IEC 60695-1-10

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REDLINE VERSION

INTERNATIONAL STANDARD

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BASIC SAFETY PUBLICATION

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

IEC 60695-1-10:2016-11 RLV(en)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIRE HAZARD TESTING –

Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines

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 redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

International Standard IEC 60695-1-10 has been prepared by IEC technical committee 89: Fire hazard testing.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

a) reference to IEC 60695-1-12;
b) modified Introduction and Scope;
c) updated normative references;
d) updated terms and definitions;
e) modified Table 1;
f) addition of Table 2;
g) new text in Subclauses 5.2, 5.3 and 5.4;
h) mandatory text in Clause 8;
i) Annex B changed to Annex A, and modified;
j) new Annex B concerning common ignition sources.

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

FDIS	Report on voting
89/1341/FDIS	89/1347/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

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 60695-1-11 and IEC 60695-1-12.

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.

IEC 60695-1 consists of the following parts:

Part 1-10: *Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

Part 1-11: *Guidance for assessing the fire hazard of electrotechnical products – Fire hazard assessment*

Part 1-12: Guidance for assessing *the fire hazard of electrotechnical products – Fire-safety engineering*

Part 1-20: *Guidance for assessing the fire hazard of electrotechnical products – Ignitability – General guidance*

Part 1-21: *Guidance for assessing the fire hazard of electrotechnical products – Ignitability – Summary and relevance of test methods*

Part 1-30: *Guidance for assessing the fire hazard of electrotechnical products – Preselection testing process – General guidelines*

Part 1-40: *Guidance for assessing the fire hazard of electrotechnical products – Insulating liquids*

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

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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 ~~product~~ equipment design, as well as the choice of materials, is to reduce ~~to acceptable levels~~ the ~~potential~~ risk~~s~~ of fire to a tolerable level even in the event of reasonably foreseeable ~~abnormal~~ (mis)use, malfunction or failure. This standard, together with its companions, IEC 60695-1-11 and IEC 60695-1-12, provides guidance on how this is to be accomplished.

The use of compartments with fire-resistant boundaries, and the use of detection and suppression systems are important methods for the mitigation of fire risk, but are not dealt with in this standard. 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:

- ~~the primary aims are~~ 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;
- ~~secondary aims include~~ trying to minimise ~~any~~ 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.

~~Fires involving electrotechnical products can also be initiated from external non-electrical sources. Considerations of this nature are dealt with in the overall risk assessment.~~

Assessing the fire hazard of electrotechnical products is accomplished by performing fire hazard tests. These tests are divided into two fundamental groups: qualitative fire tests and quantitative fire tests.

Fire testing of electrotechnical products should, whenever possible, be carried out using quantitative fire tests having the following characteristics.

a) The test should take into account the circumstances of product use, i.e. contemplated end-use conditions as well as foreseeable abnormal use. This is because fire conditions that may be hazardous under one set of circumstances will not necessarily pose the same threat under a different set.
b) It should be possible to correlate the test results with the harmful effects of fire effluents referred to above, i.e. the thermal and airborne threats to people and/or property in the relevant end-use situation. This avoids the creation of artificial, and sometimes distorted, performance scales with no clear relationship to fire safety.
c) Recognizing that there are usually multiple contributions to the effects of real fires, the test results should be expressed in well-defined terms and using rational scientific units, so that the product's contribution to the overall fire effects can be quantitatively assessed and compared with that of other products' contributions.

Although quantitative tests are preferred, the characteristics of qualitative fire tests are that they provide pass/fail and classification results. Under certain circumstances it will be appropriate to maintain such qualitative test methods or to develop new ones. This part of IEC 60695-1 establishes the circumstances under which such maintenance or development is appropriate.

FIRE HAZARD TESTING –

Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines

1 Scope

This part of IEC 60695-1 provides general guidance with respect to fire hazard testing on how to reduce to acceptable a tolerable levels the risk of fire and the potential effects of fires involving electrotechnical products. It also serves as a signpost standard to the other guidance publications in the IEC 60695 series.

It does not give guidance on the use of fire-resistant compartment boundaries or on the use of detection and suppression systems for the mitigation of fire risk.

It describes the relationship between fire risk and the potential effects of fire, and provides guidance to IEC product committees on the applicability of qualitative and quantitative fire tests to the fire hazard assessment of electrotechnical products. Details of the calculation of fire risk are not included in the scope of this document.

It emphasises the importance of the scenario approach to fire hazard and risk assessment and discusses criteria intended to ensure the development of technically sound hazard-based fire test methods.

It discusses the different types of fire tests, in particular the nature of qualitative and quantitative fire tests. It also describes the circumstances under which it is appropriate for IEC product committees to maintain or develop qualitative fire tests.

This standard is intended as guidance to IEC committees, and should is to be used with respect to their individual applications.

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 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

~~IEC 60695 (all parts), *Fire hazard testing*~~

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

IEC 60695-1-12, *Fire hazard testing – Part 1-12: Guidance for assessing the fire hazard of electrotechnical products – Fire-safety engineering*

IEC 60695-1-30~~:2008~~, *Fire hazard testing – Part 1-30: Guidance for assessing the fire hazard of electrotechnical products – Preselection testing process – General guidelines*[2]

IEC 60695-4:2012, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

~~IEC/TS 62441:2006, *Accidentally caused candle flame ignition for audio/video, communication and information technology equipment*~~

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 their inclusion in standards*

ISO 13943:2008, *Fire safety – Vocabulary*

~~ISO 197063:2007, *Guidelines for assessing the fire threat to people*~~

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60695-4:2012 and ISO 13943:2008 (some of which are reproduced below), as well as the following, apply.

3.1
fire
⟨general⟩ process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, 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* (3.2) and *fire* (3.3), 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, 4.96]

3.2
fire
⟨controlled⟩ self-supporting combustion that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[SOURCE: ISO 13943:2008, 4.97]

3.3
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

~~1 To be published.~~

2 Under preparation. Stage at time of publication: IEC/FDIS 60695-1-30:2016.

~~3 ISO 9122-1, Toxicity testing of fire effluents – Part 1: General, has been withdrawn and replaced by ISO 19706.~~

[SOURCE: ISO/IEC 13943:2008, 4.98]

3.4
fire hazard
physical object or condition with a potential for an undesirable consequence from *fire* (3.3)

[SOURCE: ISO/IEC 13943:2008, 4.112]

3.5
fire risk
probability of a *fire* (3.3) combined with a quantified measure of its consequence

Note 1 to entry: It is often calculated as the product of probability and consequence.

[SOURCE: ISO/IEC 13943:2008, 4.124]

3.6
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* (3.7) or through the quantification of risk for a group of fire scenarios

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

3.7
fire scenario
qualitative description of the course of a *fire* (3.3) 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, 4.129]

3.8
intermediate-scale fire test
fire test performed on a test specimen of medium dimensions

Note 1 to entry: A fire test performed on a test specimen for which the maximum dimension is between 1 m and 3 m is usually called an intermediate-scale fire test.

[SOURCE: ISO/IEC 13943:2008, 4.200]

3.9
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/IEC 13943:2008, 4.205]

3.10
qualitative fire test
fire test which is either:

a) a pass/fail test; or

b) a test which categorizes the behaviour of the test specimen by determining its position in a rank order of performance

[SOURCE: IEC 60695-4:2012, 3.2.22]

3.11
quantitative fire test
fire test which takes into account the circumstances of product use in which the test conditions are based on, or are relatable to, the circumstances of use of the test specimen, and which measures a parameter or parameters, expressed in well-defined terms and using rational scientific units, which can be used in the quantitative assessment of fire risk

[SOURCE: IEC 60695-4:2012, 3.2.23]

3.12
reaction to fire
response of a test specimen when it is exposed to *fire* (3.2) under specified conditions in a fire test

Note 1 to entry: Fire resistance is regarded as a special case and is not normally considered as a reaction to fire property.

[SOURCE: ISO~~/IEC~~ 13943:2008, 4.272]

3.13
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, 4.273]

3.14
short-circuit
unintended connection of two nodes of an electrical circuit

Note 1 to entry: Current flow can occur, which could cause circuit damage, overheating, fire or explosion.

3.15
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, 4.292]

4 Fire hazards associated with electrotechnical products

The transmission, distribution, storage and utilization of electrical energy can have the potential to contribute to fire hazard.

With electrotechnical products, the most frequent causes of ignition are overheating and arcing. The likelihood of ignition will depend on the product and system design, the use of safety devices and systems, and the type of materials used.

Electrotechnical products, when operating, generate heat. In some cases, arcing and sparking are normal phenomena. ~~These potential risks~~ They should not lead to hazardous conditions provided that they have been taken into account initially at the design stage, and subsequently during installation, use and maintenance.

Although it is a commonly held belief that most electrical fires are caused by a short-circuit, there are many other possible causes of ignition. These can include improper installation, improper ~~utilization~~ usage, and inadequate maintenance. Examples are: operation under overload for temporary or extended periods; operation under conditions not provided for by the manufacturer or contractor; inadequate heat dissipation; faulty ventilation. Table 1 lists common ignition phenomena encountered in electrotechnical products.

In Table 1, unless otherwise indicated, the sources of ignition are considered to be internal to the electrotechnical product. ~~It includes~~ The table lists the most frequently encountered cases. ~~The sequence indicated is not related to the magnitude or frequency of occurrence.~~

Fires involving electrotechnical products can also be initiated from external non-electrical sources. Hazardous conditions, which do not arise from the use of the electrotechnical product itself, can and often do involve that product. Considerations of this nature are dealt with in the overall hazard assessment, individual product safety standards, or, for example, by the provisions of IEC TS 62441 [21].

Examples of the power output of potential ignition sources are provided in Annex A.

When designing products, the prevention of ignition in normal and abnormal operating conditions requires a higher priority compared to minimizing the eventual spread of flames.

After ignition has occurred, for whatever reason, the effects of the subsequent fire must be assessed. Factors to be taken into account include:

a) fire growth and flame spread;
b) heat release;
c) smoke generation (visibility);
d) production of toxic fire effluent;
e) production of potentially corrosive fire effluent;
f) the potential for explosion.

References to IEC guidance on items a) to e) can be found in Annex B. The safety of electrotechnical equipment used in explosive atmospheres is discussed in IEC 60079-0.

5 Fundamentals of fire hazard testing

5.1 Objectives

The objectives of fire hazard testing of electrotechnical products are to determine which fire properties of the product contribute to the potential effects of fire and/or how the product or part of the product contributes to the initiation, growth and effect of fire, and then to use this knowledge to reduce the risks of fire in electrotechnical products.

5.2 Fire hazard and fire risk

5.2.1 Fire hazard

A fire hazard is a physical object or condition with a potential for an undesirable consequence from fire (see 3.4). Fire hazards therefore encompass potential fuels and ignition sources. Ignition of an electrotechnical product can be caused by an electrically energised component part, and the conditions which can cause ignition are of three types: an abnormal temperature rise, a short-circuit, or accidental arcs or sparks. Table 1 lists possible origins of such phenomena and also lists the possible consequential effects. Ignition occurs as a result of an increase in temperature (see IEC 60695-1-20 [20]) that may have a chemical, mechanical or electrical origin.

Common ignition phenomena encountered in electrotechnical products are described in detail in Table 1, which also lists possible consequential effects.

Fires involving electrotechnical products can also be initiated from external non-electrical sources, and an overall risk fire hazard assessment should include this possibility.

