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NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

Fire hazard testing –
Part 9-2: Surface spread of flame – Summary and relevance of test methods

Essais relatifs aux risques du feu –
Partie 9-2: Propagation des flammes en surface – Résumé et pertinence des méthodes d'essai

IEC 60695-9-2:2014-03(en-fr)

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FOREWORD

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International Standard IEC 60695-9-2 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 first edition cancels and replaces the second edition of IEC TS 60695-9-2 published in 2005. This edition constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
89/1202/FDIS	89/1209/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.

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

This International standard is to be used in conjunction with IEC 60695-9-1.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

The risk of fire needs to be considered in any electrical circuit. The objective of component, circuit and equipment design, as well as 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. Fire hazard increases as the burning area increases, leading in some cases to flashover and a fully developed fire. This is a typical fire scenario in buildings. It is therefore useful to measure the rate and extent of the surface spread of flame.

This part of IEC 60695-9 describes surface spread of flame test methods in common use to assess electrotechnical products or materials used in electrotechnical products. It forms part of the IEC 60695-9 series which gives guidance to product committees wishing to incorporate test methods for surface spread of flame in product standards.

IEC 60695-9 consists of the following parts:

– Part 9-1: *Surface spread of flame – General guidance*
– Part 9-2: *Surface spread of flame – Summary and relevance of test methods*.

FIRE HAZARD TESTING –

Part 9-2: Surface spread of flame – Summary and relevance of test methods

1 Scope

This part of IEC 60695 presents a summary of published test methods that are used to determine the surface spread of flame of electrotechnical products or materials from which they are formed.

It represents the current state of the art of the test methods and, where available, includes special observations on their relevance and use.

The list of test methods is not to be considered exhaustive, and test methods that were not developed by IEC TC89 are not to be considered as endorsed by IEC TC89 unless this is specifically stated.

This summary cannot be used in place of published standards which are the only valid reference documents.

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

IEC 60695-9-1, *Fire hazard testing – Part 9-1: Surface spread of flame – General guidance*

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 13943:2008, *Fire Safety – Vocabulary*

3 Terms and definitions

For the purposes of this document, terms and definitions given in ISO 13943 and IEC 60695-4, some of which are reproduced below for the user's convenience, as well as the following additional definitions, apply:

3.1
burned length
maximum extent in a specified direction of the burned area

Note 1 to entry: The typical units are metres (m).

cf. **damaged length** (3.6)

[SOURCE: ISO 13943: 2008, definition 4.31]

3.2
char, noun
carbonaceous residue resulting from **pyrolysis** (3.26) or incomplete **combustion** (3.5)

[SOURCE: ISO 13943: 2008, definition 4.38]

3.3
char length
length of charred area

cf. **burned length** (3.1) and **damaged length** (3.6)

Note 1 to entry: In some standards, char length is defined by a specific test method.

[SOURCE: ISO 13943: 2008, definition 4.40]

3.4
combustible, noun
item capable of **combustion** (3.5)

[SOURCE: ISO 13943: 2008, definition 4.44]

3.5
combustion
exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion generally emits fire effluent accompanied by **flames** (3.14) and/or glowing.

[SOURCE: ISO 13943: 2008, definition 4.46]

3.6
damaged length
maximum extent in a specified direction of the damaged area

cf. **char length** (3.3) and **burned length** (3.1)

[SOURCE: ISO 13943: 2008, definition 4.60]

3.7
extent of combustion
⟨electrotechnical⟩ maximum length of a test specimen that has been destroyed by **combustion** (3.5) or **pyrolysis** (3.26), under specified test conditions, excluding any region damaged only by deformation

[SOURCE: ISO 13943: 2008, definition 4.91]

3.8
fire
⟨general⟩ process of **combustion** (3.5) characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame (3.14), 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** (3.9) and **fire** (3.10), 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, definition 4.96]

3.9
fire
⟨controlled⟩ self-supporting **combustion** (3.5) that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[SOURCE: ISO 13943: 2008, definition 4.97]

3.10
fire
⟨uncontrolled⟩ self-supporting **combustion** (3.5) 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, definition 4.98]

3.11
fire hazard
physical object or condition with a potential for an undesirable consequence from **fire** (3.10)

[SOURCE: ISO 13943: 2008, definition 4.112]

3.12
fire retardant, noun
substance added, or a treatment applied, to a material in order to delay **ignition** (3.22) or to reduce the rate of **combustion** (3.5)

[SOURCE: ISO 13943: 2008, definition 4.123, modified by deletion of “cf. flame retardant”]

3.13
fire scenario
qualitative description of the course of a fire (3.10) 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** (3.22) and fire growth processes, the **fully developed fire** (3.20) stage, the fire decay stage, and the environment and systems that impact on the course of the fire.

