plastics – Standard atmospheres for conditioning and testing*

ISO 4046-4:2016, *Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

ISO 13943:2008, *Fire safety – Vocabulary*

ASTM-B187, *Standard specification for copper, bus bar, rod, and shapes and general purpose rod, bar, and shapes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2008, IEC 60695-4:2012 and ISO 4046:2002, as well as the following, apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

combustible, adj.

capable of being ignited and burned

[SOURCE: ISO 13943:2008, 4.43]

3.2

draught-free environment

space in which the results of experiments are not significantly affected by the local air speed

Note 1 to entry: A qualitative example is a space in which a wax candle flame remains essentially undisturbed. Quantitative examples are small-scale fire tests in which a maximum air speed of $0,1 \text{ m} \times \text{s}^{-1}$ or $0,2 \text{ m} \times \text{s}^{-1}$ is sometimes specified.

[SOURCE: ISO 13943:2008, 4.70]

3.3

fire

⟨general⟩ process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, glowing or a combination thereof

Note 1 to entry: In the English language the term “fire” is used to designate three concepts, two of which, **fire** (3.4) and **fire** (3.5), relate to specific types of self-supporting combustion with different meanings and two of them are designated using two different terms in both French and German.

[SOURCE: ISO 13943:2008, 4.96]

3.4

fire

⟨controlled⟩ self-supporting combustion that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[SOURCE: ISO 13943:2008, 4.97]

3.5

fire

⟨uncontrolled⟩ self-supporting combustion that has not been deliberately arranged to provide useful effects and is not limited in its extent in time and space

[SOURCE: ISO 13943:2008, 4.98]

3.6

fire hazard

physical object or condition with a potential for an undesirable consequence from fire (3.1)

[SOURCE: ISO 13943:2008, 4.112]

3.7**fire risk**

probability of a fire (3.3) combined with a quantified measure of its consequence

Note 1 to entry: It is often calculated as the product of probability and consequence.

[SOURCE: ISO 13943:2008, 4.124]

3.8**flame, noun**

rapid, self-sustaining, sub-sonic propagation of combustion in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2008, 4.133]

3.9**glowing, noun**

luminosity caused by heat

cf. incandescence

[SOURCE: ISO 13943:2008, 4.168]

3.10**glowing combustion**

combustion of a material in the solid phase without flame but with emission of light from the combustion zone

cf. incandescence

[SOURCE: ISO 13943:2008, 4.169]

3.11**ignition**

sustained ignition (deprecated)
(general) initiation of combustion

[SOURCE: ISO 13943:2008, 4.187]

3.12**ignition**

sustained ignition (deprecated)
(flaming combustion) initiation of sustained flame

[SOURCE: ISO 13943:2008, 4.188]

3.13**wrapping tissue**

soft and strong, lightweight wrapping paper of grammage generally between 12 g/m² and 30 g/m², primarily intended for protective packaging of delicate articles and for gift wrapping

Note 1 to entry: In French, the word “mousseline” includes both white tissue and “bulle corde”, which is unbleached or coloured tissue.

[SOURCE: ISO 4046-4:2016, 4.215]

4 Purpose of the test

The test is performed to determine that, under defined conditions, the test flame either does not cause ignition of parts or if it does, combustible parts ignited by the test flame have a limited duration of burning or a limited extent of burning, without spreading fire by flames or burning or glowing particles falling from the test specimen.

The test flame, applied to the test specimen, imitates a flame that might arise from a component that is close to the test specimen in the real application. Such a flame might have occurred, for example, because of an electrical fault.

The relevant product specification shall specify, if applicable, the duration of the test flame application and the acceptance criteria.

5 Description of the test apparatus

5.1 Burner

The burner to produce the test flame shall consist of a tube at least 35 mm long with a bore of $0,5 \text{ mm} \pm 0,1 \text{ mm}$ and an outer diameter not exceeding 0,9 mm.

NOTE The tubing specified in ISO 9626:2016 [1]¹ (0,8 mm normal walled or thin walled) meets these requirements.

5.2 Gas supply

The burner is supplied with either propane or butane gas having a purity not less than 95 %.

5.3 Flame

With the axis of the burner in the vertical position, ignite the gas supply and adjust the gas flow rate to ensure that the overall height of the flame is $12 \text{ mm} \pm 1 \text{ mm}$, when viewed in subdued light against a dark background (see Figure 1), and that the flame is symmetrical. Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium. There shall be no air admitted to the burner tube.

The flame shall be confirmed using the apparatus and procedure detailed in Annex A.

5.4 Control valve

A control valve is required to set the gas flow rate to ensure that the overall height of the flame is within the required tolerances.

5.5 Laboratory fumehood/chamber

The laboratory fumehood/chamber shall have an inside volume of at least $0,5 \text{ m}^3$. The chamber shall provide a draught-free environment, whilst allowing normal thermal circulation of air past the test specimen. The chamber shall permit observation of the test in progress. The inside surfaces of the walls shall be of a dark colour. In case of dispute, the recorded light level shall be less than 20 lx using a light meter, facing towards the rear of the chamber and positioned in place of the test specimen.

For safety and convenience, it is desirable that this fumehood/chamber (which can be completely closed) be fitted with an extraction device, such as an exhaust fan, to remove products of combustion, which may be toxic. The extraction device, if used, shall be turned off

¹ Numbers in square brackets refer to the bibliography.

during the test and turned on immediately after the timing measurements have been made. A positive closing damper may be needed.

NOTE Placing a mirror in the chamber, to provide a rear view of the test specimen, has been found to be useful.

5.6 Layer

5.6.1 Specified layer

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

5.6.2 Standardized layer

If the test specimen is a sub-assembly or a component of the equipment and is tested separately, such that surrounding materials and distances are unknown, a piece of flat smooth wooden board, approximately 10 mm thick covered in close contact with a single layer of wrapping tissue (3.13), shall be positioned at a distance of $200 \text{ mm} \pm 5 \text{ mm}$ below the place where the needle-flame is applied to the test specimen. If the test specimen is a complete free-standing equipment, it shall be placed in its normal position of use on the tissue covered wooden board, extending for a minimum of 100 mm outside the base of the equipment in all directions.

