IEC TS 60695-11-11

Edition 2.0 2016-02

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing – Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source

Essais relatifs aux risques du feu – Partie 11-11: Flammes d'essai – Détermination du flux de chaleur caractéristique pour l'allumage à partir d'une flamme source sans contact

IEC TS 60695-11-11:2016-02(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIRE HAZARD TESTING –

Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 60695-11-11, which is a technical specification, has been prepared by IEC technical committee 89: Fire hazard testing.

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

This second edition of IEC TS 60695-11-11 cancels and replaces the first edition published in 2008. It constitutes a technical revision.

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

a) Fix of editiorials throughout the text;

b) Introduction updated;

c) Normative references updated;

d) Results of recent round-robin testing incorporated; and

e) Informative Annex C "Precision data" added.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
89/1227/DTS	89/1248/RVC

Full information on the voting for the approval of this technical specification 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.

This technical specification is to be used in conjunction with IEC 60695-11-4.

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.

Part 11 consists of the following parts:

Part 11-2: Test flames – 1 kW nominal pre-mixed flame – Apparatus, confirmatory test arrangement and guidance

Part 11-3: Test flames – 500 W flames – Apparatus and confirmational test methods

Part 11-4: Test flames – 50 W flame – Apparatus and confirmational test method

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

Part 11-10: Test flames – 50 W horizontal and vertical flame test methods

Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source

Part 11-20: Test flames – 500 W flame test methods

Part 11-21: Test flames – 500 W vertical flame test method for tubular polymeric materials

Part 11-30: Test flames – History and development from 1979 to 1999

Part 11-40: Test flames – Confirmatory tests – Guidance

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

- transformed into an International standard,
- 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

In the design of any electrotechnical product, the risk of fire and the potential hazards associated with fire need to be considered. In this respect the objective of component, circuit and equipment design as well as the choice of materials is to reduce the risk of fire to a tolerable level even in the event of reasonably foreseeable (mis)use, malfunction or failure. IEC 60695-1-10, together with its companion, IEC 60695-1-11, provide guidance on how this is to be accomplished.

Fires involving electrotechnical products can be initiated from external non-electrical sources. Considerations of this nature are dealt with in an overall fire hazard assessment.

The aim of the IEC 60695 series of standards is to save lives and property by reducing the number of fires or reducing the consequences of the fire. This can be accomplished by

- trying to prevent ignition caused by an electrically energised component part and, in the event of ignition, to confine any resulting fire within the bounds of the enclosure of the electrotechnical product.
- trying to minimise flame spread beyond the product's enclosure and to minimise the harmful effects of fire effluents including heat, smoke, and toxic or corrosive combustion products.

This technical specification is to be used to measure and describe the properties of materials used for electrotechnical products and sub-assemblies in response to heat from a non-contacting flame source under controlled laboratory conditions and is to not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test can 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. A test specimen cut from end-product or sub-assembly can be tested by this test method.

This technical specification 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 to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Test methods to determine flammability by contact of flame have been developed and standardized already, such as IEC 60695-11-10 [1][1] and IEC 60695-11-20 [2][1] and ISO 4589-2 [3][1].

This is the first test method to determine the characteristic heat flux for ignition (CHFI) of materials used for electrotechnical products and sub-assemblies from a non-contacting flame source. CHFI characterizes ignition behaviour in terms of incident heat flux. This test method simulates the fire behaviour of materials used for electrotechnical products where a flame source exists close to, but does not contact with these items. An example is a candle flame near an electrotechnical product.

1 Numbers in square brackets refer to the bibliography.

FIRE HAZARD TESTING –

Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source

1 Scope

This part of IEC 60695, which is a technical specification describes a test method used to determine the characteristic heat flux for ignition (CHFI) from a non-contacting flame source for materials used in electrotechnical products and sub-assemblies. It provides a relationship between ignition time and incident heat flux. A test specimen cut from an end-product or sub-assembly can be tested by this test method.