[SOURCE: ISO 13943: 2008, definition 4.129]

3.14
flame, noun
zone in which there is rapid, self-sustaining, sub-sonic propagation of **combustion** (3.5) in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943: 2008, definition 4.133 – modified by the addition of “zone in which there is”]

3.15
flame front
boundary of flaming **combustion** (3.5) at the surface of a material or propagating through a gaseous mixture

[SOURCE: ISO 13943: 2008, definition 4,136]

3.16
flame retardant, noun
substance added, or a treatment applied, to a material in order to suppress or delay the appearance of a **flame** (3.14) and/or reduce the **flame-spread rate** (3.18)

Note 1 to entry: The use of (a) flame retardant(s) does not necessarily suppress **fire** (3.8) or terminate **combustion** (3.5)..

[SOURCE: ISO 13943: 2008, definition 4.139]

3.17
flame spread
propagation of a **flame front** (3.15)

[SOURCE: ISO 13943: 2008, definition 4.142]

3.18
flame-spread rate
burning rate (deprecated)
rate of burning (deprecated)
distance travelled by a **flame front** (3.15) during its propagation, divided by the time of travel, under specified conditions

[SOURCE: ISO 13943: 2008, definition 4.143]

3.19
flashover
⟨stage of fire⟩ transition to a state of total surface involvement in a **fire** (3.10) of combustible materials within an enclosure

[SOURCE: ISO 13943: 2008, definition 4.156]

3.20
fully developed fire
state of total involvement of combustible materials in a **fire** (3.8)

[SOURCE: ISO 13943: 2008, definition 4.164]

3.21
heat release rate
burning rate (deprecated)
rate of burning (deprecated)
rate of thermal energy production generated by combustion ()

Note 1 to entry: The typical units are watts (W).

[SOURCE: ISO 13943: 2008, definition 4.177]

3.22
ignition
sustained ignition (deprecated)

⟨general⟩ initiation of **combustion** (3.5)

[SOURCE: ISO 13943: 2008, definition 4.188]

3.23
ignition source
source of energy that initiates **combustion** (3.5)

[SOURCE: ISO 13943: 2008, definition 4.189]

3.24
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 1 to entry: 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.

[SOURCE: ISO 13943: 2008, definition 4.205]

3.25
minimum ignition temperature
ignition point

minimum temperature at which sustained **combustion** (3.5) can be initiated under specified test conditions

Note 1 to entry: The minimum ignition temperature implies the application of a thermal stress for an infinite length of time.

Note 2 to entry: The typical units are degrees Celsius (°C).

[SOURCE: ISO 13943: 2008, definition 4.231]

3.26
pyrolysis
chemical decomposition of a substance by the action of heat

Note 1 to entry: Pyrolysis is often used to refer to a stage of **fire** (3.8) before flaming **combustion** (3.5) has begun.

Note 2 to entry: In fire science, no assumption is made about the presence or absence of oxygen.

[SOURCE: ISO 13943: 2008, definition 4.266]

3.27
pyrolysis front
boundary between the region of **pyrolysis** (3.26) and the region of unaffected material at the surface of the material

[SOURCE: ISO 13943: 2008, definition 4.267]

3.28
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 13943: 2008, definition 4.273]

3.29
riser cable
cable that runs vertically between floors in a building

Note 1 to entry: This is a term used predominantly in North America

3.30
riser shaft
shaft provided to run services between floors in a building

Note 1 to entry: This is a term used predominantly in North America

3.31
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 13943: 2008, definition 4.292]

3.32
surface spread of flame
flame spread (3.17) away from the source of **ignition** (3.22) across the surface of a liquid or a solid

[SOURCE: ISO 13943: 2008, definition 4.317]

4 Summary of published test methods

4.1 Small-scale and intermediate-scale burning tests

4.1.1 Horizontal and vertical 50 W and 500 W flame tests – IEC 60695-11-10 and IEC 60695-11-20

4.1.1.1 General

IEC 60695-11-10 [1] [1] is a test using a 50 W flame. IEC 60695-11-20 [2] is a test using a 500 W flame.

4.1.1.2 Purpose and principle

These tests refer to solid electrical insulating materials and are intended to serve as a preliminary indication of their behaviour when exposed to an ignition source. The results make it possible to check the constancy of the characteristics of a material and provide an indication of the progress in the development of the flame retardancy of insulating materials. The results also provide a relative comparison and classification of insulating materials.

4.1.1.3 Test specimen

The relatively small test specimen is 125 mm long, 13 mm wide, and up to 13 mm thick.

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1 Numbers in square brackets refer to the bibliography.