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

5.7 Timing device

The timing device shall have a resolution of not more than 0,5 s.

6 Test specimen

If possible, the test specimen shall 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 shall be taken to ensure that the test conditions are not significantly different from those occurring in normal use with regard to shape, ventilation conditions, effect of thermal stresses and possible flames occurring, or burning or glowing particles falling in the vicinity of the test specimen.

If the test specimen is a suitable part cut from a larger unit, care shall 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 conduct the test on a sub-assembly or component within the equipment, the test is conducted on a test specimen removed from the equipment.

7 Flame application times

Preferred values of the duration of application (t_a) of the test flame are as follows:

5 s, 10 s, 15 s, 20 s, 30 s, 60 s, 120 s.

The tolerance for all values is ${}^0_{-1}$ s.

The duration of application of the test flame should be chosen in relation to the characteristics of the end product.

NOTE See Annex C for an example of a classification system for the needle-flame test.

8 Conditioning and test conditions

8.1 Conditioning

If not otherwise specified in the relevant specification, the test specimen and the tissue-covered wooden board shall be conditioned for not less than 24 h in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 % before starting the test. Once removed from the conditioning atmosphere, the test specimens shall be tested within 1 h (see ISO 291).

8.2 Test conditions

Unless otherwise specified, all test specimens shall be tested under standard atmospheric conditions for testing as follows:

- temperature: 15 °C to 35 °C; and
- relative humidity: ≤ 75 %.

9 Test procedure

9.1 General

Warning

Precautions shall 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; and
- toxic residues.

9.2 Position of test specimen

Unless otherwise specified in the relevant specification, the test specimen shall be arranged in a position of normal use such that ignition is most likely to occur during the test. The means to fix the test 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.

9.3 Application of needle-flame

The test flame shall be applied to that part of the surface of the test specimen which is most likely to be affected by flames resulting from normal use or from fault conditions. Examples of flame test positions are shown in Figures 2a and 2b.

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

With the central axis of the burner tube vertical, place the burner remote from the test specimen, set the burner (see 5.1) to produce a standardized 12 mm nominal test flame, conforming to 5.3. Wait for a minimum of 5 min to allow the burner conditions to reach equilibrium. Rotate the burner so that the burner tube is positioned at an angle of $45 \pm 5^\circ$ from the vertical (see Figure 1) throughout the duration of the test.

The test flame shall be positioned so that the tip of the flame is in contact with the surface of the test specimen. If the test specimen is located vertically above the test flame, a spacing of

8 mm ± 1 mm shall be maintained between the center of the top of the burner and the remaining portion of the test specimen during the test, ignoring any strings of molten material. If the test specimen is located horizontally from the test flame, a spacing of 5 mm ± 1 mm shall be maintained between the center of the top of the burner and the remaining portion of the test specimen during the test (see Figure 1).

The test flame is removed after the specified flame application time (t_a) (see Clause 7).

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

9.4 Number of test specimens

Unless otherwise specified in the relevant specification, the test is performed on three test specimens.

10 Observations and measurements

In the case of ignition of the test specimen and/or the specified layer and/or the surrounding parts, the duration of burning (t_b) is measured and reported. Ignition of the specified layer shall be observed and noted. The duration of burning denotes the time interval from the moment the test flame is removed from the test specimen, until the last flames have extinguished and the glowing combustion of the test specimen, the specified layer and/or the surrounding parts is no longer visible.

11 Evaluation of test results

The test specimen is considered to have satisfactorily withstood the needle-flame test if one of the following criteria applies:

- a) There is no ignition of the specified layer and, after the removal of the needle-flame, there is no flame and no glowing of the test specimen.
- b) Flames or glowing of the test specimen and the surrounding parts extinguish within 30 s after the removal of the needle-flame, that is $t_b < 30$ s. Also, the surrounding parts have not burnt away completely and there has been no ignition of the specified layer.

12 Information to be given in the relevant specification

The relevant specification shall indicate the following details:

- a) any conditioning, if different from that specified in Clause 8;
- b) the number of test specimens, if different from that specified in 9.4;
- c) the position of the test specimen (see 9.2);
- d) the surface to be tested and the point of application (see 9.3);
- e) the specified layer to be used to evaluate the effect of burning or glowing particles falling from the test specimen (see 5.6);
- f) the duration of application of the test flame (t_a) (see Clause 7);
- g) the permissible duration and extent of burning, considering the design and arrangements of the various parts, shields and barriers inside the equipment;
- h) whether the criteria specified are sufficient to check compliance with the safety requirements, or whether further criteria should be introduced;
- i) any requirements if different from those given in Clauses 10 and 11.

13 Test report

The test report shall include the following information:

- a) the type and description of the test specimen (see Clause 6);
- b) the method of preparation (see Clause 6);
- c) any conditioning of the test specimens (see Clause 8);
- d) the number of test specimens (see 9.4);
- e) the duration of application of the test flame (t_a) (see Clauses 7 and 12);
- f) the surface tested and the point of application of the needle-flame (see 9.3);
- g) the specified layer used to evaluate the effect of burning or glowing particles falling from the test specimen (see 5.6);
- h) whether the test flame has been applied at more than one point on the same test specimen, (see 9.3); and
- i) the test results (see Clauses 10 and 11).