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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60695-11-4, *Fire hazard testing – Part 11-4: Test flames – 50 W flame – Apparatus and confirmational test method*

IEC Guide 104, *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 293, *Plastics – Compression moulding of test specimens of thermoplastic materials*

ISO 294 (all parts), *Plastics – Injection moulding of test specimens of thermoplastic materials*

ISO 295, *Plastics – Compression moulding of test specimens of thermosetting materials*

ISO 13943:2008, *Fire safety – Vocabulary*

ISO 14934-4:2014, *Fire tests – Calibration of heat flux meters – Part 4: Guidance on the use of heat flux meters in fire tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943:2008, some of which are reproduced below for the user's convenience, as well as the following apply.

3.1

average ignition time, $\bar{t}_{ig}$

arithmetic mean of three ignition times measured at a given heat flux

3.2
characteristic heat flux for ignition
CHFI
maximum incident heat flux which is a multiple of 5 kW/m^2 and at which $\bar{t}_{ig}$ is greater than 120 s

3.3
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 or 0,2 m/s is sometimes specified.

[SOURCE: ISO 13943:2008, 4.70]

3.4
heat flux
amount of thermal energy emitted, transmitted or received per unit area and per unit time

Note 1 to entry: The typical units are watts per square metre (W/m^2).

[SOURCE: ISO/IEC 13943:2008, 4.173]

3.5
ignition
initiation of combustion which results in a sustained flaming combustion for at least 5 s

Note 1 to entry: The term "ignition" in French has a very different meaning [state of body combustion].

3.6
incident heat flux
heat flux received by the surface of a test specimen

[SOURCE: IEC 60695-4:2012, 3.2.15]

4 Principle of the test

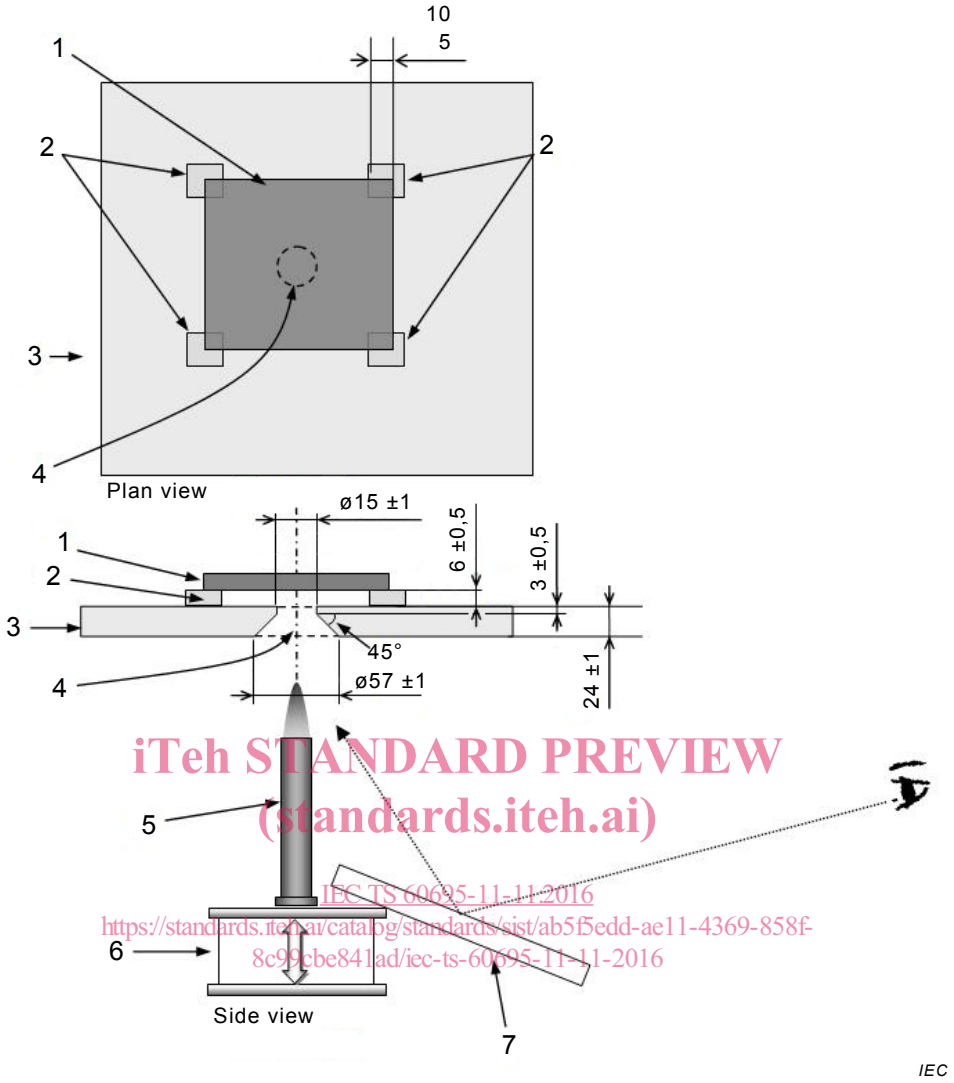
The incident heat flux is measured using the apparatus described in 5.3 and 5.4. The incident heat flux value is controlled by changing the distance between the top of the burner tube and the lower surface of the test specimen and by changing the flow rate of gas to the burner (See Annex A). The time required to ignite the test specimen is measured as a function of the incident heat flux. The tests are performed at different incident heat flux values until the maximum heat flux, at which $\bar{t}_{ig}$ is greater than 120 s and defined as the characteristic heat flux for ignition (CHFI), is obtained. The incident heat flux values at which the tests are carried out are chosen within the range of 30 kW/m^2 to 75 kW/m^2 and shall be a multiple of 5 kW/m^2.

