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INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

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

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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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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;

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e) The reference for the copper block material has changed – the ISO publication (ISO 1337) has been withdrawn with no replacement.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*

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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 m × s^{-1} or 0,2 m × 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]

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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/m^2 and 30 g/m^2, 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]

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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 mm ± 0,1 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 mm ± 1 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 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.

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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 mm ± 5 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 mm ± 5 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.

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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 ± 5° 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

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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.

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