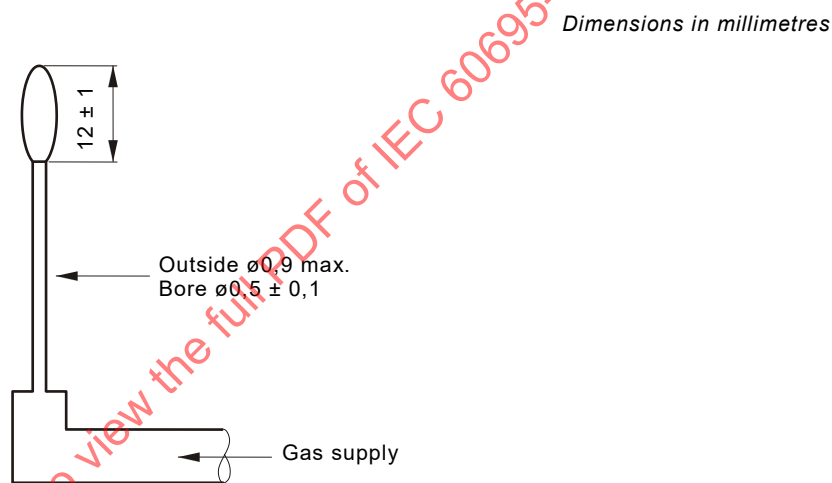


Figure 1 – Burner and flame

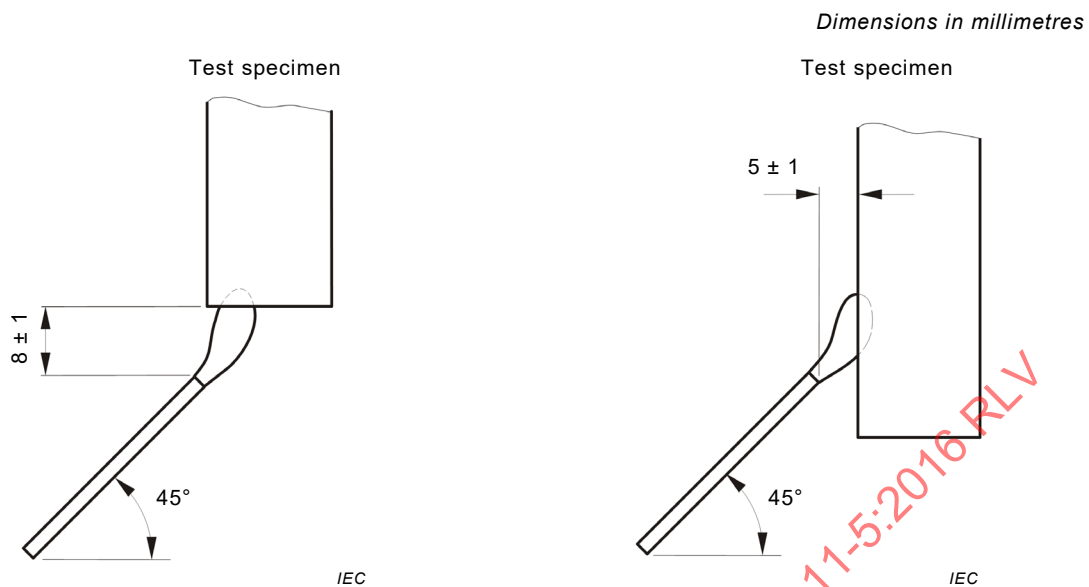


Figure 2a – Test position (horizontal example)

Figure 2b – Test position (vertical example)

Figure 2 – Test positions

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Annex A (normative)

Confirmatory test arrangement

A.1 Confirmation of the test flame – Principle

The time for the temperature of the copper block, described in Figure A.1, to increase from $100\text{ °C} \pm 5\text{ °C}$ to $700\text{ °C} \pm 3\text{ °C}$ shall be $23,5\text{ s} \pm 1,0\text{ s}$, when the flame confirmatory test arrangement of Figure A.2 is used.

The flame shall be confirmed in accordance with this Annex A every time the gas supply is changed or replaced.

NOTE Detailed background information for the confirmation of a test flame can be found in IEC 60695-11-40 [2].

A.2 Test apparatus

A.2.1 Burner

The burner shall be in accordance with 5.1.

A.2.2 Control valve

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

A.2.3 Copper block

The copper block material shall be specified as: Cu-ETP UNS C11000 (see ASTM-B187). The diameter of the copper block shall be $4\text{ mm} \pm 0,01\text{ mm}$ with a mass of $0,58\text{ g} \pm 0,01\text{ g}$ in the fully machined and polished but undrilled state, see Figure A.1.

A.2.4 Thermocouple

The thermocouple shall be a sheathed fine wire type K (NiCr/NiAl) with an outer sheath diameter of 0,5 mm.

The preferred method of fastening the thermocouple to the copper block is by compressing the copper around the thermocouple, after first ensuring that the thermocouple is inserted to the full depth of the hole as shown in Figure A.2.

A.2.5 Temperature/time indicating/recording devices

These devices shall be appropriate for the measurement of the time for the copper block to heat up from $100\text{ °C} \pm 5\text{ °C}$ to $700\text{ °C} \pm 3\text{ °C}$. The timing device shall have a tolerance of not more than 0,5 s.

