IEC 60695-6-1

Edition 2.1 2010-09

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

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

Essais relatifs aux risques du feu –
Partie 6-1: Opacité des fumées – Lignes directrices générales

IEC 60695-6-1:2005+A1:2010

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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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 consolidated version of IEC 60695-6-1 consists of the second edition (2005) [documents 89/692/FDIS and 89/696/RVD] and its amendment 1 (2010) [documents 89/905/CDV and 89/946A/RVC]. It bears the edition number 2.1.

The technical content is therefore identical to the base edition and its amendment and has been prepared for user convenience. A vertical line in the margin shows where the base publication has been modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through.

International Standard IEC 60695-6-1 has been prepared by IEC technical committee 89: Fire hazard testing.

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

– Modified title.
– Updated normative references.
– Expanded terms and definitions.
– Numerous editorial changes of a technical nature throughout the publication.
– A flowchart has been added for the evaluation and consideration of smoke test methods.

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

This standard is to be used in conjunction with IEC 60695-6-2.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The IEC 60695-6 series, under the general heading *Fire hazard testing*, 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 – Guidance and test methods on the assessment of obscuration hazard of vision caused by smoke opacity from electrotechnical products involved in fires – Small scale static method - Determination of smoke opacity - Description of the apparatus

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

The committee has decided that the contents of the base publication and its amendments 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

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

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

Smoke particles reduce the visibility due to light absorption and scattering. Consequently, people may experience difficulties in finding exit signs, doors and windows. Visibility is often determined as the distance at which an object is no longer visible. It depends on many factors, but close relationships have been established between visibility and the measurements of the extinction coefficient of smoke – see Annex A.

The production of smoke and its optical properties can be measured as well as other fire properties, such as heat release, flame spread, and the production of toxic gas and corrosive effluent. This part of IEC 60695-6 serves as a guidance document and focuses on obscuration of light by smoke.

FIRE HAZARD TESTING –

Part 6-1: Smoke obscuration – General guidance

1 Scope

This part of IEC 60695 gives guidance on:

a) optical measurement of smoke obscuration;

b) general aspects of optical smoke test methods;

c) consideration of test methods;

d) expression of smoke test data;

e) relevance of optical smoke data to hazard assessment.

One of the responsibilities of a technical committee is, wherever applicable, to make use of basic safety publications in the preparation of its publications.

2 Normative references

The following referenced documents are indispensable for the application 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 60695-1-1, *Fire hazard testing – Part 1-1: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*~~

~~IEC 60695-4:2001, *Fire hazard testing – Part 4: Terminology concerning fire tests*~~

~~IEC 60695-6-2:2001, *Fire hazard testing – Part 6-2: Smoke obscuration – Summary and relevance of test methods*~~

~~IEC 60695-6-30, *Fire hazard testing – Part 6: Guidance and test methods on the assessment of obscuration hazard 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 60695-6-31, *Fire hazard testing – Part 6-31: Smoke obscuration – Small-scale static test – Materials*~~

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

~~ISO/TR 9122-1:1989, *Toxicity testing of fire effluents – Part 1: General*~~

~~ISO 5659-2:1994, *Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test*~~

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

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

IEC 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

IEC 60695-1-11[1], *Fire hazard testing – Part 1-11: Guidance for assessing the fire hazard of electrotechnical products – Fire hazard assessment*

IEC 60695-4:2005, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

IEC 60695-6-2[2], *Fire hazard testing – Part 6-2: Smoke obscuration – Summary and relevance of test methods*

IEC 60695-6-30:1996, *Fire hazard testing – Part 6: Guidance and test methods on the assessment of obscuration hazard 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 60695-6-31:1999, *Fire hazard testing – Part 6-31: Smoke obscuration – Small-scale static test – Materials*

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 inclusion in standards*

ISO 5659-2:2006, *Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test*

ISO 5660-2:2002, *Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 2: Smoke production rate (dynamic measurement)*

ISO 13943:2008, *Fire safety – Vocabulary*

ISO 19706:2007, *Guidelines for assessing the fire threat to people*

NOTE ISO 9122-1:1989, *Toxicity testing of fire effluents – Part 1: General,* has been withdrawn and replaced by ISO 19706:2007.