Table 1 – Common causes of ignition phenomena encountered in electrotechnical products

Cause [a, b]	Possible origins [c]	Possible consequential effects and comments
Short-circuit (see 3.14)	Direct contact of conducting live parts at different potentials (e.g. because of the loosening of terminals, disengaged conductors, or ingress of conducting foreign bodies). Gradual degradation of some components causing changes in their insulation impedances. Sudden failure of a component or an internal part.	Protection devices[c] are may not always be activated. The rise in temperature is significant after a very short time and quite may be localized. Possible emission of light, smoke and/or flammable gases. Possible production of flames Ignition can occur locally in surrounding components. Possible release of glowing material or substances.
Accidental sparks or arcs NOTE 1 Some products produce sparks or arcs in normal operation.	A cause external to the product (e.g. overvoltage of the system network, or an accidental mechanical action that exposes live parts or bringing them together, etc.). An internal cause (e.g. on-off switching with gradual degradation of a component, or ingress of moisture). Sudden failure of a component or an internal part.	Protection devices[c] are may not always be activated. Possible emission of visible light, smoke and/or flammable gases and flames. Possible production of flames. Substantial risk of ignition in potentially explosive atmospheres. Ignition may can occur locally in surrounding components or gases.
High transient peak current	A defect in the electrical circuit. A cause external to the product (e.g. overvoltage of the system network).	Protection devices [c] may not always be activated.
An abnormal temperature rise (other than that caused by any of the above) NOTE 2 Some products dissipate heat in normal operation.	Overcurrent in a conductor. Defective contacts. Leakage currents (insulation loss and heating). Failure of a component, an internal part or an associated system,, e.g. ventilation. Mechanical distortions which modify electrical contacts or the insulation system. Seizure of a motor shaft (locked rotor). Premature thermal ageing.	At start-up, protection devices [c] are not normally activated (except in special protection cases). They may be activated after a variable length of time. The temperature rises are gradual and at times can be very slow. Therefore a significant accumulation of heat and effluent in the vicinity of the product may result, sufficient to support fire as soon as ignition starts occurs. Accumulation and diffusion of flammable gases in air may give rise to an ignition or explosion, especially inside hermetically sealed products. A locked seized motor shaft (locked rotor) can cause smouldering or flaming due to excessive heating of the windings of the motor.

[a] The sequence indicated is not related to the magnitude or frequency of occurrence.

[b] Mechanical distortions and structural changes induced by any one of the three phenomena may four causes can result in the occurrence of one or more of the other two three.

[c] The protection devices may can include thermal (fuse), mechanical (circuit breaker), electrical or electronic types.

5.2.2 Fire risk

5.2.2.1 Quantification of fire risk

In order to calculate fire risk, it is necessary to quantify the consequences of the fire that is being assessed. The consequences may refer to injury or loss of life from threats such as heat, low oxygen levels, or the concentration of incapacitating fire gases; or the consequences may refer to loss of property, such as the extent of fire damage. A wide range of potential fire scenarios may be analysed quantitatively to establish measures of overall fire risk.

If c is the consequence of the fire (i.e. a quantified measure), and p is the probability of the fire occurring within a defined time period, then the fire risk (in that time period) is usually calculated as the product of p and c:

$$\text{Fire risk} = p \times c \qquad (1)$$

If it is assumed that, within a given time-frame, that there is a probability, p_1, of a fire incident involving a given product in a given scenario (scenario 1), and a probability, p_2, of a fire incident involving the same product in a different scenario (scenario 2), and so on, covering all relevant scenarios, the total fire risk associated with that product, within that time-frame is:

$$\text{Total fire risk} = \sum_{i=1}^{m} p_i c_i \qquad (2)$$

where

p_i is the probability of scenario i;

c_i is the consequence of scenario i;

m is the total number of scenarios being considered.

NOTE Further discussions of fire risk, and its use in selecting scenarios on which to base fire hazard tests, can be found in ISO/TS 16732 [1][4].

5.2.2.2 Mitigation of fire risk

There are two ways of mitigating fire risks. One is to reduce the probability of occurrence (reduction of p in Equation 1). The other is to reduce the consequence (reduction of c in Equation 1). Fire hazard testing is concerned with the reduction of p.

There are several distinct ways in which the probability of fire can be reduced. The most important, in no particular order, are:

a) product design and selection, including the selection of appropriate materials;
b) containment using fire resistant enclosures and compartment boundaries;
c) the use of appropriate assembly and installation methods;
d) the incorporation of circuit protection devices;
e) the use of detection and suppression systems.

Fire tests (see Clause 6) are used principally for a) and b) and also to some extent for c).

NOTE 1 Guidance on containment and fire resistance testing for buildings is given in the ISO 834 series of standards [2].

[4] Numbers in square brackets refer to the Bibliography.

NOTE 2 Guidance on detection, activation and suppression is given in ISO/TR 13387-7 [3].

5.3 Fire scenarios

Fire scenarios differ in fire stages (phases), the oxygen content, the CO/CO_2 ratio, the temperature and the irradiance (see Table 1 in ISO 19706 2).

Analysis of the circumstances of use of a product involved in a given fire incident (real or hypothetical) facilitates the description of the conditions and the chain of events that play a significant role in the outcome of the fire.

~~There is a scenario associated with every fire incident involving a given product. While in principle each incident, and hence each scenario is unique, there usually occur crucial common elements, such as the presence of nearby combustibles or exposure to a secondary source of heat, which in effect determine why and how an incident occurs. These common elements permit the scenarios to be grouped, and the grouped scenarios in turn to be ranked in importance with respect to fire hazard. Such a ranking can be by frequency of occurrence, severity of the incident, or other appropriate measure.~~

Analysis of product fire incidence using the scenario approach links product fire behaviour to the outcome of the incident. Part of the rationale for choosing any set of fire hazard tests of an electrotechnical product should be a description of the fire scenario or scenarios on which the set of tests is based. This effectively tells the user why this set of test and exposure conditions was chosen and not another.

Table 2 – Characteristics of fire stages *(from Table 1 in ISO 19706:2011* [22]*)*

Fire stage	Heat flux to fuel surface	Max. temperature		Oxygen volume		Fuel/air equivalence ratio (plume)	$\frac{[CO]}{[CO_2]}$	$\frac{100 \times [CO_2]}{([CO_2]+[CO])}$
		°C		%				
	kW/m²	Fuel surface	Upper layer	Entrained	Exhausted		v/v	% efficiency
1. Non-flaming								
a. self-sustaining (smouldering)	not applicable	450 to 800	25 to 85 [d]	20	20	–	0,1 to 1	50 to 90
b. oxidative pyrolysis from externally applied radiation	–	300 to 600 a	[b]	20	20	< 1	[c]	[c]
c. anaerobic pyrolysis from externally applied radiation	–	100 to 500	[b]	0	0	>> 1	[c]	[c]
2. Well-ventilated flaming [d]	0 to 60	350 to 650	50 to 500	≈ 20	≈ 20	< 1	< 0,05 [e]	> 95
3. Underventilated flaming [f]								
a. small, localized fire, generally in a poorly ventilated compartment	0 to 30	300 to 600 [a]	50 to 500	15 to 20	5 to 10	> 1	0,2 to 0,4	70 to 80
b. post-flashover fire	50 to 150	350 to 650 [g]	> 600	< 15	< 5	> 1 [h]	0,1 to 0,4 [i]	70 to 90

[a] The upper limit is lower than for well-ventilated flaming combustion of a given combustible.

[b] The temperature in the upper layer of the fire room is most likely determined by the source of the externally applied radiation and room geometry.

[c] There are few data, but for pyrolysis this ratio is expected to vary widely depending on the material chemistry and the local ventilation and thermal conditions.

[d] The fire's oxygen consumption is small compared to that in the room or the inflow, the flame tip is below the hot gas upper layer or the upper layer is not yet significantly vitiated to increase the CO yield significantly, the flames are not truncated by contact with another object, and the burning rate is controlled by the availability of fuel.

[e] The ratio can be up to an order of magnitude higher for materials that are fire-resistant. There is no significant increase in this ratio for equivalence ratios up to ≈ 0,75. Between ≈ 0,75 and 1, some increase in this ratio can occur.

[f] The fire's oxygen demand is limited by the ventilation opening(s); the flames extend into the upper layer.

[g] Assumed to be similar to well-ventilated flaming.

[h] The plume equivalence ratio has not been measured; the use of a global equivalence ratio is inappropriate.

[i] Instances of lower ratios have been measured. Generally, these result from secondary combustion outside the room vent.

5.4 Fire-safety engineering

Although the definition of fire-safety engineering given in 3.6 is principally concerned with the major fire safety characteristics of civil engineering scenarios, some aspects of fire-safety engineering are applicable to electrotechnical products. It follows that, if the principles of fire-safety engineering are to be adhered to, quantitative fire tests are required. Guidance on fire-safety engineering is given in IEC 60695-1-12.

~~NOTE More detailed guidance on fire safety engineering is given in ISO/TS 16732 [1], the ISO/TR 13387 series of standards [2], and in ISO/TS 16733 [3].~~

5.5 Fire hazard assessment

The methodology of fire hazard assessment is intended to identify significant fire scenarios associated with a given electrotechnical product in order to establish:

a) the extent to which the fire properties of the product are relevant to the significant scenarios, and

b) appropriate test methods and performance requirements.

A full fire hazard assessment for a product may involve more than one fire scenario, in which case the resulting procedure may include several tests and multiple scenario-dependent performance criteria.

The procedure for conducting a fire hazard assessment of a fire scenario is detailed in IEC 60695-1-11.

6 Types of fire test

6.1 General

Assessing the fire hazard of electrotechnical products is accomplished by performing fire tests which, dependent on the maximum dimension of the test specimen, can be small-scale (see 3.15), intermediate-scale (see 3.8), large-scale (see 3.9) or real-scale tests (see 3.13). Due to the test criteria, all types of fire hazard tests applied to electrotechnical products are divided into two fundamental groups: qualitative fire tests (see 3.10) and quantitative fire tests (see 3.11).

6.2 Quantitative and qualitative groups of fire tests

6.2.1 Quantitative fire tests

Quantitative fire test criteria are defined as follows.

a) Quantitative fire tests take into account the circumstances of product use in which the test conditions are based, i.e. expected end-use conditions as well as foreseeable abnormal use. This is because fire conditions that may be hazardous under one set of circumstances will not necessarily pose the same threat under a different set of circumstances.

b) Quantitative fire tests have the possibility of allowing the correlation of the test results with the harmful effects of fire effluents referred to above, i.e. the thermal and airborne threats to people and/or property in the relevant end situation. This correlation avoids the possibility of the creation of artificial and sometimes distorted performance scales with no clear relationship to fire safety.

c) Test results from quantitative fire tests should be expressed in well-defined terms and use rational scientific units so that the product contribution to the overall fire effects can be quantitatively assessed and compared with the contributions of other products.

~~NOTE~~ When fire tests for electrotechnical products are revised or when new ones are developed, they should preferably be quantitative fire tests. Technical committees are encouraged to adopt the use of quantitative fire tests whenever possible. Consideration should be given to specific measurements that reflect hazards from end-use conditions.

6.2.2 Qualitative fire tests

Qualitative fire tests are those which express results on a discontinuous scale. The qualitative fire tests group includes pass-fail tests and other tests which classify products according to their position in a rank order of performance. Qualitative fire tests do not give data which are suitable for the purpose of quantifying fire risks. The results of such tests cannot be correlated with real-scale fire performance as the test conditions cannot be related to the fire scenario or scenarios of concern. However, because the qualitative fire tests classify products with regard to fire risk or give a clear pass-fail result when tested according to the standardized fire test procedure, this group of tests is useful at the material preselection level or for particular end-product testing and, under certain circumstances, the results of a qualitative test can be used indirectly in fire hazard assessment of electrotechnical products.

