

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 60695-11-5:2016

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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

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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~~⁷ 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.

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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 104:1997, *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 $100 \text{ °C} \pm 5 \text{ °C}$ to $700 \text{ °C} \pm 3 \text{ °C}$ 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 ${}_{-1}^0$ 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.