A.3 Procedure

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

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

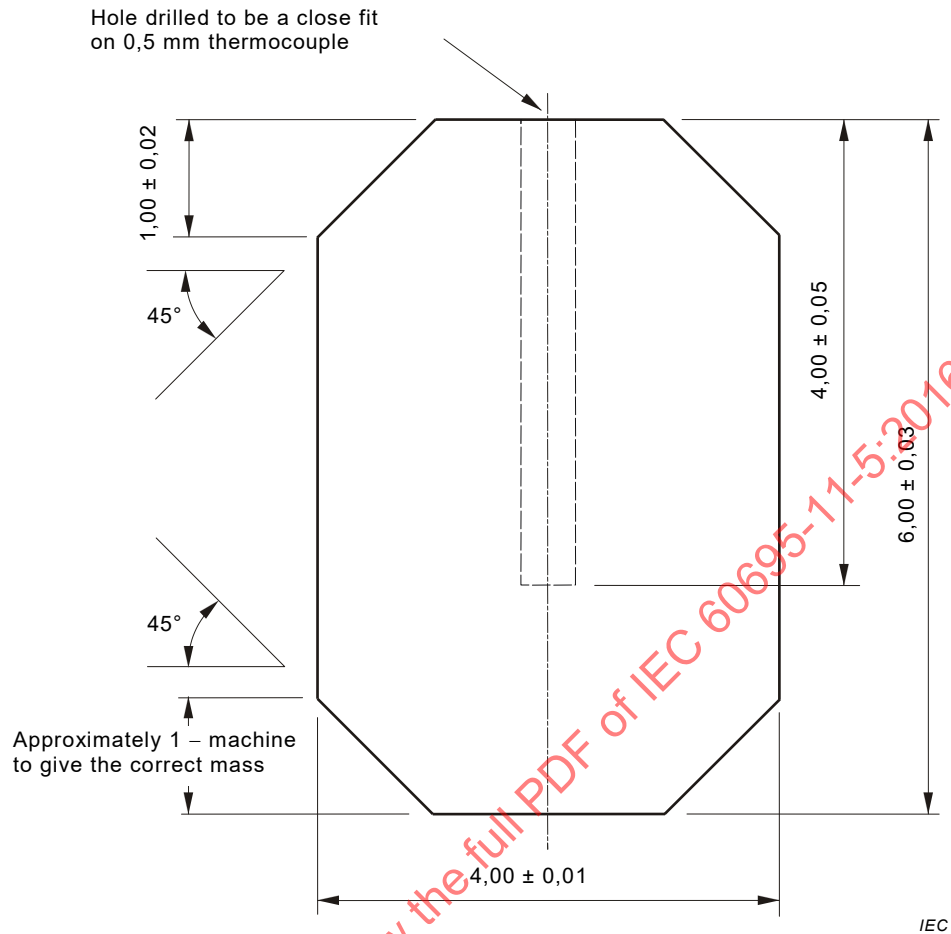
- Temporarily remove the burner away from the copper block to ensure no influence of the flame on the copper block during the preliminary adjustment of the gas flow rate.
- With the axis of the burner in the vertical position, ignite the gas supply and adjust the gas flow rate to ensure that the overall height of the flame is $12 \text{ mm} \pm 1 \text{ mm}$, when viewed in subdued light against a dark background, and that the flame is symmetrical.
- Wait for a period of at least 5 min to allow the burner conditions to reach equilibrium and measure the flame height to determine that ensure that the height is within the required limits.
- With the temperature/time indicating/recording devices operational, reposition the burner under the copper block.
- Conduct three determinations of the time for the temperature of the copper block to increase from $100 \text{ }^{\circ}\text{C} \pm 5 \text{ }^{\circ}\text{C}$ to $700 \text{ }^{\circ}\text{C} \pm 3 \text{ }^{\circ}\text{C}$. Allow the copper block to cool naturally in air to below $50 \text{ }^{\circ}\text{C}$ between determinations.

NOTE At temperatures above $700 \text{ }^{\circ}\text{C}$, the thermocouple can be easily damaged, therefore it is advisable to remove the burner immediately after reaching $700 \text{ }^{\circ}\text{C}$.

- If the copper block has not been used before, conduct a preliminary run to condition the copper block surface. Discard the result.
- Calculate the mean time in seconds as the result.
- The flame is confirmed if the result is within the range $23,5 \text{ s} \pm 1,0 \text{ s}$.

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Dimensions in millimetres



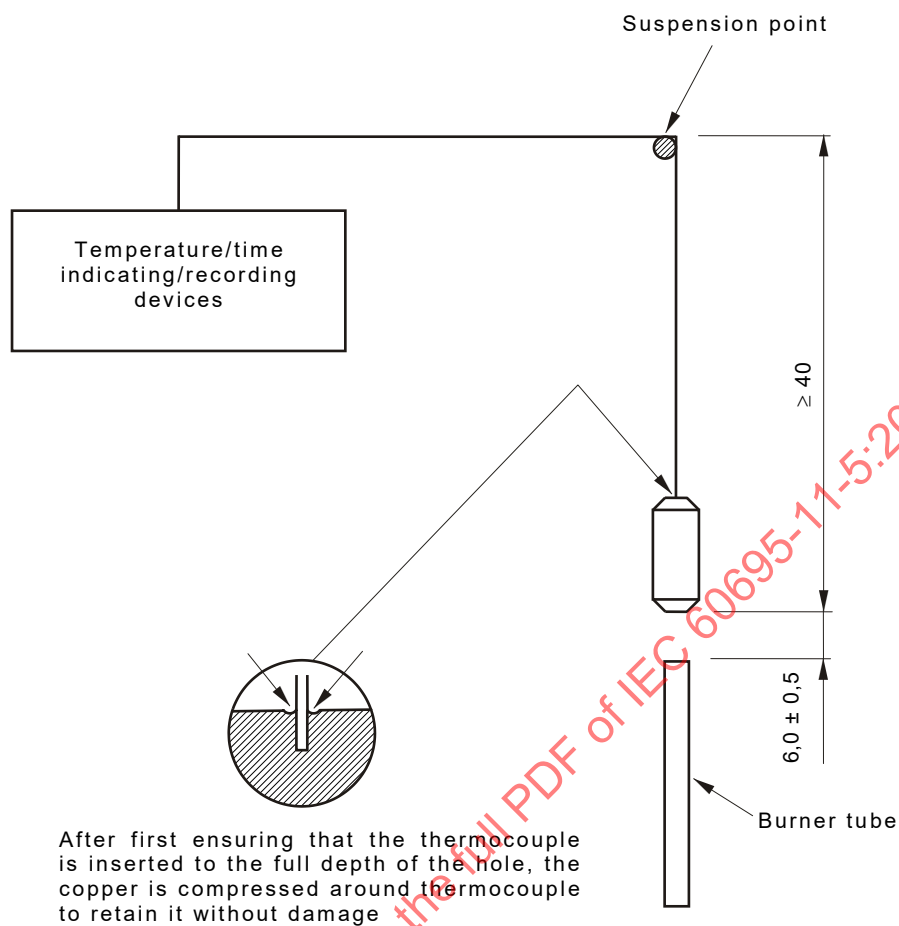
Copper block polished all over

Tolerance: $\pm 0,1$, ± 30 min (angular), unless otherwise stated

Material: high conductive electrolytic copper Cu-ETP UNS C 11000 (see ASTM-B187)

Mass: 0,58 g $\pm$ 0,01 g before drilling

Figure A.1 – Copper block

Dimensions in millimetres

IEC

The mode of suspension of the copper block shall be such that the block remains essentially stationary during the test.