6.3 Types of fire tests

6.3.1 Fire simulation test

Fire simulation tests (also known as real-scale fire tests – see 3.13) examine the reaction to fire of electrotechnical products and are intended to be as representative as possible of the use of the product in practice. Since the real conditions of use (including foreseeable abnormal use, malfunction, or failure) of a product are simulated as closely as possible, and the design of the test procedure is related to actual risks, such tests assess the relevant aspects of the fire hazard associated with the use of the product. The findings of such tests may not be valid when a change in the design is made, or when the conditions of use are different from those simulated in the test.

6.3.2 Fire resistance tests

Fire resistance tests are intended to assess the ability of a product or a part to retain its functional properties under specified conditions of exposure to fire, for a stated period of time. They are intended to provide data on the behaviour and performance of a product or a finished assembly under a particular condition of heat, fire or test flame exposure.

Recent studies have shown that to relate the findings of such tests to performance in actual fire situations, very careful consideration needs to be given to a comparison of the test conditions with actual fire situations and the possible effect of any uncontrolled variables, such as the environment in which the product is placed.

NOTE 1 Many fire resistance tests have been developed by ISO to test building products and are defined in the ISO 834 series [2].

NOTE 2 Examples of IEC fire resistance tests of electric cables, which are known as circuit integrity tests, are defined in the IEC 60331 series [4].

6.3.3 Tests with regard to reaction to fire

Tests of reaction to fire are carried out on standard test specimens under defined conditions and in most cases are used to give data on properties related to burning behaviour and for comparative evaluation. Properties such as ignitability, flammability, flame spread, heat release, smoke production, toxic gas production, and corrosive gas production are measured.

6.3.4 Preselection fire tests

A preselection fire test is one which is used in the process of assessing and choosing candidate materials, components or sub-assemblies for making an end product. Guidance on the use of the preselection testing procedure is given in IEC 60695-1-30.

6.3.5 Basic property tests

Basic property tests are designed to ensure that, on measuring a basic physical or chemical property of a material, they yield information that is independent of the testing method. Properties relevant to the assessment of fire hazard include, for example, thermal conductivity, thermal capacity, density, melting point, boiling point, heat of vaporization, and heat of combustion.

7 Appropriate use of qualitative fire tests

It is recognized that there are circumstances where existing qualitative fire tests should be maintained and where the development of new qualitative fire tests is acceptable.

A qualitative fire test may be maintained and/or developed if:

a) the test is cited in, or used as the basis for, regulations having the force of law; or
b) the test produces a clear fire safety benefit; or
c) the test is intended solely for quality control or developmental purposes (and this intention is stated in the body of the standard); or
d) the test is used as a preselection test.

8 Preparation of requirements and test specifications

When preparing requirements and test specifications concerning the fire hazard testing of electrotechnical products, it is suggested that technical committees follow the procedures shown below. In cases where fire tests are not yet specified, and need to be developed or altered for the special purpose of an IEC technical committee, this shall be done in liaison with TC 89 as mandated by IEC Guide 104.

The test method(s) selected shall be relevant to the fire scenario of concern.

Procedure:

a) Examine the known existing and recommended test methods developed for a similar purpose and consider their possible applicability and limitations.
b) Collect as much relevant background information as possible on the fire scenario, or scenarios, of concern.
c) Take into account the relevant scope and significance of the existing test methods.
d) If an existing test method appears suitable, check its provisions against the following features.
   - It should preferably be a quantitative fire test. The test conditions should be related to the fire scenario, or scenarios, of concern, and the measured parameters should be appropriate for the purpose of designing the product based on fire-safety engineering.
   - If it is a qualitative fire test, it ~~should~~ shall meet the requirements given in Clause 7.
   - Relevant characteristics of the test method should be checked for their sensitivity (e.g. detection level), reproducibility and repeatability.
e) Undertake an investigation of the proposed test procedure and study its ability to meet the objectives.
f) Prepare the standard for the test method, including the relevant information on its field of application, its limitations and reservations, and on the use of the test results obtained. Make reference in the standard to recommended test procedures wherever possible.

9 Common ignition sources

A list of some common electrical and non-electrical ignition sources is given in Annex A.

10 Reference documents of TC 89

A ~~complete~~ list of reference documents developed by the IEC is given in Annex B.

Annex A
(informative)

The power output of ignition sources

A.1 General

Fires can be started from as small a source as a single spark. However, in the field of electrotechnical products, with appropriate choice of materials and design, it is often assumed that ignition is unlikely to occur if the electrical power consumption is less than 15 W.

For example, in IEC 60950-1 [5], parts used in information technology equipment do not require a fire enclosure if they are supplied with a power source of no more than 15 W, and in IEC 60065 [6], 15 W is also used as a limit above which printed boards must be category V-1 or better according to IEC 60695-11-10 unless protected by a suitable enclosure.

NOTE Further guidance on the different levels of power and energy related to the probability of ignition and fire in low voltage electrotechnical products is given in IEC TS 60695-1-14 [19] (under preparation).

A.2 Some common electrical and non-electrical ignition sources

Table A.1 lists some common electrical and non-electrical ignition sources and provides some information about their power and energy.

Table A.1 – Examples of ignition sources

Source of ignition	Publication number	Duration / s [a]	Power / W	Energy / kJ
Needle flame	IEC 60695-11-5 [18]	5 to 120 [b]	38 to 50 [c]	0,19 to 6,0
50W flame	IEC 60695-11-10 [18]	30 (Test method A)	50 [d]	1,5
Match flame	–	–	approx. 40 [e]	–
Candle flame	–	–	approx. 90 [f]	–
Glow-wire at 550 °C	IEC 60695-2-10 [11]	30	approx. 55	approx. 1,65
Glow-wire at 750 °C	IEC 60695-2-10 [11]	30	approx. 120	approx. 3,6
Glow-wire at 960 °C	IEC 60695-2-10 [11]	30	approx. 240	approx. 7,2
500 W flame	IEC 60695-11-20 [18]	25 (Bar test procedure)	500 [d]	12,5
1 kW flame	IEC 60332-1-2 [7]	60 (Cables with D ≤ 25 mm)	1 000 [d]	30
1 sheet of crumpled paper [8]	–	152	2 237	340
Waste paper basket [8]	–	360	9 444	3 400

[a] In fire tests, the duration refers to the time that the ignition source is applied to the test specimen.

[b] Preferred times are 5 s, 10 s, 20 s, 30 s, 60 s and 120 s.

[c] Assessments of the power of the flame vary. With butane, values of 49,75 W and 37,8 W have been calculated; with propane, a value of 40,4 W has been calculated.

[d] Nominal value.

[e] A typical household match (e.g. 2 mm × 2 mm × 45 mm) has a mass of about 0,08 g and burns horizontally in 25 s to 35 s. Matchwood has a heat of combustion of about 15 kJ/g. This equates to an average energy output of approximately 40 W.

[f] A typical household candle has a mass of 38 g and burns in 5 h (manufacturer's data – Price's Candles[5]). The heat of combustion of candle wax is about 42 kJ/g. This equates to an average energy output of approximately 90 W.

A.3 Power source classification in IEC 62368-1 [9]

IEC 62368-1 specifies safeguards for persons using audio/video, information and communication technology equipment.

With respect to electrically-caused fire, three classes of power source are defined:

– PS1 – a circuit where the power source does not exceed 500 W during the first 3 s and does not exceed 15 W after 3 s;

– PS2 – a circuit that exceeds PS1 limits, but does not exceed 100 W after 5 s;

– PS3 – a circuit that exceeds PS2 limits.

Various requirements are specified based on these classifications.

The following assumptions are made:

– PS1 – ignition is not likely to occur;

– PS2 – ignition can occur under some conditions, but there will be limited growth and spread of fire;

– PS3 – ignition may occur and fire will spread where fuel is available.

5 Price's Candles is an example of a candle manufacturer. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of their products.

Annex B
(informative)

Guidance publications and test methods

Guidance publications and test methods developed by the IEC are shown in Table B.1 (see [10] to [18]).

Table B.1 – TC 89 guidance publications and test methods

Subject	Reference
Fire hazard testing	
General guidelines	IEC 60695-1-10
Fire hazard assessment	IEC 60695-1-11
Fire-safety engineering	IEC 60695-1-12
Preselection testing process	IEC 60695-1-30
Insulating liquids	IEC 60695-1-40
Terms and definitions	
Terminology (see also ISO 13943)	IEC 60695-4
~~Fire safety – Vocabulary~~	~~ISO/IEC 13943~~
Ignitability	
General guidance	IEC 60695-1-20
Summary and relevance of test methods	IEC 60695-1-21
Ignition characteristics – Test method using heat flux from a flame	IEC 60695-11-11
Glow-wire ignitability test for materials	IEC 60695-2-13
Corrosivity	
General guidance	IEC 60695-5-1
Summary and relevance of test methods	IEC 60695-5-2
~~Leakage current and/or metal loss test method~~	~~IEC 60695-5-3~~
Smoke	
General guidance	IEC 60695-6-1
Summary and relevance of test methods	IEC 60695-6-2
~~Small scale static test method – Apparatus~~	~~IEC 60695-6-30~~
~~Small scale static test method – Materials test~~	~~IEC 60695-6-31~~
Toxicity	
General guidance	IEC 60695-7-1
Summary and relevance of test methods	IEC 60695-7-2
Use and interpretation of test results	IEC 60695-7-3
~~Toxic potency – Apparatus~~	~~IEC 60695-7-50~~
~~Toxic potency – Calculation and interpretation of test results~~	~~IEC 60695-7-51~~
Heat release	
General guidance	IEC 60695-8-1
Summary and relevance of test methods	IEC 60695-8-2
~~Insulating liquids – Test method~~	~~IEC 60695-8-3~~
Surface spread of flame	

Subject	Reference
General guidance	IEC 60695-9-1
Summary and relevance of test methods	IEC 60695-9-2
Glow-wire test – Flammability test – End products	IEC 60695-2-11
Glow-wire test – Flammability test – Materials	IEC 60695-2-12
Resistance to abnormal heat	
Ball pressure test	IEC 60695-10-2
Mould stress relief distortion test	IEC 60695-10-3
Test flames	
1 kW flame – Apparatus	IEC 60695-11-2
500 W flame – Apparatus	IEC 60695-11-3
50 W flame – Apparatus	IEC 60695-11-4
Needle flame – Apparatus	IEC 60695-11-5
History and development 1979-1999	IEC 60695-11-30
Confirmatory tests – Guidance	IEC 60695-11-40
Flame test methods	
Needle flame	IEC 60695-11-5
Heat flux from a non-contacting flame	IEC 60695-11-11
50 W horizontal and vertical test methods	IEC 60695-11-10
500 W test methods	IEC 60695-11-20
500 W vertical test method for tubular polymeric materials	IEC 60695-11-21
Glow-wire tests	
Apparatus and common test procedure	IEC 60695-2-10
End products – flammability test	IEC 60695-2-11
Materials – flammability test	IEC 60695-2-12
Materials – ignitability	IEC 60695-2-13

Bibliography

[1] ISO/TS 16732:2005, *Fire-safety engineering – Guidance on fire risk assessment*

~~[2] ISO/TR 13387:1999 (all parts), *Fire safety engineering*~~

~~[3] ISO/TS 16733:2006, *Fire safety engineering – Selection of design fire scenarios and design fires*~~

[2] ISO 834 (all parts), *Fire-resistance tests – Elements of building construction*

[3] ISO/TR 13387-7, *Fire-safety engineering – Part 7: Detection, activation and suppression.*

[4] IEC 60331 (all parts), *Tests for electric cables under fire conditions – Circuit integrity*

[5] IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

[6] IEC 60065, *Audio, video and similar electronic apparatus – Safety requirements*

[7] IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

[8] Paul, K. T. and Christian, S. D., J. Fire Sciences, 5(3), 178-211, 1987.

