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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

**Fire hazard testing –
Part 6-31: Smoke obscuration – Small-scale static test – Materials**

**Essais relatifs aux risques du feu –
Partie 6-31: Opacité des fumées – Méthode statique à petite échelle – Matériaux**

IEC/TS 60695-6-31:2013

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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FOREWORD

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- 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 60695-6-31, which is a technical specification, has been prepared by IEC technical committee 89: Fire hazard testing.

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

Enquiry draft	Report on voting
89/1055/DTS	89/1093/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 second edition of IEC/TS 60695-6-31 cancels and replaces the first edition published in 1999. It constitutes a technical revision.

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

This technical specification is to be used in conjunction with IEC/TS 60695-6-30.

The main changes with respect to the previous edition are listed below:

– The Foreword has been revised and updated.
– The Introduction has been updated.
– The Scope has been updated.
– The Normative references have been updated.
– Minor technical changes have been made throughout the document.
– Detailed editorial updates have been added throughout the document.

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

Part 6 consists of the following parts:

Part 6-1: Smoke obscuration – General guidance
Part 6-2: Smoke obscuration – Summary and relevance of test methods
Part 6-30: Smoke obscuration – Small scale static method – Apparatus
Part 6-31: Smoke obscuration – Small-scale static test – Materials

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

INTRODUCTION

The risk of fire needs to be considered in any electrical circuit, and the objective of component, circuit and equipment design, and the choice of materials, is to reduce the likelihood of fire, even in the event of foreseeable abnormal use, malfunction or failure.

Electrotechnical products, primarily as victims of fire, may nevertheless contribute to the fire. One of the contributing hazards is the release of smoke, which may cause a reduction of visibility and/or orientation which could impede escape from the building, or could impede fire fighting.

Consequently, a reduction in the amount and the rate of generation of smoke produced by materials/products during a fire reduces damage to equipment, facilitates evacuation of people and facilitates the intervention of emergency services.

FIRE HAZARD TESTING –

Part 6-31: Smoke obscuration – Small-scale static test – Materials

1 Scope

This part of IEC 60695 describes the test methods for the determination of the specific optical density of smoke produced by materials used in electrotechnical products using the apparatus described in technical specification IEC/TS 60695-6-30. Test specimens are exposed vertically to a radiant heat source with or without the application of a pilot flame in a closed chamber (i.e. without air-change).

The test methods are only applicable to flat, solid, non-metallic test specimens of materials used in electrotechnical products.

This technical specification does not provide a classification system for the behaviour of materials.

The test methods are not applicable to materials which melt and flow away from the direct impingement of heat flux.

The test methods are not recommended for further development for electrotechnical products, nor are they recommended as the basis for regulation or other controls on smoke release due to the limitations of the physical fire model and the test specimen geometry – see Clause 4.

WARNING: Appropriate safety measures are to be taken as toxic and harmful fire effluents may be produced by pyrolysis or combustion of test specimens.

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 60695-6-1, *Fire hazard testing – Part 6-1: Smoke obscuration – General guidance*

IEC/TS 60695-6-30:2012, *Fire hazard testing – Part 6: Guidance and test methods on the assessment of obscuration hazards of vision caused by smoke opacity from electrotechnical products involved in fires – Section 30: Small scale static method. Determination of smoke opacity. Description of the apparatus*

IEC Guide 104:2010, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO 5659-2:2012, *Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1
fire effluent
totality of gases and aerosols, including suspended particles, created by combustion or pyrolysis in a fire

[SOURCE: ISO/IEC 13943, definition 4.105]

3.2
fire hazard assessment
evaluation of the possible causes of fire, the possibility and nature of subsequent fire growth, and the possible consequences of fire

3.3
fire-safety engineering
application of engineering methods based on scientific principles to the development or assessment of designs in the built environment through the analysis of specific fire scenarios or through the quantification of risk for a group of fire scenarios

[SOURCE: ISO/IEC 13943:2008, definition 4.126]

3.4
fire scenario
qualitative description of the course of a fire with respect to time, identifying key events that characterise the studied fire and differentiate it from other possible fires

Note 1 to entry: It typically defines the ignition and fire growth processes, the fully developed fire stage, the fire decay stage, and the environment and systems that impact on the course of the fire.

[SOURCE: ISO/IEC 13943:2008, definition 4.129]

3.5
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 ($W \times m^{-2}$).

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

3.6
obscuration of smoke
reduction in the intensity of light due to its passage through smoke

Note 1 to entry: In practice, obscuration of smoke is usually measured as the transmittance, which is normally expressed as a percentage.