Figure A.2 – Confirmatory test arrangement

Dimensions in millimetres

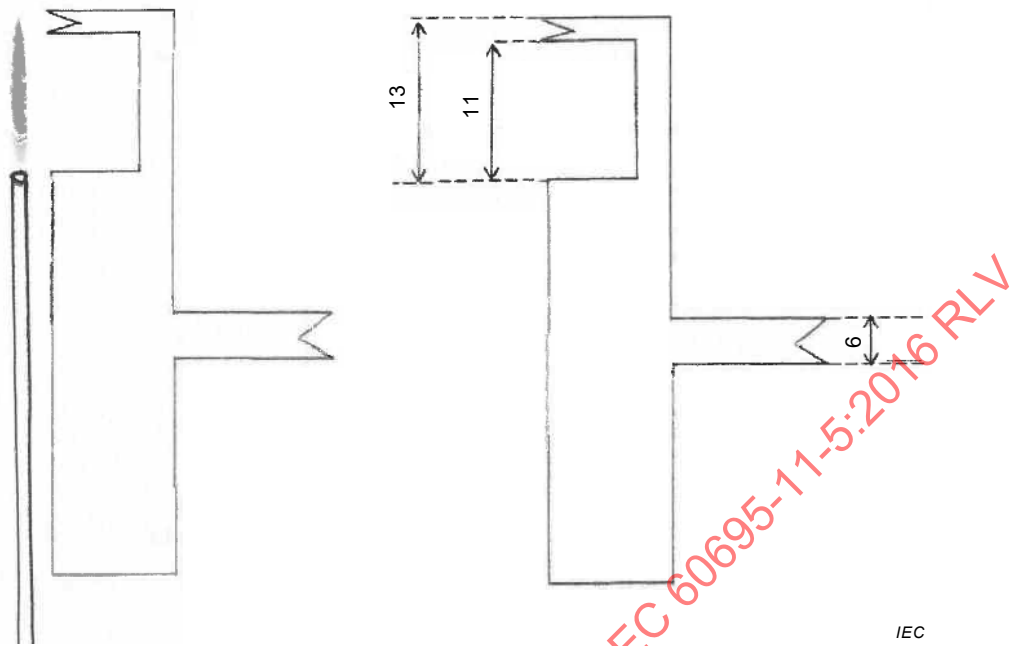


Figure A.3 – Gauge to measure flame height and the distance between burner and copper block (example)

Annex B (informative)

Example of a product committee specification

The IEC references the IEC 60695-11-5 Needle-flame test method in 4.38, *Passive flammability*, of IEC 60384-1:2015, *Fixed capacitors for use in electronic equipment – Part 1: General specification* [3]. The test procedure specifies in Table 7 of IEC 60384-1:2015 that the test flame exposure time and the maximum burning time are dependent upon both the volume of the part under test and the specified category of the capacitor. For example, a capacitor with an assigned category of passive flammability of code C and a volume greater than 1 750 mm³ would be subjected to a 30 s flame application time and should not burn for more than 30 s after the test flame has been removed.

The criteria in Table 7 of IEC 60384-1:2015 are as follows (Table B.1):

Table B.1 – Severities and requirements

Category of flammability	Severities Flame exposure time, in seconds, for capacitor volume ranges				Maximum burning time s
	Volume ≤ 250 mm ³	250 mm ³ < Volume ≤ 500 mm ³	500 mm ³ < Volume ≤ 1 750 mm ³	Volume > 1 750 mm ³	
A	15	30	60	120	3
B	10	20	30	60	10
C	5	10	20	30	30

Annex C (informative)

Comparison of results of confirmatory tests using propane and butane as fuel

This Annex shows the results of the comparison of confirmatory tests using propane and butane as the fuel for producing the test flame.

The results (Table C.1) show that either fuel, propane or butane, is suitable to produce a test flame that complies with Annex A of this standard.

Table C.1 – Results of the confirmatory test using propane and butane as fuel

Fuel		Propane C_3H_8	Butane C_4H_{10}
Date conducted		January 16, 2014	February 27, 2014
Flame height [mm]		12	12
Results Time for increasing the copper block temperature from 100 °C to 700 °C [s]	1 st test	22,3	23,1
	2 nd test	22,4	23,9
	3 rd test	23,2	22,6
	4 th test	23,2	22,8
	5 th test	22,8	23,1

NOTE According to Annex A, the flame is confirmed if the result is within the range $23,5 \text{ s} \pm 1,0 \text{ s}$.