[9] IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

[10][6] IEC 60695-1(all parts), *Fire hazard testing – Part 1: Guidance for assessing the fire hazard of electrotechnical products*

[11] IEC 60695-2 (all parts), *Fire hazard testing – Part 2: Glowing/hot-wire based test methods*

~~[8] IEC 60695-4, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*~~

[12] IEC 60695-5 (all parts), *Fire hazard testing – Part 5: Corrosion damage effects of fire effluent*

[13] IEC 60695-6 (all parts), *Fire hazard testing – Part 6: Smoke obscuration*

[14] IEC 60695-7 (all parts), *Fire hazard testing – Part 7: Toxicity of fire effluent*

[15] IEC 60695-8 (all parts), *Fire hazard testing – Part 8: Heat release*

[16] IEC 60695-9 (all parts), *Fire hazard testing – Part 9: Surface spread of flame*

[17] IEC 60695-10 (all parts), *Fire hazard testing – Part 10: Abnormal heat*

~~[6] Although these publications are not referenced throughout the text, they have, however, been numbered.~~

[18] IEC 60695-11 (all parts), *Fire hazard testing – Part 11: Test flames*

~~[16] ISO/IEC 13943:2008, *Fire safety – Vocabulary*~~

[19] IEC TS 60695-1-14, *Fire hazard testing – Part 1-14: Guidance on the different levels of power and energy related to the probability of ignition and fire in low voltage electrotechnical products*[7]

[20] IEC 60695-1-20, *Fire hazard testing – Part 1-20: Guidance for assessing the fire hazard of electrotechnical products – Ignitability – General guidance*

[21] IEC TS 62441, *Safeguards against accidentally caused candle flame ignition for audio/video, communication and information technology equipment*

[22] ISO 19706:2011, *Guidelines for assessing the fire threat to people*

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INTERNATIONAL STANDARD

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BASIC SAFETY PUBLICATION

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

Essais relatifs aux risques du feu –
Partie 1-10: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Lignes directrices générales

IEC 60695-1-10:2016-11(en-fr)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FIRE HAZARD TESTING –

Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines

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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International Standard IEC 60695-1-10 has been prepared by IEC technical committee 89: Fire hazard testing.

This second edition cancels and replaces the first edition published in 2009. This edition constitutes a technical revision.

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

a) reference to IEC 60695-1-12;
b) modified Introduction and Scope;
c) updated normative references;
d) updated terms and definitions;
e) modified Table 1;

f) addition of Table 2;

g) new text in Subclauses 5.2, 5.3 and 5.4;

h) mandatory text in Clause 8;

i) Annex B changed to Annex A, and modified;

j) new Annex B concerning common ignition sources.

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

FDIS	Report on voting
89/1341/FDIS	89/1347/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

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 60695-1-11 and IEC 60695-1-12.

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.

IEC 60695-1 consists of the following parts:

Part 1-10: *Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

Part 1-11: *Guidance for assessing the fire hazard of electrotechnical products – Fire hazard assessment*

Part 1-12: Guidance for assessing *the fire hazard of electrotechnical products – Fire-safety engineering*

Part 1-20: *Guidance for assessing the fire hazard of electrotechnical products – Ignitability – General guidance*

Part 1-21: *Guidance for assessing the fire hazard of electrotechnical products – Ignitability – Summary and relevance of test methods*

Part 1-30: *Guidance for assessing the fire hazard of electrotechnical products – Preselection testing process – General guidelines*

Part 1-40: *Guidance for assessing the fire hazard of electrotechnical products – Insulating liquids*

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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

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. This standard, together with its companions, IEC 60695-1-11 and IEC 60695-1-12, provides guidance on how this is to be accomplished.

The use of compartments with fire-resistant boundaries, and the use of detection and suppression systems are important methods for the mitigation of fire risk, but are not dealt with in this standard. 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.

Assessing the fire hazard of electrotechnical products is accomplished by performing fire hazard tests. These tests are divided into two fundamental groups: qualitative fire tests and quantitative fire tests.

Fire testing of electrotechnical products should, whenever possible, be carried out using quantitative fire tests having the following characteristics.

a) The test should take into account the circumstances of product use, i.e. contemplated end-use conditions as well as foreseeable abnormal use. This is because fire conditions that may be hazardous under one set of circumstances will not necessarily pose the same threat under a different set.
b) It should be possible to correlate the test results with the harmful effects of fire effluents referred to above, i.e. the thermal and airborne threats to people and/or property in the relevant end-use situation. This avoids the creation of artificial, and sometimes distorted, performance scales with no clear relationship to fire safety.
c) Recognizing that there are usually multiple contributions to the effects of real fires, the test results should be expressed in well-defined terms and using rational scientific units, so that the product's contribution to the overall fire effects can be quantitatively assessed and compared with that of other products' contributions.

Although quantitative tests are preferred, the characteristics of qualitative fire tests are that they provide pass/fail and classification results. Under certain circumstances it will be appropriate to maintain such qualitative test methods or to develop new ones. This part of IEC 60695-1 establishes the circumstances under which such maintenance or development is appropriate.

FIRE HAZARD TESTING –

Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines

1 Scope

This part of IEC 60695-1 provides general guidance with respect to fire hazard testing on how to reduce to a tolerable level the risk of fire and the potential effects of fires involving electrotechnical products. It also serves as a signpost standard to the other guidance publications in the IEC 60695 series.

It does not give guidance on the use of fire-resistant compartment boundaries or on the use of detection and suppression systems for the mitigation of fire risk.

It describes the relationship between fire risk and the potential effects of fire, and provides guidance to IEC product committees on the applicability of qualitative and quantitative fire tests to the fire hazard assessment of electrotechnical products. Details of the calculation of fire risk are not included in the scope of this document.

It emphasises the importance of the scenario approach to fire hazard and risk assessment and discusses criteria intended to ensure the development of technically sound hazard-based fire test methods.

It discusses the different types of fire tests, in particular the nature of qualitative and quantitative fire tests. It also describes the circumstances under which it is appropriate for IEC product committees to maintain or develop qualitative fire tests.

This standard is intended as guidance to IEC committees, and is to be used with respect to their individual applications.

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 60079-0, *Explosive atmospheres − Part 0: Equipment − General requirements*

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

IEC 60695-1-12, *Fire hazard testing – Part 1-12: Guidance for assessing the fire hazard of electrotechnical products – Fire-safety engineering*

IEC 60695-1-30, *Fire hazard testing – Part 1-30: Guidance for assessing the fire hazard of electrotechnical products – Preselection testing process – General guidelines*[1]

IEC 60695-4:2012, *Fire hazard testing – Part 4: Terminology concerning fire tests for electrotechnical products*

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, the terms and definitions given in IEC 60695-4:2012 and ISO 13943:2008 (some of which are reproduced below), as well as the following, apply.

3.1
fire
⟨general⟩ process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, 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* (3.2) and *fire* (3.3), 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, 4.96]

3.2
fire
⟨controlled⟩ self-supporting combustion that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

[SOURCE: ISO 13943:2008, 4.97]

3.3
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

[SOURCE: ISO 13943:2008, 4.98]

3.4
fire hazard
physical object or condition with a potential for an undesirable consequence from *fire* (3.3)

[SOURCE: ISO 13943:2008, 4.112]

[1] Under preparation. Stage at time of publication: IEC/FDIS 60695-1-30:2016.

3.5
fire risk
probability of a *fire* (3.3) combined with a quantified measure of its consequence

Note 1 to entry: It is often calculated as the product of probability and consequence.

[SOURCE: ISO 13943:2008, 4.124]

3.6
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* (3.7) or through the quantification of risk for a group of fire scenarios

[SOURCE: ISO 13943:2008, 4.126]

3.7
fire scenario
qualitative description of the course of a *fire* (3.3) 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 13943:2008, 4.129]

3.8
intermediate-scale fire test
fire test performed on a test specimen of medium dimensions

Note 1 to entry: A fire test performed on a test specimen for which the maximum dimension is between 1 m and 3 m is usually called an intermediate-scale fire test.

[SOURCE: ISO 13943:2008, 4.200]

3.9
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, 4.205]

3.10
qualitative fire test
fire test which is either:

a) a pass/fail test; or

b) a test which categorizes the behaviour of the test specimen by determining its position in a rank order of performance

[SOURCE: IEC 60695-4:2012, 3.2.22]

3.11
quantitative fire test
fire test which takes into account the circumstances of product use in which the test conditions are based on, or are relatable to, the circumstances of use of the test specimen,

and which measures a parameter or parameters, expressed in well-defined terms and using rational scientific units, which can be used in the quantitative assessment of fire risk

[SOURCE: IEC 60695-4:2012, 3.2.23]

3.12
reaction to fire
response of a test specimen when it is exposed to *fire* (3.2) under specified conditions in a fire test

Note 1 to entry: Fire resistance is regarded as a special case and is not normally considered as a reaction to fire property.

[SOURCE: ISO 13943:2008, 4.272]

3.13
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, 4.273]

3.14
short-circuit
unintended connection of two nodes of an electrical circuit

Note 1 to entry: Current flow can occur, which could cause circuit damage, overheating, fire or explosion.

3.15
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, 4.292]

4 Fire hazards associated with electrotechnical products

The transmission, distribution, storage and utilization of electrical energy can have the potential to contribute to fire hazard.

With electrotechnical products, the most frequent causes of ignition are overheating and arcing. The likelihood of ignition will depend on the product and system design, the use of safety devices and systems, and the type of materials used.

Electrotechnical products, when operating, generate heat. In some cases, arcing and sparking are normal phenomena. They should not lead to hazardous conditions provided that they have been taken into account initially at the design stage, and subsequently during installation, use and maintenance.

Although it is a commonly held belief that most electrical fires are caused by a short-circuit, there are many other possible causes of ignition. These can include improper installation, improper usage, and inadequate maintenance. Examples are: operation under overload for temporary or extended periods; operation under conditions not provided for by the manufacturer or contractor; inadequate heat dissipation; faulty ventilation. Table 1 lists common ignition phenomena encountered in electrotechnical products.

In Table 1, unless otherwise indicated, the sources of ignition are considered to be internal to the electrotechnical product. The table lists the most frequently encountered cases.

Fires involving electrotechnical products can also be initiated from external non-electrical sources. Hazardous conditions, which do not arise from the use of the electrotechnical product itself, can and often do involve that product. Considerations of this nature are dealt with in the overall hazard assessment, individual product safety standards, or, for example, by the provisions of IEC TS 62441 [21].

Examples of the power output of potential ignition sources are provided in Annex A.

When designing products, the prevention of ignition in normal and abnormal operating conditions requires a higher priority compared to minimizing the eventual spread of flames.

After ignition has occurred, for whatever reason, the effects of the subsequent fire must be assessed. Factors to be taken into account include:

a) fire growth and flame spread;
b) heat release;
c) smoke generation (visibility);
d) production of toxic fire effluent;
e) production of potentially corrosive fire effluent;
f) the potential for explosion.

References to IEC guidance on items a) to e) can be found in Annex B. The safety of electrotechnical equipment used in explosive atmospheres is discussed in IEC 60079-0.

5 Fundamentals of fire hazard testing

5.1 Objectives

The objectives of fire hazard testing of electrotechnical products are to determine which fire properties of the product contribute to the potential effects of fire and/or how the product or part of the product contributes to the initiation, growth and effect of fire, and then to use this knowledge to reduce the risks of fire in electrotechnical products.