Note 2 to entry: Obscuration of smoke causes a reduction in visibility.

[SOURCE: ISO/IEC 13943:2008, definition 4.242]

3.7
opacity of smoke
ratio of incident light intensity to transmitted light intensity through smoke, under specified conditions

Note 1 to entry: Opacity of smoke is the reciprocal of transmittance.

Note 2 to entry: The opacity of smoke is dimensionless.

[SOURCE: ISO/IEC 13943:2008, definition 4.243]

3.8
optical density of smoke
measure of the attenuation of a light beam passing through smoke expressed as the logarithm to the base 10 of the opacity of smoke

cf. **specific optical density**, D_s (3.13)

Note 1 to entry: The optical density of smoke is dimensionless.

[SOURCE: ISO/IEC 13943:2008, definition 4.244]

3.9
physical fire model
laboratory process, including the apparatus, the environment and the fire test procedure intended to represent a certain phase of a fire

[SOURCE: ISO/IEC 13943:2008, definition 4.251]

3.10
real-scale fire test
fire test that simulates a given application, taking into account the real scale, the real way the item is installed and used, and the environment

Note 1 to entry: Such a fire test normally assumes that the products are used in accordance with the conditions laid down by the specifier and/or in accordance with normal practice.

[SOURCE: ISO/IEC 13943:2008, definition 4.273]

3.11
small-scale fire test
fire test performed on a test specimen of small dimensions

Note 1 to entry: A fire test performed on a test specimen of which the maximum dimension is less than 1 m is usually called a small-scale fire test.

[SOURCE: ISO/IEC 13943:2008, definition 4.292]

3.12
smoke
visible part of **fire effluent**

[SOURCE: ISO/IEC 13943:2008, definition 4.293]

3.13
specific optical density, D_s
optical density of smoke multiplied by a geometric factor, plus a filter factor

Note 1 to entry: The geometric factor is $V/(A \times L)$, where V is the volume of the test chamber, A is the area of the exposed surface of the test specimen, and L is the light path length.

Note 2 to entry: The use of the term "specific" does not denote "per unit mass" but rather denotes a quantity associated with a particular test apparatus and area of the exposed surface of the test specimen.

Note 3 to entry: The filter factor is a number which is calculated from the optical density of a moveable neutral density filter (see 7.2).

Note 4 to entry: The specific optical density of smoke is dimensionless.

3.14
transmittance
⟨smoke⟩ ratio of transmitted light intensity through smoke to incident light intensity, under specified conditions

cf. obscuration of smoke (3.6)

Note 1 to entry: Transmittance through smoke is the reciprocal of opacity of smoke.

Note 2 to entry: It is dimensionless and is usually expressed as a percentage.

[SOURCE: ISO/IEC 13943:2008 definition 4.346]

4 Relevance of test data and special observations

This small-scale fire test apparatus has been in worldwide use since about 1970, primarily for material evaluation purposes. In the early 1990s, ISO/TC61 developed a similar apparatus that was designed, in part, to overcome a number of limitations of the IEC apparatus, and in 1994 the first edition of ISO 5659-2 was published. It is now recognised that ISO 5659-2 overcomes the following significant limitations:

a) The heat flux is relatively low; consequently the method is only able to replicate conditions found in ISO 19706 fire stage 1b and, possibly, fire stage 2.

b) The test specimen is vertically mounted, which excludes liquids and some thermoplastics. Test specimens which swell towards the furnace also give problems, as the incident heat flux experienced by the front of the test specimen increases significantly, and the pilot flames can be extinguished, rendering the test invalid.

c) The limitations of the low heat flux and test specimen geometry mean that it is difficult to establish a link between data from the apparatus and real fire scenarios.

d) There are no means of monitoring the test specimen mass during the test

Further limitations include the following:

e) There is little or no correlation between data from this apparatus, and the behaviour of products in fires or real-scale fire tests.

f) The air supply is limited and the test specimen ceases to burn if the oxygen concentration falls below approximately 14 %.

g) The deposition of smoke on the walls is significant.

The test methods do however offer the useful option to evaluate smoke production from both flaming and non-flaming combustion, albeit at a low heat flux.

The data generated are not suitable for use as input to fire hazard assessment or for fire safety engineering.

Overall, these test methods are not recommended for further development for electrotechnical products. Neither are they recommended as the basis for regulation or other controls on smoke release for electrotechnical products, due to the limitations of the physical fire model and the test specimen geometry.

5 Test specimens

5.1 General

These test methods are sensitive to small variations in geometry, surface orientation, thickness, mass, composition and method of preparation; results obtained by these test methods are therefore dependent on the above parameters.