Bibliography

- [1] ISO 9626:2016, *Stainless steel needle tubing for the manufacture of medical devices – Requirements and test methods*
 - [2] IEC TS 60695-11-40, *Fire hazard testing – Part 11-40: Test flames – Confirmatory tests – Guidance*
 - [3] IEC 60384-1:2016, *Fixed capacitors for use in electronic equipment – Part 1: Generic specification*
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SOMMAIRE

AVANT-PROPOS	26
INTRODUCTION	28
1 Domaine d'application	29
2 Références normatives	29
3 Termes et définitions	30
4 Objectif de l'essai	32
5 Description de l'appareillage d'essai	32
5.1 Brûleur	32
5.2 Alimentation en gaz	32
5.3 Flamme	32
5.4 Vanne de commande	32
5.5 Hotte de laboratoire/enceinte	32
5.6 Couche	33
5.6.1 Couche spécifiée	33
5.6.2 Couche normalisée	33
5.7 Dispositif de chronométrage	33
6 Eprouvette	33
7 Durées d'application de la flamme	34
8 Conditionnement et conditions d'essai	34
8.1 Conditionnement	34
8.2 Conditions d'essai	34
9 Mode opératoire	34
9.1 Généralités	34
9.2 Position de l'éprouvette	34
9.3 Application du brûleur-aiguille	35
9.4 Nombre d'éprouvettes	35
10 Observations et mesures	35
11 Evaluation des résultats d'essai	35
12 Renseignements devant figurer dans la spécification particulière	36
13 Rapport d'essai	36
Annexe A (normative) Dispositif d'essai de vérification	38
A.1 Vérification de la flamme d'essai – Principe	38
A.2 Appareillage d'essai	38
A.2.1 Brûleur	38
A.2.2 Vanne de commande	38
A.2.3 Bloc de cuivre	38
A.2.4 Thermocouple	38
A.2.5 Dispositifs d'indication et d'enregistrement de la température et du temps	38
A.3 Mode opératoire	38
Annexe B (informative) Exemple de spécification de comité de produit	43
Annexe C (informative) Comparaison des résultats des essais de vérification effectués à l'aide du propane et du butane comme combustibles	44
Bibliographie	45

Figure 1 – Brûleur et flamme.....	36
Figure 2 – Positions d'essai	37
Figure A.1 – Bloc de cuivre	40
Figure A.2 – Disposition de l'essai de vérification	41
Figure A.3 – Calibre de mesure de la hauteur de la flamme et de la distance entre le brûleur et le bloc de cuivre (exemple)	42
Tableau B.1 – Sévérités et exigences	43
Tableau C.1 – Résultats des essais de vérification effectués à l'aide de propane et de butane comme combustibles	44

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

ESSAIS RELATIFS AUX RISQUES DU FEU –

**Partie 11-5: Flamme d'essai – Méthode d'essai au brûleur-aiguille –
Appareillage, dispositif d'essai de vérification et lignes directrices**

AVANT-PROPOS

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La Norme internationale IEC 60695-11-5 a été établie par le comité d'études 89 de l'IEC: Essais relatifs aux risques du feu.

Cette deuxième édition annule et remplace la première édition parue en 2004. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) Le domaine d'application de la présente méthode d'essai a été élargi pour simuler les effets des petites flammes d'origine externe à l'équipement.
- b) Le gaz propane et le gaz butane sont les sources de combustible spécifiées avec une pureté minimale de 95 %.

- c) Un nouveau concept a été ajouté qui permet le déplacement du brûleur au cours de l'essai pour éviter que du matériau qui s'écoule tombe sur l'extrémité du tube du brûleur.
- d) Le matériau du tube du brûleur est maintenant une source référencée.
- e) La référence pour le matériau du bloc de cuivre a changé – la publication ISO (ISO 1337) a été supprimée sans remplacement et une nouvelle désignation est désormais utilisée.
- f) L'Annexe informative C et une bibliographie ont été ajoutées.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
89/1346/FDIS	89/1351/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Elle a le statut d'une publication fondamentale de sécurité conformément au Guide IEC 104 et au Guide ISO/IEC 51.

Une liste de toutes les parties de la série IEC 60695, publiées sous le titre général *Essais relatifs aux risques du feu*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous «<http://webstore.iec.ch>» dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite;
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- amendée.

INTRODUCTION

La meilleure méthode pour soumettre des produits électrotechniques aux essais au feu et en évaluer les dangers consiste à reproduire exactement les conditions qui apparaissent dans la pratique. Dans la plupart des cas, cela n'est pas possible. En conséquence, pour des raisons pratiques, les essais des produits électrotechniques, en ce qui concerne les dangers du feu, sont réalisés au mieux en simulant d'aussi près que possible les effets qui se produisent réellement dans la pratique.

Les parties d'un matériel électrotechnique peuvent être exposées à une contrainte thermique excessive due à des effets électriques, ce qui peut engendrer une détérioration susceptible de nuire à la sécurité du matériel. Il convient que ces parties ne soient pas affectées d'une manière anormale par la chaleur ou par le feu engendré(e) à l'intérieur du matériel.

Des parties de matériau isolant ou autre matériau combustible susceptibles de propager des flammes à l'intérieur du matériel peuvent être enflammées par des flammes produites par un composant défaillant. Des flammes peuvent également se produire sous certaines conditions, par exemple: cheminement d'un courant de défaut, composants ou des parties de composant en surcharge et mauvais contacts; de telles flammes peuvent venir lécher des parties combustibles dans leur voisinage.

La présente partie de l'IEC 60695 est destinée à être utilisée pour mesurer et décrire les propriétés des matériaux, des produits ou des assemblages en réponse à la chaleur et aux flammes dans des conditions de laboratoire contrôlées. Elle n'est pas destinée à être utilisée pour décrire ou évaluer le danger d'incendie ou le risque d'incendie des matériaux, des produits ou des assemblages dans des conditions de feu réelles. Cette norme peut mettre en œuvre des matériaux, des opérations et des matériels dangereux.

Cette norme ne prétend pas couvrir tous les problèmes de sécurité liés à son utilisation.

Il est de la responsabilité de l'utilisateur de cette norme d'établir des pratiques d'hygiène et de sécurité appropriées et de déterminer l'applicabilité des limitations réglementaires avant utilisation.