5.2 Fire hazard and fire risk

5.2.1 Fire hazard

A fire hazard is a physical object or condition with a potential for an undesirable consequence from fire (see 3.4). Fire hazards therefore encompass potential fuels and ignition sources. Ignition of an electrotechnical product can be caused by an electrically energised component part. Ignition occurs as a result of an increase in temperature (see IEC 60695-1-20 [20]) that may have a chemical, mechanical or electrical origin.

Common ignition phenomena encountered in electrotechnical products are described in detail in Table 1, which also lists possible consequential effects.

Fires involving electrotechnical products can also be initiated from external non-electrical sources, and an overall fire hazard assessment should include this possibility.

Table 1 – Common causes of ignition encountered in electrotechnical products

Cause [a, b]	Possible origins	Possible consequential effects and comments
Short-circuit (see 3.14)	Direct contact of conducting live parts at different potentials (e.g. because of the loosening of terminals, disengaged conductors, or ingress of conducting foreign bodies). Gradual degradation of some components causing changes in their insulation impedances. Sudden failure of a component or an internal part.	Protection devices [c] may not always be activated. The rise in temperature is significant after a very short time and may be localized. Possible emission of light, smoke and/or flammable gases. Possible production of flames Ignition can occur locally in surrounding components. Possible release of glowing material.
Accidental sparks or arcs NOTE 1 Some products produce sparks or arcs in normal operation.	A cause external to the product (e.g. overvoltage of the system network, or an accidental mechanical action that exposes live parts). An internal cause (e.g. gradual degradation of a component, or ingress of moisture). Sudden failure of a component or an internal part.	Protection devices [c] may not always be activated. Possible emission of light, smoke and/or flammable gases. Possible production of flames. Substantial risk of ignition in potentially explosive atmospheres. Ignition can occur locally in surrounding components or gases.
High transient peak current	A defect in the electrical circuit. A cause external to the product (e.g. overvoltage of the system network).	Protection devices [c] may not always be activated.
An abnormal temperature rise (other than that caused by any of the above) NOTE 2 Some products dissipate heat in normal operation.	Overcurrent in a conductor. Defective contacts. Leakage currents (insulation loss and heating). Failure of a component, an internal part or an associated system, e.g. ventilation. Mechanical distortions which modify electrical contacts or the insulation system. Seizure of a motor shaft (locked rotor). Premature thermal ageing.	At start-up, protection devices [c] are not normally activated (except in special protection cases). They may be activated after a variable length of time. The temperature rises are gradual and can be very slow. Therefore a significant accumulation of heat and effluent in the vicinity of the product may result, sufficient to support fire as soon as ignition occurs. Accumulation and diffusion of flammable gases in air may give rise to an ignition or explosion, especially inside hermetically sealed products. A seized motor shaft (locked rotor) can cause smouldering or flaming due to excessive heating of the windings of the motor.

[a] The sequence indicated is not related to the magnitude or frequency of occurrence.

[b] Mechanical distortions and structural changes induced by any one of the four causes can result in the occurrence of one or more of the other three.

[c] The protection devices can include thermal (fuse), mechanical (circuit breaker), electrical or electronic types.

5.2.2 Fire risk

5.2.2.1 Quantification of fire risk

In order to calculate fire risk, it is necessary to quantify the consequences of the fire that is being assessed. The consequences may refer to injury or loss of life from threats such as heat, low oxygen levels, or the concentration of incapacitating fire gases; or the consequences may refer to loss of property, such as the extent of fire damage. A wide range of potential fire scenarios may be analysed quantitatively to establish measures of overall fire risk.

If c is the consequence of the fire (i.e. a quantified measure), and p is the probability of the fire occurring within a defined time period, then the fire risk (in that time period) is usually calculated as the product of p and c:

$$\text{Fire risk} = p \times c \tag{1}$$

If it is assumed that, within a given time-frame, that there is a probability, p_1, of a fire incident involving a given product in a given scenario (scenario 1), and a probability, p_2, of a fire incident involving the same product in a different scenario (scenario 2), and so on, covering all relevant scenarios, the total fire risk associated with that product, within that time-frame is:

$$\text{Total fire risk} = \sum_{i=1}^{m} p_i c_i \tag{2}$$

where

p_i is the probability of scenario i;

c_i is the consequence of scenario i;

m is the total number of scenarios being considered.

NOTE Further discussions of fire risk, and its use in selecting scenarios on which to base fire hazard tests, can be found in ISO/TS 16732 [1][2].

5.2.2.2 Mitigation of fire risk

There are two ways of mitigating fire risks. One is to reduce the probability of occurrence (reduction of p in Equation 1). The other is to reduce the consequence (reduction of c in Equation 1). Fire hazard testing is concerned with the reduction of p.

There are several distinct ways in which the probability of fire can be reduced. The most important, in no particular order, are:

a) product design and selection, including the selection of appropriate materials;

b) containment using fire resistant enclosures and compartment boundaries;

c) the use of appropriate assembly and installation methods;

d) the incorporation of circuit protection devices;

e) the use of detection and suppression systems.

Fire tests (see Clause 6) are used principally for a) and b) and also to some extent for c).

NOTE 1 Guidance on containment and fire resistance testing for buildings is given in the ISO 834 series of standards [2].

2 Numbers in square brackets refer to the Bibliography.

NOTE 2 Guidance on detection, activation and suppression is given in ISO/TR 13387-7 [3].

5.3 Fire scenarios

Fire scenarios differ in fire stages (phases), the oxygen content, the CO/CO_2 ratio, the temperature and the irradiance (see Table 2).

Analysis of the circumstances of use of a product involved in a given fire incident (real or hypothetical) facilitates the description of the conditions and the chain of events that play a significant role in the outcome of the fire.

Analysis of product fire incidence using the scenario approach links product fire behaviour to the outcome of the incident. Part of the rationale for choosing any set of fire hazard tests of an electrotechnical product should be a description of the fire scenario or scenarios on which the set of tests is based. This effectively tells the user why this set of test and exposure conditions was chosen and not another.

Table 2 – Characteristics of fire stages *(from Table 1 in ISO 19706:2011* [22]*)*

Fire stage	Heat flux to fuel surface kW/m²	Max. temperature °C		Oxygen volume %		Fuel/air equivalence ratio (plume)	$\frac{[CO]}{[CO_2]}$ v/v	$\frac{100 \times [CO_2]}{([CO_2]+[CO])}$ % efficiency
		Fuel surface	Upper layer	Entrained	Exhausted			
1. Non-flaming								
a. self-sustaining (smouldering)	not applicable	450 to 800	25 to 85 [d]	20	20	–	0,1 to 1	50 to 90
b. oxidative pyrolysis from externally applied radiation	–	300 to 600 a	[b]	20	20	< 1	[c]	[c]
c. anaerobic pyrolysis from externally applied radiation	–	100 to 500	[b]	0	0	>> 1	[c]	[c]
2. Well-ventilated flaming [d]	0 to 60	350 to 650	50 to 500	≈ 20	≈ 20	< 1	< 0,05 [e]	> 95
3. Underventilated flaming [f]								
a. small, localized fire, generally in a poorly ventilated compartment	0 to 30	300 to 600 [a]	50 to 500	15 to 20	5 to 10	> 1	0,2 to 0,4	70 to 80
b. post-flashover fire	50 to 150	350 to 650 [g]	> 600	< 15	< 5	> 1 [h]	0,1 to 0,4 [i]	70 to 90

[a] The upper limit is lower than for well-ventilated flaming combustion of a given combustible.

[b] The temperature in the upper layer of the fire room is most likely determined by the source of the externally applied radiation and room geometry.

[c] There are few data, but for pyrolysis this ratio is expected to vary widely depending on the material chemistry and the local ventilation and thermal conditions.

[d] The fire's oxygen consumption is small compared to that in the room or the inflow, the flame tip is below the hot gas upper layer or the upper layer is not yet significantly vitiated to increase the CO yield significantly, the flames are not truncated by contact with another object, and the burning rate is controlled by the availability of fuel.

[e] The ratio can be up to an order of magnitude higher for materials that are fire-resistant. There is no significant increase in this ratio for equivalence ratios up to ≈ 0,75. Between ≈ 0,75 and 1, some increase in this ratio can occur.

[f] The fire's oxygen demand is limited by the ventilation opening(s); the flames extend into the upper layer.

[g] Assumed to be similar to well-ventilated flaming.

[h] The plume equivalence ratio has not been measured; the use of a global equivalence ratio is inappropriate.

[i] Instances of lower ratios have been measured. Generally, these result from secondary combustion outside the room vent.

5.4 Fire-safety engineering

Although the definition of fire-safety engineering given in 3.6 is principally concerned with the major fire safety characteristics of civil engineering scenarios, some aspects of fire-safety engineering are applicable to electrotechnical products. It follows that, if the principles of fire-safety engineering are to be adhered to, quantitative fire tests are required. Guidance on fire-safety engineering is given in IEC 60695-1-12.

5.5 Fire hazard assessment

The methodology of fire hazard assessment is intended to identify significant fire scenarios associated with a given electrotechnical product in order to establish:

a) the extent to which the fire properties of the product are relevant to the significant scenarios, and
b) appropriate test methods and performance requirements.

A full fire hazard assessment for a product may involve more than one fire scenario, in which case the resulting procedure may include several tests and multiple scenario-dependent performance criteria.

The procedure for conducting a fire hazard assessment of a fire scenario is detailed in IEC 60695-1-11.

6 Types of fire test

6.1 General

Assessing the fire hazard of electrotechnical products is accomplished by performing fire tests which, dependent on the maximum dimension of the test specimen, can be small-scale (see 3.15), intermediate-scale (see 3.8), large-scale (see 3.9) or real-scale tests (see 3.13). Due to the test criteria, all types of fire hazard tests applied to electrotechnical products are divided into two fundamental groups: qualitative fire tests (see 3.10) and quantitative fire tests (see 3.11).

6.2 Quantitative and qualitative groups of fire tests

6.2.1 Quantitative fire tests

Quantitative fire test criteria are defined as follows.

a) Quantitative fire tests take into account the circumstances of product use in which the test conditions are based, i.e. expected end-use conditions as well as foreseeable abnormal use. This is because fire conditions that may be hazardous under one set of circumstances will not necessarily pose the same threat under a different set of circumstances.
b) Quantitative fire tests have the possibility of allowing the correlation of the test results with the harmful effects of fire effluents referred to above, i.e. the thermal and airborne threats to people and/or property in the relevant end situation. This correlation avoids the possibility of the creation of artificial and sometimes distorted performance scales with no clear relationship to fire safety.
c) Test results from quantitative fire tests should be expressed in well-defined terms and use rational scientific units so that the product contribution to the overall fire effects can be quantitatively assessed and compared with the contributions of other products.

When fire tests for electrotechnical products are revised or when new ones are developed, they should preferably be quantitative fire tests. Technical committees are encouraged to adopt the use of quantitative fire tests whenever possible. Consideration should be given to specific measurements that reflect hazards from end-use conditions.

6.2.2 Qualitative fire tests

Qualitative fire tests are those which express results on a discontinuous scale. The qualitative fire tests group includes pass-fail tests and other tests which classify products according to their position in a rank order of performance. Qualitative fire tests do not give data which are suitable for the purpose of quantifying fire risks. The results of such tests cannot be correlated with real-scale fire performance as the test conditions cannot be related to the fire scenario or scenarios of concern. However, because the qualitative fire tests classify products with regard to fire risk or give a clear pass-fail result when tested according to the standardized fire test procedure, this group of tests is useful at the material preselection level or for particular end-product testing and, under certain circumstances, the results of a qualitative test can be used indirectly in fire hazard assessment of electrotechnical products.