5 Apparatus

5.1 Test arrangement

The arrangement and position of the test specimen and burner are shown in Figure 1. The test specimen and masking board shall be mounted horizontally. The burner tube shall be mounted vertically. The centre line of the test specimen, the burner tube, the sensor of the heat flux meter and the conical hole in the masking board shall all be aligned vertically. The sensor of the heat flux meter shall be placed horizontally 6 mm above the upper surface of the masking board with its sensing surface facing down.

Dimensions in milimetres



Key

1	Test specimen
2	Test specimen support
3	Masking board
4	Conical hole (diameter at the top side 15 mm)
5	Burner tube and test flame (inner diameter 9,5 mm)
6	Burner support (adjustable vertically)
7	Mirror

Figure 1 – Arrangement and position of test specimen and burner

5.2 Burner and test flame

The laboratory burner apparatus shall conform to IEC 60695-11-4. The flame size and the gas flow rate will differ from that specified in IEC 60695-11-4 in order to obtain the heat flux value necessary for the test. The flame used for each test shall be maintained throughout the test.

NOTE ISO 10093 [4] describes the burner as ignition source P/PF2 (50 W).

5.3 Heat flux meter

The heat flux meter shall be of a water-cooled thermopile type (see ISO 14934-4:2014) which determines the incident heat flux applied to the test specimen.

When incident heat flux measurements are made, the heat flux meter is placed in the centre of a dummy test specimen board, and the heat flux meter shall not have any optical filter in-line with the sensor.

NOTE 1 The incident heat flux measurement is of critical importance to the test results. ISO 14934-3 [5] provides the calibration method for the heat flux meter.

NOTE 2 A thermopile of the Schmidt-Boelter type, with a designed range up to 100 kW/m^2 and a target diameter of approximately 12,5 mm, has been found to be suitable.