5.2 Number of test specimens

For each test on a given material, at least three test specimens shall be tested under the same conditions.

Under certain circumstances, it may be necessary to test three additional test specimens (see 6.5).

5.3 Size of test specimens

This method is applicable only to essentially flat solid materials.

The test specimens shall be square with sides $76^{+0,2}_{-0,6}$ mm. The thickness shall be a maximum of 25,4 mm and, when practicable, shall be that of the end-use application of the material.

For comparative testing, materials shall be tested at the same thickness as there is no known correlation between the specific optical density and thickness.

5.4 Conditioning of test specimens

Before the test, the test specimens shall be conditioned for at least 24 h at 23 °C ± 3 °C and at a relative humidity of 50 % ± 10 %. The test specimen shall be tested within 30 min of being conditioned.

6 Test procedure

6.1 Preparation and calibration of the test chamber

Preparation and calibration of the test chamber shall be carried out as described in Clause 7 of IEC/TS 60695-6-30:2012.

6.2 Preparation of test specimens

Each test specimen shall be wrapped in a single layer of aluminium foil (about 0,04 mm thick), with the bright face outside, taking care to avoid unnecessary wrinkles or perforations.

It is then mounted in the test specimen holder ensuring that it is retained close against the front window by a backing board, rod and a spring arrangement behind the test specimen.

Excess aluminium foil along the side and top edges should be trimmed off after mounting. The excess foil on the bottom edge shall be folded in such a way as to minimize losses of any melted material at the bottom of the holder.

6.3 Test conditions

The test specimen is exposed to the radiant heat flux emitted by the furnace. The average heat flux at the surface of the test specimen shall be 25 kW/m^2 ± 0,5 kW/m^2.

In the test with the pilot flame, in addition to the radiant heat flux, the test specimen is exposed to a multi-flame burner fed with a mixture of air and propane (air: 0,5 l/min; propane: 0,05 l/min).

The test chamber shall be located in a room or enclosed space having an ambient temperature of 23 °C ± 3 °C and relative humidity of approximately 50 % at the time of test. Precautions shall be taken to provide a means for removing potentially hazardous gases from the area of operation.

Caution shall be exercised during use of the apparatus to prevent explosion of pyrolyzates, particularly under conditions without application of pilot flames, and exposure of the operator to smoke, particularly during removal of the sample from the chamber or during clean-up.

The chamber walls shall be cleaned whenever periodic visual inspection indicates the need. Before each test, the exposed surfaces of the glass windows separating the photo detector and light source housing from the interior of the chamber shall be cleaned (ethyl alcohol is generally effective). Charred residues on the test specimen holder should be removed between tests to avoid contamination.

During the warm-up period all electric systems (furnace, light source, photometer, etc.) should be on, the exhaust vent and chamber door closed, and the inlet vent open. When the temperature on the centre surface of the back wall reaches a steady-state value in the range of 33 °C ± 4 °C, the chamber is ready for furnace calibrating or testing.

The blank test specimen holder should always be directly in front of the furnace, except when displaced to the side by the test specimen holder during a test, or by the radiometer during calibration. It should be returned immediately to this position when testing or calibration is completed to prevent excessive heating of the adjacent wall surface.

The calibration is performed according to the procedure described in Clause 7 of IEC/TS 60695-6-30:2012.

For exposures without application of pilot flames, remove the multi-flame burner; for exposures with application of pilot flames, position the burner across the lower edge of the test specimen as described in 6.4 of IEC/TS 60695-6-30:2012.

Before positioning the test specimen, flush the chamber with the door and exhaust and inlet vents open for about 2 min, and verify the starting temperature of the chamber.

6.4 Determination of smoke opacity – running a test

Stop the exhaust extractor, close the exhaust vent and place the specimen holder containing the test specimen on the retaining rods, adjacent to the blank test specimen holder.

Slide the test specimen holder along the retaining rods, displacing the blank test specimen holder, such that the test specimen is positioned centrally in front of the furnace.

Close the door, and start the data recorder and stopwatch. When the data recorder shows a reduction in transmittance from 100 %, close the inlet vent.

Throughout the test monitor, and, where appropriate, adjust the following:

– The furnace voltage, to maintain it at the level established during calibration (see 6.3).
– The reading on the potentiometer scale, and adjust the range setting so that readings are always between 10 % and 100 %. If the transmittance falls below 0,01 %, the neutral density filter shall be removed and the range setting adjusted to 10 times greater. To avoid spurious results from ambient light, the chamber door shall be blacked out at range settings below 0,01 %.