ESSAIS RELATIFS AUX RISQUES DU FEU –

Partie 11-5: Flammes d'essai – Méthode d'essai au brûleur-aiguille – Appareillage, dispositif d'essai de vérification et lignes directrices

1 Domaine d'application

La présente partie de l'IEC 60695 spécifie un essai au brûleur-aiguille pour simuler l'effet d'une petite flamme qui peut provenir de conditions de défaut, afin d'évaluer le danger d'incendie par simulation. Les résultats de cet essai peuvent être utilisés comme éléments d'évaluation d'un danger d'incendie qui tient compte de tous les facteurs qui sont pertinents pour une évaluation de danger d'incendie dans une utilisation finale spécifique.

Elle est applicable aux matériels électrotechniques, à leurs sous-ensembles et à leurs composants ainsi qu'aux matériaux isolants électriques solides ou à d'autres matériaux combustibles.

La présente publication fondamentale de sécurité est destinée à être utilisée par les comités d'études dans le cadre de l'élaboration de normes conformément aux principes établis dans le Guide IEC 104 et le Guide ISO/IEC 51.

L'une des responsabilités d'un comité d'études consiste, le cas échéant, à utiliser les publications fondamentales de sécurité dans le cadre de l'élaboration de ses publications. Les exigences, les méthodes ou les conditions d'essai de la présente publication fondamentale de sécurité s'appliqueront seulement si elles servent spécifiquement de référence ou sont intégrées dans les publications correspondantes.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60695-4:2012, *Essais relatifs aux risques du feu – Partie 4: Terminologie relative aux essais au feu pour les produits électrotechniques*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications* (disponible en anglais seulement)

ISO/IEC Guide 51, *Aspects liés à la sécurité – Principes directeurs pour les inclure dans les normes*

ISO 291, *Plastiques – Atmosphères normales de conditionnement et d'essai*

ISO 4046-4:2016, *Papier, carton, pâtes et termes connexes – Vocabulaire – Partie 4: Catégories et produits transformés de papier et de carton*

ISO 13943:2008, *Sécurité au feu – Vocabulaire*

ASTM-B187, *Standard specification for copper, bus bar, rod, and shapes and general purpose rod, bar, and shapes*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'ISO 13943:2008, de l'IEC 60695-4:2012 et de l'ISO 4046:2002, ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

3.1

combustible, adj.

susceptible d'être allumé et de brûler

[SOURCE: ISO 13943:2008, 4.43]

3.2

environnement en air calme

environnement dans lequel les résultats des expériences ne sont pas affectés de manière significative par la vitesse locale de l'air

Note 1 à l'article: Un exemple qualitatif en est l'environnement dans lequel une flamme de bougie de cire demeure fondamentalement stable. Les exemples quantitatifs sont illustrés par des essais au feu à petite échelle dans lesquels une vitesse maximale de l'air de $0,1 \text{ m} \times \text{s}^{-1}$ ou $0,2 \text{ m} \times \text{s}^{-1}$ est parfois spécifiée.

[SOURCE: ISO 13943:2008, 4.70]

3.3

feu

(général) processus de combustion caractérisé par l'émission de chaleur et d'effluents du feu et accompagné généralement par de la fumée, des flammes, une incandescence, ou par une combinaison de ces éléments

Note 1 à l'article: En anglais, le terme "fire" est utilisé pour désigner trois concepts, dont deux, **fire** (3.4) et **fire** (3.5), se rapportent à des types spécifiques de combustion auto-entretenue ayant des significations diverses et deux d'entre eux sont désignés par deux termes différents, tant en français qu'en allemand.

[SOURCE: ISO 13943:2008, 4.96]

3.4

feu

(contrôlé) combustion auto-entretenue qui a été délibérément assurée pour produire des effets utiles et dont l'extension dans le temps et l'espace est contrôlée

[SOURCE: ISO 13943:2008, 4.97]

3.5

incendie

(non contrôlé) combustion auto-entretenue qui n'a pas été délibérément assurée pour produire des effets utiles et dont l'extension dans le temps et l'espace n'est pas contrôlée

[SOURCE: ISO 13943:2008, 4.98]

3.6

danger d'incendie

objet physique ou condition susceptible d'entraîner des conséquences non souhaitables causées par un incendie (3.1)

[SOURCE: ISO 13943:2008, 4.112]

3.7

risque d'incendie

combinaison entre la probabilité qu'un incendie (3.3) se produise et les conséquences particulières quantifiées qui en découlent

Note 1 à l'article: Il est souvent calculé comme le produit de la probabilité et des conséquences.

[SOURCE: ISO 13943:2008, 4.124]

3.8

flamme, nom

propagation subsonique, auto-entretenue et rapide de la combustion dans un milieu gazeux, généralement accompagnée d'une émission de lumière

[SOURCE: ISO 13943:2008, 4.133]

3.9

incandescent

émission de lumière produite par la chaleur

cf. incandescence

[SOURCE: ISO 13943:2008, 4.168]

3.10

combustion incandescente

combustion d'un matériau, en phase solide, sans flamme mais avec émission de lumière émanant de la zone de combustion

cf. incandescence

[SOURCE: ISO 13943:2008, 4.169]

3.11

allumage

allumage persistant (déconseillé)
(général) amorçage de la combustion

[SOURCE: ISO 13943:2008, 4.187]

3.12

allumage

allumage persistant (déconseillé)
(combustion avec flammes) déclenchement d'une flamme persistante

[SOURCE: ISO 13943:2008, 4.188]

3.13

papier mousseline

papier d'emballage mince, souple et résistant de grammage compris généralement entre 12 g/m² et 30 g/m², essentiellement destiné à l'emballage, à la protection ou à la présentation des objets fragiles et des cadeaux

Note 1 à l'article: Le terme français "mousseline" s'applique aux papiers blancs et aux papiers "bulle corde" (écrus ou colorés).