ASTM E 1354:2008, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*

EN 13823:2002, *Reaction to fire tests for building products – Building products, excluding floorings, exposed to thermal attack by a single burning item*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purpose of this document, the terms and definitions ~~and symbols~~ given in ISO/IEC 13943, some of which are reproduced below for the uses' convenience, as well as the following apply.

---

[1] To be published.

[2] To be published.

3.1.1
combustion
exothermic reaction of a substance with an oxidizer

NOTE Combustion generally emits effluent accompanied by flames and/or visible light.

[ISO/IEC 13943, definition 23]

3.1.2
extinction area of smoke
product of the extinction coefficient and the volume occupied by the smoke

NOTE It is a measure of the amount of smoke.

[IEC 60695-4, definition 2.130]

3.1.3
extinction coefficient of smoke
natural logarithm of the opacity of smoke divided by the path length of the light used to measure the smoke opacity

[IEC 60695-4, definition 2.131]

3.1.4
fire
a) process of combustion characterized by the emission of heat and effluent accompanied by smoke, and/or flame, and/or glowing;
b) rapid combustion spreading uncontrolled in time and space

[IEC 60695-4, definition 2.29]

3.1.5
fire effluent
total gaseous, particulate or aerosol effluent from combustion or pyrolysis

[IEC 60695-4, definition 2.33]

3.1.6
fire hazard
potential for injury or loss of life and/or damage to property by fire

[IEC 60695-4, definition 2.36]

3.1.7
fire model
a laboratory process, including both the apparatus and the mode of operation, intended to simulate a certain stage of a real fire

[IEC 60695-4, definition 2.120]

3.1.8
fire scenario
detailed description of conditions, including environmental, of one or more stages from before ignition to after completion of combustion in an actual fire at a specific location or in a real-scale simulation

[ISO/IEC 13943, definition 58]

3.1.9
flash-over
the rapid transition to a state of total surface involvement in a fire of combustible materials within an enclosure

[IEC 60695-4, definition 2.59]

3.1.10
heat flux
amount of thermal energy emitted, transmitted or received per unit area and unit time

NOTE It is expressed in watts per square metre.

[ISO/IEC 13943, definition 85]

3.1.11
ignition
initiation of combustion

NOTE The term "ignition" in French has a very different meaning [state of body combustion].

[ISO/IEC 13943, definition 96]

3.1.12
large scale test
a test, the size of which exceeds that of a typical laboratory bench test

[IEC 60695-4, definition 2.122]

3.1.13
mass optical density of smoke
optical density multiplied by a factor, $V/(L \times \Delta m)$, where V is the volume of the test chamber, Δm is the mass loss of the test specimen and L is the light path length

[IEC 60695-4, definition 2.133]

3.1.14
opacity (of smoke)
the ratio (I/T) of incident luminous flux (I) to transmitted luminous flux (T) through smoke, under specified test conditions

[IEC 60695-4, definition 2.89]

3.1.15
optical density (of smoke) [lg(I/T)]
common logarithm of the opacity of smoke (see also *specific optical density*)

[IEC 60695-4, definition 2.90]

3.1.16
realscale test
a test which simulates an end-use situation in both size and surroundings

[IEC 60695-4, definition 2.123]

3.1.17
small scale test
a test which may be made on a typical laboratory bench

[IEC 60695-4, definition 2.124]

3.1.18
smoke
a visible suspension of solid and/or liquid particles in gases resulting from combustion or pyrolysis

~~[IEC 60695-4, definition 2.101]~~

~~**3.1.19**~~
~~**smoke obscuration**~~
~~the reduction in visibility due to smoke~~

~~[IEC 60695-4, definition 2.102]~~

~~**3.1.20**~~
~~**smoke production rate**~~
~~extinction area of smoke produced, per unit time, by the combustion of a material under specified test conditions~~

~~**3.1.21**~~
~~**smoke release rate**~~
~~see "smoke production rate"~~

~~**3.1.22**~~
~~**specific extinction area of smoke**~~
~~extinction area of smoke divided by the mass loss of the test specimen~~