6.3 Types of fire tests

6.3.1 Fire simulation test

Fire simulation tests (also known as real-scale fire tests – see 3.13) examine the reaction to fire of electrotechnical products and are intended to be as representative as possible of the use of the product in practice. Since the real conditions of use (including foreseeable abnormal use, malfunction, or failure) of a product are simulated as closely as possible, and the design of the test procedure is related to actual risks, such tests assess the relevant aspects of the fire hazard associated with the use of the product. The findings of such tests may not be valid when a change in the design is made, or when the conditions of use are different from those simulated in the test.

6.3.2 Fire resistance tests

Fire resistance tests are intended to assess the ability of a product or a part to retain its functional properties under specified conditions of exposure to fire, for a stated period of time. They are intended to provide data on the behaviour and performance of a product or a finished assembly under a particular condition of heat, fire or test flame exposure.

Recent studies have shown that to relate the findings of such tests to performance in actual fire situations, very careful consideration needs to be given to a comparison of the test conditions with actual fire situations and the possible effect of any uncontrolled variables, such as the environment in which the product is placed.

NOTE 1 Many fire resistance tests have been developed by ISO to test building products and are defined in the ISO 834 series [2].

NOTE 2 Examples of IEC fire resistance tests of electric cables, which are known as circuit integrity tests, are defined in the IEC 60331 series [4].

6.3.3 Tests with regard to reaction to fire

Tests of reaction to fire are carried out on standard test specimens under defined conditions and in most cases are used to give data on properties related to burning behaviour and for comparative evaluation. Properties such as ignitability, flammability, flame spread, heat release, smoke production, toxic gas production, and corrosive gas production are measured.

6.3.4 Preselection fire tests

A preselection fire test is one which is used in the process of assessing and choosing candidate materials, components or sub-assemblies for making an end product. Guidance on the use of the preselection testing procedure is given in IEC 60695-1-30.

6.3.5 Basic property tests

Basic property tests are designed to ensure that, on measuring a basic physical or chemical property of a material, they yield information that is independent of the testing method. Properties relevant to the assessment of fire hazard include, for example, thermal conductivity, thermal capacity, density, melting point, boiling point, heat of vaporization, and heat of combustion.

7 Appropriate use of qualitative fire tests

It is recognized that there are circumstances where existing qualitative fire tests should be maintained and where the development of new qualitative fire tests is acceptable.

A qualitative fire test may be maintained and/or developed if:

a) the test is cited in, or used as the basis for, regulations having the force of law; or
b) the test produces a clear fire safety benefit; or
c) the test is intended solely for quality control or developmental purposes (and this intention is stated in the body of the standard); or
d) the test is used as a preselection test.

8 Preparation of requirements and test specifications

When preparing requirements and test specifications concerning the fire hazard testing of electrotechnical products, it is suggested that technical committees follow the procedures shown below. In cases where fire tests are not yet specified, and need to be developed or altered for the special purpose of an IEC technical committee, this shall be done in liaison with TC 89 as mandated by IEC Guide 104.

The test method(s) selected shall be relevant to the fire scenario of concern.

Procedure:

a) Examine the known existing and recommended test methods developed for a similar purpose and consider their possible applicability and limitations.
b) Collect as much relevant background information as possible on the fire scenario, or scenarios, of concern.
c) Take into account the relevant scope and significance of the existing test methods.
d) If an existing test method appears suitable, check its provisions against the following features.
   – It should preferably be a quantitative fire test. The test conditions should be related to the fire scenario, or scenarios, of concern, and the measured parameters should be appropriate for the purpose of designing the product based on fire-safety engineering.
   – If it is a qualitative fire test, it shall meet the requirements given in Clause 7.
   – Relevant characteristics of the test method should be checked for their sensitivity (e.g. detection level), reproducibility and repeatability.
e) Undertake an investigation of the proposed test procedure and study its ability to meet the objectives.
f) Prepare the standard for the test method, including the relevant information on its field of application, its limitations and reservations, and on the use of the test results obtained. Make reference in the standard to recommended test procedures wherever possible.

9 Common ignition sources

A list of some common electrical and non-electrical ignition sources is given in Annex A.

10 Reference documents of TC 89

A list of reference documents developed by the IEC is given in Annex B.

Annex A
(informative)

The power output of ignition sources

A.1 General

Fires can be started from as small a source as a single spark. However, in the field of electrotechnical products, with appropriate choice of materials and design, it is often assumed that ignition is unlikely to occur if the electrical power consumption is less than 15 W.

For example, in IEC 60950-1 [5], parts used in information technology equipment do not require a fire enclosure if they are supplied with a power source of no more than 15 W, and in IEC 60065 [6], 15 W is also used as a limit above which printed boards must be category V-1 or better according to IEC 60695-11-10 unless protected by a suitable enclosure.

NOTE Further guidance on the different levels of power and energy related to the probability of ignition and fire in low voltage electrotechnical products is given in IEC TS 60695-1-14 [19] (under preparation).

A.2 Some common electrical and non-electrical ignition sources

Table A.1 lists some common electrical and non-electrical ignition sources and provides some information about their power and energy.

Table A.1 – Examples of ignition sources

Source of ignition	Publication number	Duration / s [a]	Power / W	Energy / kJ
Needle flame	IEC 60695-11-5 [18]	5 to 120 [b]	38 to 50 [c]	0,19 to 6,0
50W flame	IEC 60695-11-10 [18]	30 (Test method A)	50 [d]	1,5
Match flame	–	–	approx. 40 [e]	–
Candle flame	–	–	approx. 90 [f]	–
Glow-wire at 550 °C	IEC 60695-2-10 [11]	30	approx. 55	approx. 1,65
Glow-wire at 750 °C	IEC 60695-2-10 [11]	30	approx. 120	approx. 3,6
Glow-wire at 960 °C	IEC 60695-2-10 [11]	30	approx. 240	approx. 7,2
500 W flame	IEC 60695-11-20 [18]	25 (Bar test procedure)	500 [d]	12,5
1 kW flame	IEC 60332-1-2 [7]	60 (Cables with D ≤ 25 mm)	1 000 [d]	30
1 sheet of crumpled paper [8]	–	152	2 237	340
Waste paper basket [8]	–	360	9 444	3 400

[a] In fire tests, the duration refers to the time that the ignition source is applied to the test specimen.

[b] Preferred times are 5 s, 10 s, 20 s, 30 s, 60 s and 120 s.

[c] Assessments of the power of the flame vary. With butane, values of 49,75 W and 37,8 W have been calculated; with propane, a value of 40,4 W has been calculated.

[d] Nominal value.

[e] A typical household match (e.g. 2 mm × 2 mm × 45 mm) has a mass of about 0,08 g and burns horizontally in 25 s to 35 s. Matchwood has a heat of combustion of about 15 kJ/g. This equates to an average energy output of approximately 40 W.

[f] A typical household candle has a mass of 38 g and burns in 5 h (manufacturer's data – Price's Candles[3]). The heat of combustion of candle wax is about 42 kJ/g. This equates to an average energy output of approximately 90 W.

A.3 Power source classification in IEC 62368-1 [9]

IEC 62368-1 specifies safeguards for persons using audio/video, information and communication technology equipment.

With respect to electrically-caused fire, three classes of power source are defined:

– PS1 – a circuit where the power source does not exceed 500 W during the first 3 s and does not exceed 15 W after 3 s;

– PS2 – a circuit that exceeds PS1 limits, but does not exceed 100 W after 5 s;

– PS3 – a circuit that exceeds PS2 limits.

Various requirements are specified based on these classifications.

The following assumptions are made:

– PS1 – ignition is not likely to occur;

– PS2 – ignition can occur under some conditions, but there will be limited growth and spread of fire;

– PS3 – ignition may occur and fire will spread where fuel is available.

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3 Price's Candles is an example of a candle manufacturer. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of their products.

Annex B
(informative)

Guidance publications and test methods

Guidance publications and test methods developed by the IEC are shown in Table B.1 (see [10] to [18]).

Table B.1 – TC 89 guidance publications and test methods

Subject	Reference
Fire hazard testing	
General guidelines	IEC 60695-1-10
Fire hazard assessment	IEC 60695-1-11
Fire-safety engineering	IEC 60695-1-12
Preselection testing process	IEC 60695-1-30
Insulating liquids	IEC 60695-1-40
Terms and definitions	
Terminology (see also ISO 13943)	IEC 60695-4
Ignitability	
General guidance	IEC 60695-1-20
Summary and relevance of test methods	IEC 60695-1-21
Ignition characteristics – Test method using heat flux from a flame	IEC 60695-11-11
Glow-wire ignitability test for materials	IEC 60695-2-13
Corrosivity	
General guidance	IEC 60695-5-1
Summary and relevance of test methods	IEC 60695-5-2
Smoke	
General guidance	IEC 60695-6-1
Summary and relevance of test methods	IEC 60695-6-2
Toxicity	
General guidance	IEC 60695-7-1
Summary and relevance of test methods	IEC 60695-7-2
Use and interpretation of test results	IEC 60695-7-3
Heat release	
General guidance	IEC 60695-8-1
Summary and relevance of test methods	IEC 60695-8-2
Surface spread of flame	
General guidance	IEC 60695-9-1
Summary and relevance of test methods	IEC 60695-9-2
Glow-wire test – Flammability test – End products	IEC 60695-2-11
Glow-wire test – Flammability test – Materials	IEC 60695-2-12
Resistance to abnormal heat	
Ball pressure test	IEC 60695-10-2
Mould stress relief distortion test	IEC 60695-10-3
Test flames	

Subject	Reference
1 kW flame – Apparatus	IEC 60695-11-2
500 W flame – Apparatus	IEC 60695-11-3
50 W flame – Apparatus	IEC 60695-11-4
Needle flame – Apparatus	IEC 60695-11-5
History and development 1979-1999	IEC 60695-11-30
Confirmatory tests – Guidance	IEC 60695-11-40
Flame test methods	
Needle flame	IEC 60695-11-5
Heat flux from a non-contacting flame	IEC 60695-11-11
50 W horizontal and vertical test methods	IEC 60695-11-10
500 W test methods	IEC 60695-11-20
500 W vertical test method for tubular polymeric materials	IEC 60695-11-21
Glow-wire tests	
Apparatus and common test procedure	IEC 60695-2-10
End products – flammability test	IEC 60695-2-11
Materials – flammability test	IEC 60695-2-12
Materials – ignitability	IEC 60695-2-13

Bibliography

[1] ISO/TS 16732:2005, *Fire-safety engineering – Guidance on fire risk assessment*

[2] ISO 834 (all parts), *Fire-resistance tests – Elements of building construction*

[3] ISO/TR 13387-7, *Fire-safety engineering – Part 7: Detection, activation and suppression.*

[4] IEC 60331 (all parts), *Tests for electric cables under fire conditions – Circuit integrity*

[5] IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

[6] IEC 60065, *Audio, video and similar electronic apparatus – Safety requirements*

[7] IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

[8] Paul, K. T. and Christian, S. D., J. Fire Sciences, 5(3), 178-211, 1987.

