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INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

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 Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

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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 first edition of this standard, together with IEC 60695-1-11[1], cancels and replaces the third edition of IEC 60695-1-1, published in 1999 and constitutes a technical revision.

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

This standard is to be used in conjunction with IEC 60695-1-11.

[1] To be published.

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

FDIS	Report on voting
89/950/FDIS	89/963/RVD

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

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

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

Part 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 1-20: *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 publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

INTRODUCTION

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 design as well as the choice of materials is to reduce to acceptable levels the potential risks of fire even in the event of foreseeable abnormal use, malfunction or failure. This standard, together with its companion, IEC 60695-1-11, provides guidance on how this is to be accomplished.

The primary aims are 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 the minimisation of any flame spread beyond the product's enclosure and the minimisation of 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 on how to reduce to acceptable 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 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.

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 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60695 (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*[2]

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*

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2 To be published.

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 19706[3]:2007, *Guidelines for assessing the fire threat to people*

3 Terms and definitions

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

3.1
fire
⟨uncontrolled⟩ self-supporting combustion that has not been deliberately arranged to provide useful effects and is not limited in its extent in time and space

[ISO/IEC 13943, definition 4.98]

3.2
fire hazard
physical object or condition with a potential for an undesirable consequence from fire

[ISO/IEC 13943, definition 4.112]

3.3
fire risk
probability of a fire combined with a quantified measure of its consequence

NOTE It is often calculated as the product of probability and consequence.

[ISO/IEC 13943, definition 4.124]

3.4
fire-safety engineering
application of engineering methods based on scientific principles to the development or assessment of designs in the built environment through the analysis of specific fire scenarios or through the quantification of risk for a group of fire scenarios

[ISO/IEC 13943, definition 4.126]

3.5
fire scenario
qualitative description of the course of a fire with respect to time, identifying key events that characterise the studied fire and differentiate it from other possible fires

NOTE It typically defines the ignition and fire growth processes, the fully developed fire stage, the fire decay stage, and the environment and systems that impact on the course of the fire.

[ISO/IEC 13943, definition 4.129]

3.6
intermediate-scale fire test
fire test performed on a test specimen of medium dimensions

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

NOTE 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.

[ISO/IEC 13943, definition 4.200]

3.7
large-scale fire test
fire test that cannot be carried out in a typical laboratory chamber, performed on a test specimen of large dimensions

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

[ISO/IEC 13943, definition 4.205]

3.8
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

3.9
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

3.10
reaction to fire
response of a test specimen when it is exposed to fire under specified conditions in a fire test

NOTE Fire resistance is regarded as a special case and is not normally considered as a 'reaction to fire' property.

[ISO/IEC 13943, definition 4.272]

3.11
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 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.

[ISO/IEC 13943, definition 4.273]

3.12
small-scale fire test
fire test performed on a test specimen of small dimensions

NOTE 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.

[ISO/IEC 13943, definition 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 type of materials used.

Electrotechnical products, when operating, generate heat and in some cases arcing and sparking are normal phenomena. These potential risks 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 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; and faulty ventilation. Table 1 lists common ignition phenomena encountered in electrotechnical products.

Unless otherwise indicated, the sources of ignition are considered to be internal to the electrotechnical product. It includes 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.

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

References to TC 89 guidance on items a) through f) can be found in Clause 9.

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 3.2). 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.

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

Table 1 – Common ignition phenomena encountered in electrotechnical products

Phenomenon [a]	Origin [b]	Consequential effects
Abnormal temperature rises NOTE 1 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 (for example, ventilation) Mechanical distortions which modify electrical contacts or the insulation system Seizure of a motor shaft (locked rotor) Premature thermal ageing	At start, protection devices [b] are not activated (except in special protection cases). They may be activated after a variable length of time The temperature rises are gradual and at times 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 Accumulation and diffusion of flammable gases in air may give rise to an ignition or explosion, especially inside hermetically sealed products A locked motor shaft (locked rotor) can cause smouldering or flaming due to excessive heating of the windings of the motor
Short-circuit	Direct contact of conducting live parts at different potentials (loosening of terminals, disengaged conductors, ingress of conducting foreign bodies, etc.) Gradual degradation of some components causing changes in their insulation impedances After sudden failure of component or internal part	The protection devices [b] are activated The rise in temperature is significant after a very short time and is quite localized Possible emission of light, smoke, flammable gases Release of glowing materials or substances
Accidental sparks and arcs NOTE 2 Some products produce arcs and sparks in normal operation.	Cause external to the product (overvoltage of the system network, accidental mechanical action exposing live parts or bringing them together, etc.) Internal cause (on-off switching with gradual degradation of some components and ingress of moisture) After sudden failure of a component or an internal part	The protection devices [b] may not always be activated Possible emission of visible light, flammable gases and flames Substantial risk of ignition in potentially explosive atmospheres Ignition may occur locally in surrounding components or gases
High transient peak current	Defect in the electrical circuit	The protection devices[b] may not always be activated
[a] Mechanical distortions and structural changes induced by any one of the three phenomena may result in the occurrence of the other two. [b] The protection devices may include thermal, mechanical, electrical or electronic types.		