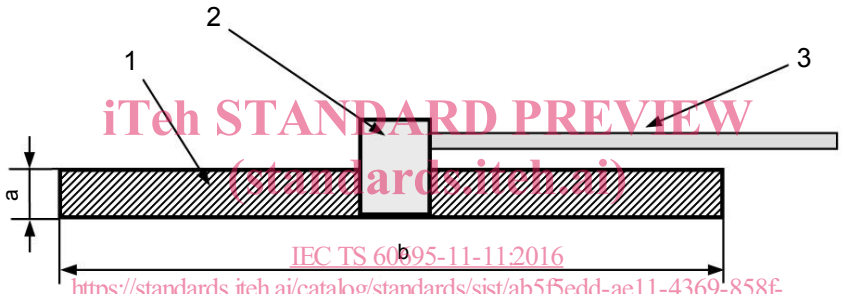
5.4 Data acquisition system

The voltmeter for measuring the output of the heat flux meter shall have a resolution of 0,01 % or better for the maximum output range.

5.5 Dummy test specimen board

The dummy test specimen board shall be approximately 75 mm × 75 mm × 12 mm with a centrally located hole whose diameter is slightly larger than the outside diameter of the heat flux meter. The board shall be made from a heat-resistant non-combustible rigid board. The dummy specimen board is used, together with the heat flux meter (see Figure 2), for the determination of incident heat flux (see 8.1).

NOTE A calcium silicate board of approximately 12 mm thickness having dry density of approximately 900 kg/m^3 has been found suitable for the dummy test specimen board.



Key

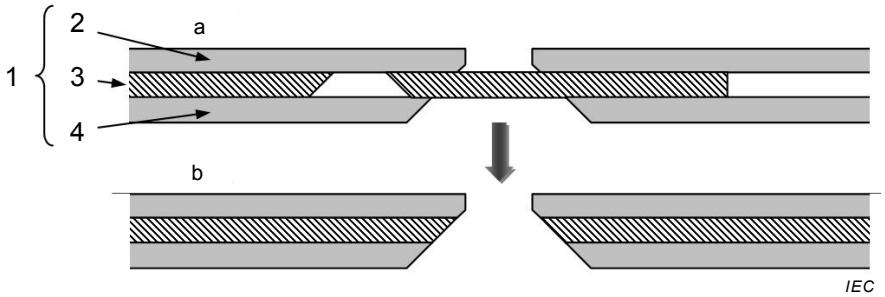
1	Dummy test specimen board
2	Heat flux meter
3	Cooling water pipe
a	Approximately 12 mm
b	Approximately 100 mm

Figure 2 – Dummy test specimen board

5.6 Masking board

The masking board shall be made of three heat-resistant non-combustible rigid boards, each having a density of 850 kg/m^3 ± 50 kg/m^3 and a thickness of 8 mm ± 0,5 mm and the total thickness of the three non-combustible board shall be 24 mm ± 1,5 mm. One board is inserted between the upper and lower boards and is made moveable. This moveable board is the radiant heat shield which protects the test specimen from the heat source before the test is started. At the centre of the masking board there shall be a conically shaped opening. The diameter of the opening on the upper surface shall be 15 mm ± 1 mm and 57 mm ± 1 mm on the lower surface. An illustration of the masking board and its operation is shown in Figure 3.

NOTE A calcium silicate board of the required density has a thermal conductivity of 0,14 W/m/K at 200 °C, 0,15 W/m/K at 400 °C, and 0,17 W/m/K at 600 °C.



Key

1	Masking board
2	Upper board
3	Moveable board (Radiant heat shield)
4	Lower board
a	Position of the moveable masking board prior to a test
b	Position of the moveable masking board during a test

Figure 3 – Structure of the masking board

5.7 Timing device

The timing device shall have a resolution of 0,5 s or better.

5.8 Conditioning

The conditioning chamber shall be maintained at a temperature of 23 °C ± 2 °C, with a relative humidity of 50 % ± 10 % (see ISO 291).

5.9 Test specimen support

The test specimen support shall maintain a distance of 6 mm ± 0,5 mm between the lower surface of the test specimen and the upper surface of the masking board.

5.10 Burner support

The burner shall be located on a support which can be adjusted in the vertical direction. The distance between the top of the burner tube and the lower surface of the test specimen shall be able to be determined using a suitable measuring device which has a resolution of 1 mm or better.