4.1.1.4 Test method

These tests involve the application of an ignition source to a horizontal or vertical test specimen and the evaluation of the linear burning rate (HB classification) and the vertical spread of flame (V classification).

4.1.1.5 Repeatability and reproducibility

Data are available in IEC 60695-11-10 [1] Annexes A and B, and IEC 60695-11-20 [2], Annex A.

4.1.1.6 Relevance of test data

These test methods are used to evaluate materials. The test methods provide classifications that may be used for quality assurance, the preselection of component materials of products, or to verify the required minimum flammability classification of materials used in end products. The tests are not valid for determining the fire behaviour and fire hazard of complete items of equipment, since the dimensions of the insulating systems, the design and heat transfer to adjacent metallic parts, greatly influence the flammability of the electrical insulating materials being used.

4.1.2 Vertical burning test for cables – IEC 60332-1 [3]

4.1.2.1 Purpose and principle

This test method specifies a method of testing a single vertical wire or cable or optical cable under fire conditions. Part 1-1 defines the apparatus. Part 1-2 defines the procedure. The char length of a vertical test specimen, exposed to a 1 kW pre-mixed flame in a suitable chamber, is measured. The standard includes, in an informative annex, recommended requirements for compliance for use where these are not given in the cable product standard. Part 1-3 is a procedure for determination of flaming droplets/particles.

The method specified is not suitable for the testing of small single insulated conductors or cables of less than 0,5 mm^2 total cross-section, because the conductor melts before the test is completed, or for the testing of small optical fibre cables because the cable is broken before the test is completed – see Clause 4.1.3.

NOTE The corresponding EN standards are EN 60332-1-1, EN 60332-1-2 and EN 60332-1-3.

4.1.2.2 Test specimen

The test specimen consists of a piece of finished wire or cable 600 mm ± 25 mm long.

4.1.2.3 Test method

The test specimen is held in a vertical position by means of two support arms within a three-sided metallic screen. A calibrated burner is used to ignite the test specimen. Its flame is continuously applied for a period of time which is related to the overall diameter of the test specimen. The damaged length of the test specimen is then noted.

4.1.2.4 Repeatability and reproducibility

No data are known to be available.

4.1.2.5 Relevance of test data

This method is used to determine the extent of vertical burning of a single finished wire or cable by measuring the char length.

The use of insulated wire or cable, which retards flame propagation and complies with the requirements of this standard, cannot be assumed by itself to prevent propagation of fire under all conditions of installation. Two examples of such conditions are:

a) vertical runs of bunched or bundled cables

b) potential ignition sources that would impose a more intense thermal environment than that provided by the test method.

It is recommended that wherever the risk of propagation is high, special installation precautions should be taken.

4.1.3 Vertical burning test for cables – IEC 60332-2 [4]

4.1.3.1 Purpose and principle

This test method specifies a method of testing a small insulated wire under fire conditions when the method specified in vertical burning test IEC 60332-1 is not suitable – see Clause 4.1.2.1.. Part 2-1 defines the apparatus. Part 2-2 defines the procedure. The char length of a vertical test specimen, exposed to a diffusion flame of length 125 mm ± 25 mm in a draught-free chamber, is measured. The standard includes, in an informative annex, recommended requirements for compliance for use where these are not given in the cable product standard.

NOTE The corresponding EN standards are EN 60332-2-1 and EN 60332-2-2.

4.1.3.2 Test specimen

The test specimen consists of a piece of finished copper wire or cable or optical cable, 600 mm ± 25 mm long.

4.1.3.3 Test method

The test specimen is held in a vertical position by means of two support arms within a three-sided metallic screen. A load of 5 N for each mm^2 of conductor area is attached to the lower part of the test specimen. A calibrated burner is used to ignite the test specimen. Its flame is continuously applied for a maximum period of 20 s. The damaged length of the test specimen is then noted.

4.1.3.4 Repeatability and reproducibility

No data are known to be available.

4.1.3.5 Relevance of test data

This method is used to determine the extent of burning by measuring the char length.

Since the use of insulated wire or cable or optical cable, which retards flame propagation and complies with the requirements of this standard, is not sufficient by itself to prevent propagation of fire under all conditions of installation, it is recommended that wherever the risk of propagation is high, for example in long vertical runs of bunched cables, special installation precautions should also be taken. It cannot be assumed that, because the cable test specimen complies with the performance required in this standard, bunched cables will behave in a similar manner.

4.1.4 Lateral flame spread on building and transport products – ISO 5658-2 [5]

4.1.4.1 Purpose and principle

This test provides a simple method by which lateral spread of flame on a vertical test specimen can be determined for comparative purposes. The test provides data suitable for comparing the performance of essentially flat materials, composites or assemblies, which are