[SOURCE: ISO 4046-4:2016, 4.215]

4 Objectif de l'essai

L'essai est effectué pour vérifier si, dans des conditions définies, la flamme d'essai ne produit pas l'inflammation de parties ou, en cas d'inflammation, si les parties combustibles enflammées par la flamme d'essai ne brûlent que pendant une durée limitée ou sur une étendue limitée, sans propager le feu par des flammes ou des particules enflammées ou incandescentes tombant de l'éprouvette.

La flamme d'essai, appliquée à l'éprouvette, imite une flamme susceptible de provenir d'un composant proche de l'éprouvette dans l'application réelle. Une telle flamme aurait pu survenir, par exemple, en raison d'un défaut électrique.

La spécification de produit applicable doit prescrire, le cas échéant, la durée d'application de la flamme d'essai et les critères d'acceptation.

5 Description de l'appareillage d'essai

5.1 Brûleur

Le brûleur destiné à produire la flamme d'essai doit se composer d'un tube d'au moins 35 mm de longueur, d'un diamètre intérieur de $0,5 \text{ mm} \pm 0,1 \text{ mm}$ et d'un diamètre extérieur ne dépassant pas 0,9 mm.

NOTE Le tube spécifié dans l'ISO 9626:2016 [1]¹ (0,8 mm à paroi normale ou paroi mince) satisfait à ces exigences.

5.2 Alimentation en gaz

Le brûleur est alimenté avec du gaz propane ou du gaz butane ayant une pureté d'au moins 95 %.

5.3 Flamme

Avec l'axe du brûleur en position verticale, enflammer l'alimentation en gaz et régler le débit de gaz de façon que la hauteur totale de la flamme soit de $12 \text{ mm} \pm 1 \text{ mm}$, lorsqu'elle est observée en lumière tamisée sur fond noir (voir Figure 1), et que la flamme soit symétrique. Attendre 5 min au moins pour permettre au brûleur d'atteindre les conditions d'équilibre. Aucune admission d'air ne doit être constatée dans le tube du brûleur.

La flamme doit être vérifiée en utilisant l'appareillage et la méthode décrits à l'Annexe A.

5.4 Vanne de commande

Une vanne de commande est exigée pour régler le débit de gaz de façon que la hauteur totale de la flamme respecte les tolérances requises.

5.5 Hotte de laboratoire/enceinte

La hotte de laboratoire/l'enceinte doit avoir un volume intérieur d'au moins $0,5 \text{ m}^3$. L'enceinte doit assurer un environnement en air calme, tout en permettant une circulation thermique normale de l'air autour de l'éprouvette. L'enceinte doit permettre l'observation des essais en cours. Les surfaces intérieures des parois doivent être de couleur sombre. En cas de litige, le

¹ Les chiffres entre crochets se réfèrent à la bibliographie.

niveau lumineux enregistré doit être inférieur à 20 lx, lorsqu'il est mesuré à l'aide d'un luxmètre orienté vers l'arrière de l'enceinte et positionné à l'emplacement de l'éprouvette.

Pour des raisons de sécurité et de commodité, il est souhaitable que cette hotte de laboratoire/enceinte (qui peut être complètement close) soit pourvue d'un dispositif d'extraction, tel qu'un ventilateur, pour enlever les produits de combustion, qui peuvent être toxiques. Le dispositif d'extraction doit être arrêté pendant l'essai et remis en service immédiatement après les chronométrages. Un clapet antiretour peut être nécessaire.

NOTE Il a été jugé utile de placer un miroir dans l'enceinte pour avoir une vue arrière de l'éprouvette.

5.6 Couche

5.6.1 Couche spécifiée

Pour évaluer la possibilité de propagation du feu, par exemple par des particules enflammées ou incandescentes tombant de l'éprouvette, une couche du matériau ou des composants entourant normalement l'éprouvette ou situés sous elle, doit être disposée sous l'éprouvette à une distance égale à celle qui existe entre l'éprouvette et le matériau ou les composants voisins lorsque cette éprouvette est montée comme en usage normal.

5.6.2 Couche normalisée

Si l'éprouvette est un sous-ensemble ou un composant du matériel et si elle est soumise aux essais séparément, de façon que les matériaux environnants et les distances soient inconnus, un panneau en bois plat et lisse, de 10 mm d'épaisseur environ recouvert d'une couche unique plaquée de papier mousseline (3.13), doit être disposé à une distance de $200 \text{ mm} \pm 5 \text{ mm}$ sous l'emplacement où la flamme est appliquée à l'éprouvette. Si l'éprouvette est un matériel complet autoportant, elle doit être placée dans sa position normale d'utilisation sur un panneau en bois recouvert de papier mousseline dépassant d'au moins 100 mm la base du matériel dans toutes les directions.

Si l'éprouvette est un matériel mural complet, elle doit être fixée dans sa position normale d'utilisation à $200 \text{ mm} \pm 5 \text{ mm}$ au-dessus du panneau en bois recouvert de papier mousseline.

5.7 Dispositif de chronométrage

Le dispositif de chronométrage doit avoir une résolution n'excédant pas 0,5 s.

6 Epreuve

Si possible, l'éprouvette doit être un matériel, un sous-ensemble ou un composant complet. S'il est nécessaire d'enlever des parties d'une enveloppe ou de découper une partie appropriée pour exécuter l'essai, il faut veiller à ce que les conditions d'essai ne soient pas sensiblement différentes des conditions normales d'emploi en ce qui concerne la forme, la ventilation, l'effet des contraintes thermiques et des flammes éventuelles qui se produisent ou des particules enflammées ou incandescentes tombant dans le voisinage de l'éprouvette.

Si l'éprouvette est un morceau convenable découpé dans un élément de taille plus grande, il faut veiller, dans ce cas particulier, à ne pas appliquer la flamme d'essai d'une manière incorrecte, par exemple sur un bord produit lors du découpage.

S'il n'est pas possible d'effectuer l'essai sur un sous-ensemble ou un composant lorsqu'il est à l'intérieur du matériel, l'essai est effectué sur une éprouvette prélevée sur le matériel.