~~[IEC 60695-4, definition 2.137]~~

~~**3.1.23**~~
~~**specific optical density (of smoke)**~~
~~optical density multiplied by a geometric factor V/AL, where V is the volume of the test chamber, A is the exposed surface area of the test specimen and L is the light path length~~

~~NOTE The use of the term 'specific' does not, in this case, denote 'per unit mass' but rather denotes a dimensionless quantity associated with a particular test apparatus and exposed surface area of the test specimen.~~

~~**3.1.24**~~
~~**visibility**~~
~~maximum distance at which an object of defined size, brightness and contrast can be seen and recognized~~

3.1.1
combustion
exothermic reaction of a substance with an oxidizing agent

NOTE Combustion generally emits fire effluent accompanied by flames and/or glowing.

[ISO/IEC 13943, definition 4.46]

3.1.2
extinction area of smoke
product of the volume occupied by smoke and the extinction coefficient of the smoke

NOTE It is a measure of the amount of smoke, and the typical units are square metres (m^2).

[ISO /IEC 13943, definition 4.92]

3.1.3
extinction coefficient
natural logarithm of the ratio of incident light intensity to transmitted light intensity, per unit light path length

NOTE Typical units are reciprocal metres (m^{-1}).

[ISO/IEC 13943, definition 4.93]

3.1.4
fire
⟨general⟩ process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame or glowing or a combination thereof

NOTE In the English language the term "fire" is used to designate three concepts, two of which, fire (3.1.5) and fire (3.1.6), 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.

[ISO/IEC 13943, definition 4.96]

3.1.5
fire
⟨controlled⟩ self-supporting combustion that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[ISO/IEC 13943, definition 4.97]

3.1.6
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

[ISO/IEC 13943, definition 4.98]

3.1.7
fire effluent
totality of gases and aerosols, including suspended particles, created by combustion or pyrolysis in a fire

[ISO/IEC 13943, definition 4.105]

3.1.8
fire hazard
physical object or condition with a potential for an undesirable consequence from fire

[ISO/IEC 13943, definition 4.112]

3.1.9
fire model
fire simulation
calculation method that describes a system or process related to fire development, including fire dynamics and the effects of fire

[ISO/IEC 13943, definition 4.116]

3.1.10
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 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.

[ISO/IEC 13943, definition 4.129]

3.1.11
flashover
⟨stage of fire⟩ transition to a state of total surface involvement in a fire of combustible materials within an enclosure

[ISO/IEC 13943, definition 4.156]

3.1.12
heat flux
amount of thermal energy emitted, transmitted or received per unit area and per unit time

NOTE The typical units are watts per square metre ($W \cdot m^{-2}$).

[ISO/IEC 13943, definition 4.173]

3.1.13
ignition
sustained ignition (deprecated)

⟨general⟩ initiation of combustion

[ISO/IEC 13943, definition 4.187]

3.1.14
ignition
sustained ignition (deprecated)

⟨flaming combustion⟩ initiation of sustained flame

[ISO/IEC 13943, definition 4.188]

3.1.15
large-scale fire test
fire test, that cannot be carried out in a typical laboratory chamber, performed on a test specimen of large dimensions

NOTE A fire test performed on a test specimen of which the maximum dimension is greater than 3 m is usually called a large-scale fire test.

[ISO/IEC 13943, definition 4.205]

3.1.16
mass optical density of smoke
optical density of smoke multiplied by a factor, $V/(\Delta m\ L)$, where V is the volume of the test chamber, Δm is the mass lost from the test specimen, and L is the light path length

NOTE The typical units are square metres per gram ($m^2 \cdot g^{-1}$).

[ISO/IEC 13943, definition 4.225]

3.1.17
obscuration by smoke
reduction in the intensity of light due to its passage through smoke

cf. **extinction area of smoke** (3.1.2) and **specific extinction area of smoke** (3.1.26).

NOTE 1 In practice, obscuration by smoke is usually measured as the transmittance, which is normally expressed as a percentage.

NOTE 2 Obscuration by smoke causes a reduction in visibility.

[ISO/IEC 13943, definition 4.242]