5.11 Observation mirror

To observe the ignition behaviour of the test specimen, an observation mirror approximately 100 mm × 100 mm shall be positioned underneath the masking board.

6 Test specimen

6.1 Specimen preparation

Test specimens shall be fabricated using the appropriate ISO method, e.g. casting and injection moulding in accordance with ISO 294, compression moulding in accordance with ISO 293 or ISO 295, or transfer moulding to the necessary shape. Where this is not possible, the test specimen shall be produced using the same fabrication process as would be normally used to mould a part of a product; and where this is not possible, specimens are to be cut from a representative sample of the moulded material taken from an end product.

After any cutting operation, care shall be taken to remove all dust and any particles from the surface; cut edges shall be fine sanded to a smooth finish.

6.2 Test specimen dimensions

The dimensions of the planar sections of the test specimens shall be at least 77,5 mm ± 2,5 mm in length and width and at the thickness under consideration. The

preferred thickness for the presentation of comparative data include 0,4 mm ± 0,05 mm, 0,75 mm ± 0,1 mm, 1,5 mm ± 0,1 mm, 3,0 mm ± 0,2 mm and 6,0 mm ± 0,4 mm.

6.3 Testing ranges in formulations

6.3.1 General

The results of tests carried out on test specimen sets of different colour, thickness, density, molecular mass, anisotropic type/direction, additives, fillers, and/or reinforcements can vary.

6.3.2 Density, melt flows and filler/reinforcement

Test specimens covering all combinations of minimum and maximum levels of density, melt flows and filler/reinforcement content may be provided and considered representative of the range if the test results yield the same CHFI. If the test results do not yield the same CHFI for all test specimens representing the range, evaluation shall be limited to the materials with the specific levels of density, melt flows and filler/reinforcement tested. In addition, test specimens with intermediate density, melt flows, and filler/reinforcement content shall be tested to determine the representative range for each CHFI determination. However, as an alternative, the least favorable performance of the specific levels of density, melt flows and filler/reinforcement tested may be considered representative of intermediate levels without additional testing.

6.3.3 Colour

When evaluating a range of colours, uncoloured test specimens and test specimens with the highest level of organic and inorganic pigment loading by weight are considered representative of the colour range if the test results yield the same CHFI. When certain pigments are known to affect flammability characteristics, the test specimens containing those pigments shall also be tested. Test specimens which shall be tested are those that

a) contain no colouring,

b) contain the highest level of organic pigments,

c) contain the highest level of inorganic pigments,

d) contain pigments which are known to adversely affect flammability characteristics.

6.4 Conditioning of test specimens

Unless otherwise specified in the relevant specification, the test specimen shall be conditioned for a minimum of 24 h at 23 °C ± 2 °C and a relative humidity of 50 % ± 10 %. Once removed from the conditioning chamber, the test specimens shall be tested within 1 h.

7 Testing conditions

All test specimens shall be tested in a laboratory atmosphere in a draught free environment at a temperature of between 15 °C and 35 °C and a relative humidity of 75 % or less.

8 Test procedure

8.1 Determination of incident heat flux calibration curve

The incident heat flux, which will be received by the surface of the test specimen, shall be determined in terms of the distance between the top of the burner and the lower surface of the test specimen and the gas flow rate to the burner. For this purpose, an incident heat flux calibration curve shall be determined by the following procedures.

a) Place the heat flux meter, which is located in the centre of a dummy test specimen board, in the test specimen position.

b) Place the burner (see 5.2) in position.

c) Place the radiation heat shield in position (see Figure 3, position a).

d) Ignite the gas and adjust the gas flow rate to an appropriate value.

NOTE For heat fluxes in the range 30 kW/m^2 to 60 kW/m^2, a gas flow of 105 cm^3/min has been found to be suitable. For heat fluxes in the range 55 kW/m^2 to 75 kW/m^2, a gas flow of 160 cm^3/min has been found to be suitable.