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Fire hazard testing - Part 9-1: Surface spread of flame - General guidance

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Fire hazard testing
Part 9-1: Surface spread of flame - General guidance
(IEC 60695-9-1:1998)

Essais relatifs aux risques du feu
Partie 9-1: Propagation de flammes en surface - Guide général
(CEI 60695-9-1:1998)

Prüfungen zur Beurteilung der Brandgefahr
Teil 9-1: Oberflächige Flammenausbreitung
Allgemeiner Leitfaden
(IEC 60695-9-1:1998)

This European Standard was approved by CENELEC on 1999-01-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 89/314/FDIS, future edition 1 of IEC 60695-9-1, prepared by IEC TC 89, Fire hazard testing, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60695-9-1 on 1999-01-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	1999-10-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2001-10-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annex A is informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60695-9-1:1998 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

Fires are responsible for creating hazards to life and property as a result of the generation of heat (thermal hazard) and toxic, corrosive, and smoke (non-thermal hazard). Fire hazard increases as the flame front moves beyond the ignition zone leading to a fully developed fire which may ultimately lead to a flashover. This is a typical fire scenario in buildings.

The surface spread of flame beyond the ignition zone occurs as a result of the creation of a pyrolysis front on the surface of the material, ahead of the flame front, arising from the heating by the flame and external heat sources. The pyrolysis front is the boundary of the pyrolysis zone on the surface of the material. Combustible vapours are generated within the pyrolysis front which mix with air and ignite, creating the flame front.

The surface spread of flame rate is the distance travelled by the flame front divided by the time required to reach that distance. The surface spread of flame rate depends on the heat supplied externally and/or by the flame of the burning material ahead of the burning zone and on the ease of ignition (ignition temperature, density, specific heat, and thermal conductivity of the material). The heat supplied by the flame depends on the heat release rate, specimen orientation, and air flow rate and direction, relative to the surface spread of flame direction. In general, materials show one of the following types of surface spread of flame behaviour:

a) non-propagation: there is no flame propagation beyond the ignition zone;

b) decelerating propagation: flame propagation stops before reaching the end of the surface of the material;

c) propagation: flame propagates beyond the ignition zone and covers the entire surface of the material.

Properties of the materials that are used to describe the surface spread of flame behaviour are associated with surface preheating and pyrolysis, generation of vapours, mixing of the vapours with air, ignition, combustion of the mixture and generation of heat and combustion products. Flame retardants and surface treatments are used to modify the surface spread of flame behaviour. Factors that need to be considered for the assessment of the surface spread of flame behaviour of materials are

a) fire scenario (vertical/horizontal, ventilation, etc.);

b) measurement techniques (see 4.5);

c) use and interpretation of results obtained.

FIRE HAZARD TESTING –

Part 9-1: Surface spread of flame – General guidance

1 Scope

This part of IEC 60695 provides guidance for the assessment of surface spread of flame for electrotechnical products and the materials from which they are formed.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60695. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 60695 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60695-4:1993, *Fire hazard testing – Part 4: Terminology concerning fire tests*

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

ISO 2592:1973, *Petroleum products – Determination of flash and fire points – Cleveland open cup method*

3 Definitions

For the purpose of this part of IEC 60695, the definitions of IEC 60695-4 apply.

4 Consideration for the selection of test methods

The test method(s) selected should be relevant to the fire scenario.

4.1 Fire scenario

4.1.1 Solids

The surface spread of flame is always associated with air flow, caused by external factors (wind and ventilation) and by air flows induced by the flame itself. The air flow blowing from the opposite direction to that of the surface spread of flame (upwind) reduces the surface spread of flame rate and the air flow in the same direction as the surface spread of flame (downwind) enhances the surface spread of flame rate.

For vertical specimens with an ignition zone at the bottom, the flame moves towards the top and is defined as the upward surface spread of flame. For vertical specimens with an ignition zone at the top, the flame moves towards the bottom, and is defined as the downward surface spread of flame. For horizontal specimens, the flame moves laterally away from the ignition zone.