[9] IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

[10] IEC 60695-1 (all parts), *Fire hazard testing – Part 1: Guidance for assessing the fire hazard of electrotechnical products*

[11] IEC 60695-2 (all parts), *Fire hazard testing – Part 2: Glowing/hot-wire based test methods*

[12] IEC 60695-5 (all parts), *Fire hazard testing – Part 5: Corrosion damage effects of fire effluent*

[13] IEC 60695-6 (all parts), *Fire hazard testing – Part 6: Smoke obscuration*

[14] IEC 60695-7 (all parts), *Fire hazard testing – Part 7: Toxicity of fire effluent*

[15] IEC 60695-8 (all parts), *Fire hazard testing – Part 8: Heat release*

[16] IEC 60695-9 (all parts), *Fire hazard testing – Part 9: Surface spread of flame*

[17] IEC 60695-10 (all parts), *Fire hazard testing – Part 10: Abnormal heat*

[18] IEC 60695-11 (all parts), *Fire hazard testing – Part 11: Test flames*

[19] IEC TS 60695-1-14, *Fire hazard testing – Part 1-14: Guidance on the different levels of power and energy related to the probability of ignition and fire in low voltage electrotechnical products*[4]

[20] IEC 60695-1-20, *Fire hazard testing – Part 1-20: Guidance for assessing the fire hazard of electrotechnical products – Ignitability – General guidance*

4 Under preparation. Stage at time of publication: IEC/DTS 60695-1-14:2016.

[21] IEC TS 62441, *Safeguards against accidentally caused candle flame ignition for audio/video, communication and information technology equipment*

[22] ISO 19706:2011, *Guidelines for assessing the fire threat to people*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

ESSAIS RELATIFS AUX RISQUES DU FEU –

Partie 1-10: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Lignes directrices générales

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9) L'attention est attirée sur le fait que certains des éléments de la présente Publication de l'IEC peuvent faire l'objet de droits de brevet. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets et de ne pas avoir signalé leur existence.

La Norme internationale IEC 60695-1-10 a été établie par le comité d'études 89 de l'IEC: Essais relatifs aux risques du feu.

Cette deuxième édition annule et remplace la première édition parue en 2009. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) référence à l'IEC 60695-1-12;
b) modification de l'Introduction et du Domaine d'application;
c) mise à jour des références normatives;

d) mise à jour des termes et définitions;

e) modification du Tableau 1;

f) ajout du Tableau 2

g) nouveau texte dans les Articles 5.2, 5.3 et 5.4.

h) texte obligatoire à l'Article 8.

i) annexe B renommée Annexe A, et modifiée.

j) ajout d'une Annexe B relative aux sources d'allumage communes.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
89/1341/FDIS	89/1347/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Elle a le statut d'une publication fondamentale de sécurité conformément au Guide IEC 104 et au Guide ISO/IEC 51.

Cette Norme Internationale doit être utilisée conjointement avec l'IEC 60695-1-11 et l'IEC 60695-1-12.

Une liste de toutes les parties de la série IEC 60695, publiées sous le titre général *Essais relatifs aux risques du feu,* peut être consultée sur le site web de l'IEC.

L'IEC 60695-1 est constituée des parties suivantes:

Partie 1-10: *Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Lignes directrices générales*

Partie 1-11: *Lignes directrices pour l'évaluation du danger du feu des produits électrotechniques – Evaluation du danger du feu*

Partie 1-12: *Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Ingénierie de la sécurité incendie*

Partie 1-20 *Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Allumabilité – Lignes directrices générales*

Partie 1-21 *Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Allumabilité – Résumé et pertinence des méthodes d'essais*

Partie 1-30 *Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Processus d'essai de présélection – Lignes directrices générales*

Partie 1-40 *Guide pour l'évaluation des risques du feu des produits électrotechniques – Liquides isolants*

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

INTRODUCTION

Il est nécessaire de prendre en considération le risque d'incendie et les dangers potentiels associés au feu dans la conception de tout produit électrotechnique. A cet égard, la conception des composants, des circuits et des équipements, ainsi que le choix des matériaux, ont pour objectif de réduire le risque d'incendie à un niveau acceptable, même dans le cas d'une (mauvaise) utilisation raisonnablement prévisible, d'un dysfonctionnement ou d'une défaillance. La présente norme, conjointement à ses normes d'accompagnement, l'IEC 60695-1-11 et l'IEC 60695-1-12, fournit des lignes directrices sur la méthode qui doit être appliquée pour y parvenir.

L'utilisation de compartiments munis de parois résistantes au feu, et l'utilisation de systèmes de détection et de suppression sont des méthodes importantes pour la réduction du risque d'incendie, mais ne sont pas couvertes par la présente norme. Les feux impliquant des produits électrotechniques peuvent être déclenchés par des sources externes non électriques. Les considérations de cette nature sont traitées dans le cadre de l'évaluation globale des dangers d'incendie.

La série de normes IEC 60695 a pour objet de sauver des vies et de préserver des biens en réduisant le nombre de feux ou les conséquences du feu. Ceci peut être réalisé en:

- tentant de prévenir l'allumage provoqué par un composant sous tension et, dans l'éventualité d'un allumage, de circonscrire le feu qui en résulte dans les limites de l'enceinte du produit électrotechnique;
- tentant de réduire le plus possible la propagation de la flamme au-delà de l'enceinte du produit et de réduire le plus possible les effets préjudiciables des effluents du feu, y compris la chaleur, la fumée et les produits de combustion toxiques ou corrosifs.

Le danger d'incendie des produits électrotechniques est évalué au moyen d'essais relatifs aux dangers d'incendie. Ces essais sont divisés en deux groupes fondamentaux: les essais au feu qualitatifs et les essais au feu quantitatifs.

Il convient, dans la mesure du possible, de réaliser les essais au feu des produits électrotechniques au moyen d'essais au feu quantitatifs ayant les caractéristiques suivantes.

a) Il convient que l'essai tienne compte des circonstances de l'utilisation du produit, c'est-à-dire les conditions d'utilisation finale prévues ainsi que l'utilisation anormale prévisible. En effet, les conditions d'incendie qui peuvent être dangereuses dans un ensemble donné de circonstances ne constituent pas nécessairement la même menace dans un ensemble différent.
b) Il convient qu'il soit possible de corréler les résultats des essais aux effets préjudiciables des effluents du feu cités plus haut, c'est-à-dire les menaces thermiques et véhiculées dans l'air pour les personnes et/ou les biens dans la situation d'utilisation finale concernée. Cela évite de créer des échelles de performances, artificielles et parfois déformées, n'ayant pas de rapport clair avec la sécurité incendie.
c) Bien que les contributions aux effets des incendies réels soient habituellement multiples, il convient d'exprimer les résultats d'essai en des termes bien définis et au moyen d'unités scientifiques rationnelles, de manière à pouvoir évaluer quantitativement les contributions du produit aux effets globaux du feu et les comparer à celles dues aux autres produits.

Bien que les essais quantitatifs soient préférentiels, les caractéristiques des essais au feu qualitatifs sont telles qu'ils fournissent des résultats de succès/d'échec et de classification. Dans certaines circonstances, il est approprié de maintenir de telles méthodes d'essais qualitatifs ou d'en développer de nouvelles. La présente partie de l'IEC 60695-1 établit les circonstances dans lesquelles le maintien ou la mise au point est approprié(e).

ESSAIS RELATIFS AUX RISQUES DU FEU –

Partie 1-10: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Lignes directrices générales

1 Domaine d'application

La présente partie de l'IEC 60695-1 fournit des lignes directrices générales concernant les essais relatifs aux dangers d'incendie, sur la manière de réduire à un niveau acceptable le risque d'incendie et les effets potentiels des incendies impliquant des produits électrotechniques. Elle sert aussi de norme de référence pour les autres publications donnant des lignes directrices dans la série IEC 60695.

La présente partie ne fournit pas de lignes directrices relatives à l'utilisation de parois de compartiment résistant au feu ou de systèmes de détection et de suppression pour la réduction du risque d'incendie.

Elle décrit la relation entre le risque d'incendie et les effets potentiels des incendies. Elle fournit des lignes directrices aux comités de produits de l'IEC sur la pertinence des essais au feu qualitatifs et quantitatifs pour l'évaluation des dangers d'incendie des produits électrotechniques. Les détails du calcul du risque d'incendie ne sont pas couverts par le domaine d'application du présent document.

Elle souligne l'importance de l'approche par scénario pour l'évaluation des dangers d'incendie et des risques d'incendie. Elle traite également des critères visant à assurer le développement de méthodes d'essai au feu basées sur les dangers qui soient techniquement solides.

Elle traite des différents types d'essais au feu et, en particulier, de la nature des essais qualitatifs et quantitatifs. Elle décrit aussi les circonstances pour lesquelles il est approprié pour les comités de produits de l'IEC de maintenir ou de mettre au point des essais au feu qualitatifs.

La présente norme est destinée à fournir des lignes directrices pour les comités de l'IEC et il convient de les utiliser en fonction de leurs applications particulières.

La présente publication fondamentale de sécurité est destinée à être utilisée par les comités d'études dans le cadre de l'élaboration de normes conformément aux principes établis dans le Guide IEC 104 et le Guide ISO/IEC 51.

L'une des responsabilités d'un comité d'études consiste, le cas échéant, à utiliser les publications fondamentales de sécurité dans le cadre de l'élaboration de ses publications. Les exigences, méthodes d'essai ou conditions d'essai de la présente publication fondamentale de sécurité ne s'appliquent pas sauf si elles sont spécifiquement citées en référence ou incluses dans les publications correspondantes.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60079-0, *Atmosphères explosives – Partie 0: Matériel – Exigences générales*

IEC 60695-1-11, *Essais relatifs aux risque du feu – Partie 1-11: Lignes directrices pour l'évaluation du danger du feu des produits électrotechniques – Evaluation du danger du feu*

IEC 60695-1-12, *Essais relatifs aux risques du feu – Partie 1-12: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Ingénierie de la sécurité incendie*

IEC 60695-1-30, *Essais relatifs aux risques du feu – Partie 1-30: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Processus d'essai de présélection – Lignes directrices générales*[1]

IEC 60695-4:2012, *Essais relatifs aux risques du feu – Partie 4: Terminologie relative aux essais au feu pour les produits électrotechniques*

Guide IEC 104, *The preparation of safety publications and the use of basic safety publications and group safety publications (disponible en anglais seulement)*

Guide ISO/IEC 51, *Aspects liés à la sécurité – Principes directeurs pour les inclure dans les normes*

ISO 13943:2008, *Sécurité au feu – Vocabulaire*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions de l'IEC 60695-4:2012 et de l'ISO 13943:2008 (dont certains sont reproduits ci-dessous), ainsi que les suivants s'appliquent.

3.1
feu
⟨général⟩ processus de combustion caractérisé par l'émission de chaleur et d'effluents du feu et accompagné généralement par de la fumée, des flammes, une incandescence, ou par une combinaison de ces éléments

Note 1 à l'article: En anglais, le terme «fire» est utilisé pour désigner trois concepts, dont deux, *fire* (3.2) et *fire* (3.3), se rapportent à des types spécifiques de combustion auto-entretenue ayant des significations diverses et deux d'entre eux sont désignés par deux termes différents, tant en français qu'en allemand.

[SOURCE: ISO 13943:2008, 4.96]

3.2
feu
⟨contrôlé⟩ combustion auto-entretenue qui a été délibérément assurée pour produire des effets utiles et dont l'extension dans le temps et l'espace est contrôlée

[SOURCE: ISO 13943:2008, 4.97]

3.3
incendie
⟨non contrôlé⟩ combustion auto-entretenue qui n'a pas été délibérément assurée pour produire des effets utiles et dont l'extension dans le temps et l'espace n'est pas contrôlée

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1 En préparation. Stade au moment de la publication: IEC/FDIS 60695-1-30:2016.

[SOURCE: ISO 13943:2008, 4.98]

3.4
danger d'incendie
objet physique ou condition susceptible d'entraîner des conséquences non souhaitables causées par un *incendie* (3.3)

[SOURCE: ISO 13943:2008, 4.112]

3.5
risque d'incendie
combinaison entre la probabilité qu'un *incendie* (3.3) se produise et les conséquences particulières quantifiées qui en découlent

Note 1 à l'article: Il est souvent calculé comme le produit de la probabilité et des conséquences.

[SOURCE: ISO 13943:2008, 4.124]

3.6
ingénierie de la sécurité incendie
application des méthodes d'ingénierie fondées sur des principes scientifiques au développement ou à l'évaluation de conceptions dans un environnement bâti au moyen de l'analyse de *scénarios d'incendie* (3.7) spécifiques ou bien par la quantification du risque pour un groupe de scénarios d'incendie

[SOURCE: ISO 13943:2008, 4.126]

3.7
scénario d'incendie
description qualitative du déroulement d'un *incendie* (3.3) dans le temps, identifiant les événements clés qui caractérisent l'incendie et le différencient des autres incendies potentiels

Note 1 à l'article: Il définit typiquement les processus d'allumage et de croissance du feu, le stade de feu complètement développé, le stade de déclin du feu ainsi que l'environnement et les systèmes qui interviennent dans le déroulement de l'incendie.

[SOURCE: ISO 13943:2008, 4.129]

3.8
essai au feu à échelle intermédiaire
essai au feu effectué sur une éprouvette d'essai de dimensions moyennes

Note 1 à l'article: Un essai au feu effectué sur une éprouvette dont la dimension maximale est située entre 1 m et 3 m est habituellement appelé «essai à échelle intermédiaire».

[SOURCE: ISO 13943:2008, 4.200]

3.9
essai au feu à grande échelle
essai au feu, qui ne peut pas être réalisé dans une pièce typique de laboratoire et qui est effectué sur une éprouvette d'essai de grandes dimensions

Note 1 à l'article: Un essai au feu effectué sur une éprouvette dont la dimension maximale est supérieure à 3 m est habituellement appelé essai à grande échelle.

[SOURCE: ISO 13943:2008, 4.205]

3.10
essai au feu qualitatif
essai au feu qui est soit:

a) un essai de succès/d'échec; soit

b) un essai qui catégorise le comportement de l'éprouvette d'essai en déterminant sa position selon une gradation de performance

[SOURCE: IEC 60695-4:2012, 3.2.22]

3.11
essai au feu quantitatif
essai au feu qui tient compte des circonstances de l'utilisation du produit sur lesquelles se fondent les conditions d'essai ou qui sont liées aux circonstances d'utilisation de l'éprouvette d'essai, et qui mesure un ou des paramètres, exprimé(s) dans des termes bien définis et utilisant des unités scientifiques rationnelles, qui peuvent être utilisées dans l'évaluation quantitative du risque au feu

[SOURCE: IEC 60695-4:2012, 3.2.23]

3.12
réaction au feu
réponse d'une éprouvette d'essai lorsqu'elle est exposée au *feu* (3.2) dans des conditions spécifiées d'essai au feu

Note 1 à l'article: La résistance au feu est considérée comme un cas spécial et n'est pas normalement considérée comme une propriété de «réaction au feu».

[SOURCE: ISO 13943:2008, 4.272]

3.13
essai au feu en grandeur réelle
essai au feu qui simule une application donnée en prenant en compte les dimensions réelles, l'utilisation ou l'installation réelle de l'objet et l'environnement

Note 1 à l'article: Cet essai suppose que les produits sont utilisés suivant les conditions fixées par le prescripteur ou conformément à la pratique normale.

[SOURCE: ISO 13943:2008, 4.273]

3.14
court-circuit
connexion non prévue entre deux nœuds d'un circuit électrique

Note 1 à l'article: Un courant peut apparaître, ce qui peut provoquer un dommage sur le circuit, un échauffement, un incendie ou une explosion.

3.15
essai au feu à petite échelle
essai au feu effectué sur une éprouvette d'essai de petites dimensions

Note 1 à l'article: Un essai au feu effectué sur une éprouvette dont la dimension maximale est inférieure à 1 m est habituellement appelé «essai au feu à petite échelle».

[SOURCE: ISO 13943:2008, 4.292]

4 Dangers d'incendie associés à des produits électrotechniques

Le transport, la distribution, le stockage et l'utilisation de l'énergie électrique peuvent potentiellement contribuer à un danger d'incendie.

Dans le cas des produits électrotechniques, les causes les plus fréquentes d'allumage sont les échauffements excessifs et les arcs électriques. La probabilité d'allumage dépend de la conception du produit et du système, de l'utilisation de dispositifs et de systèmes de sécurité et du type de matériaux utilisés.

Le fonctionnement des produits électrotechniques engendre de la chaleur. Dans certains cas, les arcs électriques et les étincelles sont des phénomènes normaux. Il convient qu'ils ne conduisent pas à des situations dangereuses lorsqu'ils sont pris en compte initialement au stade de la conception du matériel, puis durant son installation, son utilisation et son entretien.

Bien qu'une opinion communément répandue désigne le court-circuit comme la cause de la plupart des feux d'origine électrique, il existe de nombreuses autres causes possibles d'allumage. Ces causes peuvent comprendre des conditions d'installation, d'utilisation ou de maintenance incorrectes (par exemple, un fonctionnement en surcharge pendant des périodes courtes ou étendues; un fonctionnement dans des conditions non prévues par le fabricant ou l'installateur; une dissipation de chaleur inadéquate; et une ventilation défectueuse). Le Tableau 1 énumère des phénomènes d'allumage courants rencontrés dans les produits électrotechniques.

Dans le Tableau 1, sauf indication contraire, les sources d'allumage sont considérées être internes au produit électrotechnique. Le tableau énumère les cas les plus fréquemment rencontrés.

Les feux impliquant des produits électrotechniques peuvent aussi être déclenchés par des sources externes non électriques. Le produit électrotechnique peut être et est souvent impliqué dans des situations dangereuses qui ne résultent pas de son utilisation propre. Des considérations de cette nature sont traitées dans le cadre de l'évaluation globale des dangers, dans les normes individuelles de sécurité des produits ou, par exemple, par les dispositions de l'IEC TS 62441 [21].

L'Annexe A fournit des exemples de puissance de sortie des sources d'allumage potentielles.

Lors de la conception de produits, la prévention de l'allumage dans des conditions normales et anormales de fonctionnement exige une plus haute priorité comparativement à la réduction de la propagation des flammes qui s'ensuit.

Une fois que l'allumage s'est produit, quelle qu'en soit la raison, les effets du feu qui en découle doivent être évalués. Les facteurs à prendre en compte sont notamment:

a) le développement de l'incendie et la propagation des flammes;
b) le dégagement de chaleur;
c) la production de fumées (visibilité);
d) la production d'effluents toxiques du feu;
e) la production d'effluents potentiellement corrosifs du feu;
f) la potentialité d'explosion.

L'Annexe B donne des références aux lignes directrices de l'IEC relatives aux points a) à e). La sécurité des équipements électrotechniques utilisés dans les atmosphères explosives est traitée dans l'IEC 60079-0.

5 Fondamentaux des essais relatifs aux dangers d'incendie

5.1 Objectifs

La soumission des produits électrotechniques à des essais relatifs aux dangers d'incendie a pour objectifs de déterminer quelles propriétés au feu du produit contribuent aux effets potentiels du feu et/ou comment le produit ou une partie du produit contribue au déclenchement, au développement et aux effets du feu et ensuite d'utiliser cette connaissance pour réduire les risques d'incendie dans les produits électrotechniques.

5.2 Danger d’incendie et risque d'incendie

5.2.1 Danger d’incendie

Un danger d’incendie est un objet physique ou condition susceptible d'entraîner des conséquences non souhaitables causées par un incendie (voir 3.4). Les dangers d’incendie englobent donc les combustibles et les sources d'allumage potentiels. L'allumage d'un produit électrotechnique peut être provoqué par un composant sous tension électrique. L’allumage se produit par suite d’une augmentation de la température (voir l’IEC 60695-1-20 [20]) qui peut avoir une origine chimique, mécanique ou électrique.

Le Tableau 1 décrit en détail les phénomènes d'allumage courants rencontrés dans les produits électrotechniques, et énumère leurs conséquences possibles.

Les feux impliquant des produits électrotechniques peuvent aussi être déclenchés par des sources externes non électriques et il convient d'inclure cette possibilité dans toute évaluation globale des dangers d’incendie.

Tableau 1 – Causes courantes d'allumage dans les produits électrotechniques

Cause [a, b]	Origines possibles	Conséquences possibles et commentaires
Court-circuit (voir 3.14)	Contact direct de parties conductrices sous tension à des potentiels différents (par exemple, à cause du desserrage de bornes, de conducteurs accidentellement libérés, ou de la pénétration de corps étrangers conducteurs). Dégradation progressive de certains composants entraînant une baisse de leur résistance d'isolement. Défaillance soudaine d'un composant ou d'un organe interne.	Les systèmes de protection [c] peuvent ne pas toujours être activés. L'élévation de température est importante après un temps très court et peut être localisée. Emission éventuelle de lumière, de fumée et/ou de gaz inflammables. Production éventuelle de flammes L'allumage peut se produire localement sur les composants environnants. Projection éventuelle de matériaux incandescents.
Étincelles ou arcs électriques accidentels NOTE 1 Certains produits donnent lieu à des étincelles ou des arcs électriques en fonctionnement normal.	Cause externe au produit (par exemple, surtension du réseau, ou action mécanique accidentelle mettant à nu des parties sous tension). Cause interne (par exemple, dégradation progressive d'un composant, ou pénétration d'humidité). Défaillance soudaine d'un composant ou d'un organe interne.	Les systèmes de protection [c] peuvent ne pas toujours être activés. Emission éventuelle de lumière, de fumée et/ou de gaz inflammables. Production éventuelle de flammes. Risque élevé d'inflammation en atmosphère explosive. L'allumage peut se produire localement sur les composants ou dans les gaz environnants.
Fort courant de crête transitoire	Défaut du circuit électrique Cause externe au produit (par exemple, surtension du réseau).	Les systèmes de protection [c] peuvent ne pas toujours être activés.
Échauffement anormal (autre que celui provoqué par une des causes ci-dessus) NOTE 2 Certains produits dissipent de la chaleur en fonctionnement normal.	Surintensité dans un conducteur Contacts défectueux Courants de fuite (perte d'isolement et échauffements) Défaillance d'un composant, d'un organe interne ou d'un système associé, par exemple, ventilation. Déformations mécaniques entraînant une modification des contacts électriques ou du système d'isolation. Grippage d'un arbre de moteur (rotor bloqué) Vieillissement thermique prématuré	Au début, les systèmes de protection [c] ne sont normalement pas activés (sauf cas de protection spéciale). Ils peuvent être activés après une durée variable. La température s'élève progressivement et quelquefois très lentement. Il peut en résulter une accumulation importante de chaleur et d'effluents au voisinage du produit, suffisante pour entretenir le feu dès l'allumage. L'accumulation et la diffusion de gaz inflammables dans l'air peuvent donner lieu à un allumage ou à une explosion, notamment dans des produits hermétiques. Un arbre moteur bloqué (rotor bloqué) peut entraîner un feu couvant ou une inflammation à cause de l'échauffement excessif des enroulements du moteur.

[a] L'ordre indiqué ne préjuge ni de l'importance ni de la fréquence des cas.

[b] Les déformations de nature mécanique et les modifications de structure provoquées par l'une quelconque des quatre causes peuvent entraîner l'apparition d'une ou de plusieurs des trois autres.

[c] Les systèmes de protection peuvent être thermiques (fusible), mécaniques (disjoncteur), électriques ou électroniques.