4.1.2 Liquids

The surface spread of flame over a liquid surface is governed by the flash and fire points of the liquids. The flash point is the minimum temperature to which the liquid must be heated for the vapours emitted to ignite momentarily in the presence of a flame under specified test conditions. In this case, flash point is measured according to ISO 2592 (Cleveland open cup).

NOTE – Defining the test method is important because the flame spread is described over an open liquid surface, for which ISO 2592 is applicable. The alternative method of measuring flash point, described in ISO 2719* (Pensky – Martens closed cup) which is cited in IEC standards for insulating liquids, measures flash point in a confined space and is intended to detect minor amounts of volatile material. Flash point measured in this way is significantly lower than by ISO 2592.

Fire point is the temperature at which the liquid will not only ignite but will continue to burn. The surface spread of flame rate increases as the liquid is heated up to its flash point. The surface spread of flame rate is determined by the gas phase phenomenon when the temperature of the liquid is greater than that of its flash point and by the liquid phase phenomenon when the liquid is at a temperature lower than that of its flash point. The gas phase phenomenon involves the effect of wind, flame, radiation, and others. The liquid phase phenomenon involves convective fluid motion, surface tension and viscosity of the liquid, and gravity.

4.2 Ignition sources

Within the context of this International Standard, the ignition source used in the laboratory has to be relevant to the actual fire scenarios

a) from unusual localized, internal sources of excessive heat and ignition within electrotechnical equipment and systems;

b) from electrotechnical equipment and systems when exposed to external sources of flame or excessive heat.

4.3 Types of test specimens

It is desired that the test procedure is designed in such a manner that the results are valid for hazard analysis. Limited variations in the shape, size and arrangement of the test specimen is desired. The following are three types of test specimens limited to equipment and capabilities:

- *Product testing*

  The test specimen shall be manufactured products.

- *Simulated product testing*

  The specimen shall be a component or simulation of a product.

- *Material or composite testing*

  The specimen shall be a basic material (solids or liquids) or a combination of materials.

* ISO 2719:1988, *Petroleum products and lubricants – Determination of flash point – Pensky-Martens closed cup method*

4.4 Test apparatus

The test apparatus shall have the capacity to test the actual electrotechnical product, simulated products, and materials and composites, described in 4.3.

The test apparatus shall have the necessary provisions to impose a heat flux from external heat sources or flame in an approximately uniform fashion to the test specimen in the ignition zone.

The test apparatus with imposed heat flux shall have provisions to ignite the vapour-air mixture emanating from the material. An electrical spark ignitor or premixed gas-air flame have been found to be suitable.

The test apparatus with flame impingement shall have provisions to apply the flames in a uniform fashion.

Tests for surface spread of flame under well-ventilated conditions shall be performed under a realistically high air flow rate.

4.5 Measurement techniques

The rate and extent of surface spread of flame on the surface of a material are determined by two techniques:

1) char measurement, and
2) flame front measurement.

These two measurements utilize the following principles:

a) the combustion is sustained in the ignition zone;
b) the flame transfers heat flux, mostly as thermal radiation, ahead of the pyrolysis front which is sufficient to satisfy the pyrolysis and ignition requirements;
c) the magnitude of the heat flux transferred ahead of the pyrolysis front depends on the heat release rate;
d) the ignition resistance requirements consist of ignition temperature and surface heating (thermal conductivity, specific heat, and density).

4.5.1 Char measurement

This measurement utilizes horizontally or vertically mounted specimens. The specimen surface is either non-heated or preheated. The ignition zone is located towards one end of the specimen. Natural or forced flow conditions are used in this technique. Measurements are made visually to determine the time to ignition and the char length. The char length represents the estimated surface spread of flame distance.

4.5.2 Flame front measurement

This measurement utilizes vertically or horizontally mounted specimens. The ignition source is at one end of the specimen. Surface spread of flame is observed visually and represents the surface spread of flame distance. The observed flame distance and the char distance will not normally give equivalent results.