

Fire hazard testing —

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

The European Standard EN 60695-1-1:2000 has the status of a British Standard

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National foreword

This British Standard is the official English language version of EN 60695-1-1:2000. It is identical with IEC 60695-1-1:1999 including Corrigendum January 2000. It supersedes BS EN 60695-1-1:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/89, Fire hazard testing, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Cross-references

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des risques du feu des produits
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Prüfungen zur Beurteilung der
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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

The text of document 89/374/FDIS, future edition 3 of IEC 60695-1-1, prepared by IEC TC 89, Fire hazard testing, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60695-1-1 on 2000-01-01.

This European Standard supersedes EN 60695-1-1:1995.

The following dates were fixed:

- latest date by which the EN has to be implemented
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2003-01-01

Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annex ZA is normative and annexes A and B are informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60695-1-1:1999 and its corrigendum January 2000 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

The risk of fire needs to be considered in any electrical circuit. With regard to this risk, the objective of component circuit and equipment design and the choice of material is to reduce the likelihood of fire even in the event of foreseeable abnormal use, malfunction or failure. The primary aim is to prevent ignition due to the electrically energized part but, if ignition and fire do occur, to control the fire preferably within the bounds of the enclosure of the electrotechnical product. In cases where surfaces of the electrotechnical products are exposed to an external fire, care will be taken to ensure that they do not contribute to the fire growth to a greater extent than the building products or structures in the immediately surrounding areas.

FIRE HAZARD TESTING –

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

1 Scope

This part of IEC 60695 provides guidance for assessing the fire hazard of electrotechnical products (see clause 4) and for the resulting development of fire hazard testing (see clause 5) as related directly to harm to people, animals or property. Products, as defined in this standard, relate to materials, components or complete end-use products.

This standard is intended as guidance to IEC committees, and should be used with respect to their individual applications. Attention is drawn to the principles in IEC Guide 104, and to the role of committees with safety pilot functions and safety group functions.

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

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60695. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60695 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

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

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

IEC Guide 109:1995, *Environmental aspects – Inclusion in electrotechnical product standards*

ISO/IEC Guide 52:1990, *Glossary of fire terms and definitions*

3 Definitions

For the purposes of this part of IEC 60695, the following definitions apply.

3.1

fire hazard

the potential for injury or loss of life and/or damage to property by a fire

3.2

fire risk

the probability of fire

NOTE The risk is described in terms of probability, combining:

- a) the frequency of occurrence of an undesired event to be expected in a given technical operation or state, and,
- b) the extent of damage to be expected on the occurrence of the event.

4 Fire hazard assessment

4.1 General

It is important to understand and maintain the differences between "fire hazard" and "fire risk". The primary concern for hazard assessment is to minimize the risk of fires caused by electrically induced ignition within electrotechnical products and, should one start, to limit fire propagation. External events, such as the outbreak of a fire in the environment, shall also be considered, but as a secondary matter and to a lesser extent; however, deliberate misuse of an electrotechnical product shall, in general, be disregarded.

Consideration shall also be given to heat release and opacity, toxicity and corrosivity of the smoke from a burning product, and any necessary ability to function under fire conditions. These hazards are all related to ignition and fire growth. The emission of gases may also lead to a risk of explosion under certain circumstances.

Certain electrotechnical products, such as large enclosures, insulated cables and conduits, may in fact cover large portions of surfaces and finishing materials of building construction or may penetrate fire-resisting walls. In these circumstances, electrotechnical products, when exposed to an external fire, shall be evaluated from the standpoint of their contribution to the fire hazard in comparison to the building materials or structure lacking the installation of electrotechnical products.

Following a detailed review of all the hazards related to a fire scenario, the final product standards, as drafted, should include a series of tests or a single test, as appropriate, to address the specific hazard(s) defined.

4.2 Development of fire hazard assessment

4.2.1 Overview of fire hazard elements

The fire hazard of an electrotechnical product depends on its characteristics, service conditions and the environment in which it is used, including the number and type of people, the value and vulnerability of property to be exposed to a fire involving that product. Therefore, a fire hazard assessment procedure for a particular product shall describe the product, its conditions of operation and its environment.

4.2.2 Basic steps

The basic steps to follow in developing a fire hazard assessment are:

- a) the definition of the scope (for example, the electrotechnical product range concerned) and the context (for example, where and how the products are used) (see 4.2.2.1);
- b) the identification of the scenarios of concern (see 4.2.2.2);
- c) the selection of the criteria to be used (see 4.2.2.3);
- d) the interpretation of results (see 4.2.2.4).

4.2.2.1 Definition of the scope and context

The first step involves defining the range of electrotechnical products to which the fire hazard assessment is to apply, examining the points of variability and commonality in the product range and its uses which may define the parameters of the fire hazard assessment procedure. This may be done by answering the questions set out below.

a) *Range of electrotechnical products*

What is the definition of the product to be covered? Is the product described well enough that it can always be determined whether the product is in the range? Is it described by an applicable IEC standard? Is the description broad enough so that all products capable of substituting for the products covered are also included? Does the scope allow it to be determined if a given product is covered?

b) *Circumstances of use*

What are the service conditions of the electrotechnical product: continuous or intermittent use? Is the product attended or not during service? Is the surrounding temperature controlled?

What does the location of the electrotechnical product indicate about its role in causing or propagating fire, resulting from its interaction with other objects in the environment?

Is the product always in an enclosed or exposed space?

What are the number and capabilities of persons involved?

How close is the exposed population or critical equipment to the fire?

c) *Testing of the defined scope and context*

Using the answers to the above questions, formulate a trial description of the product and its circumstances of use. The *trial description* can then be tested against a list of products, which are potentially candidates for inclusion in the scope and context, by making use of the procedure outlined in annex A, flow chart 1.

4.2.2.2 Identification of scenarios of concern

A fire scenario is a detailed description of conditions of one or more stages in an actual fire from before ignition to completion of combustion, or a full-scale simulation. There will often be more than one fire scenario in which the electrotechnical product can participate, and in principle, the product can be assumed to contribute differently to the fire hazard associated with each scenario. Therefore, a separate hazard assessment is required for each important scenario identified.

Whether the focus of assessment is a product or a system, typically the most important scenario characteristics will be those that either define the fire conditions that cause the product to become involved in fire, or that indicate the time in the fire when its contribution will cause the greatest hazard consequences.

a) *Electrotechnical product involvement in fire*

The knowledge of the source of ignition is of prime importance in the case of electrotechnical products. If the product is its own source of ignition, conditions through which the ignition could take place are to be analyzed in detail in terms of electrical behaviour (see table 1). Is it a short circuit (which is seldom the case), a hot spot (cause of the hot spot), or a general overheating? How long did the electrical malfunction continue before ignition took place? Each scenario should give a precise description of the detailed conditions governing the initiation of the fire, including the possible accumulation of gases within an enclosed space.

If the electrotechnical product is not its own source of ignition, describe when and how it tends to become involved in fire:

- Is the product likely to be the first item ignited?
- Is the product a potentially significant fuel source, even if it is not the first item ignited?
- Is the product a potential agent for fire propagation?

If one of these situations can be identified as being the greatest concern, then this may mean that a single fire performance characteristic is of the greatest importance, such as that product's ability to generate a significant hazard quickly, the quantity of products in use, or the persistence of the hazard during and after suppression operations. Such determinations can then be used to define test methods or calculation procedures that will measure the product's contribution to fire hazard at these stages of a fire.

b) *Relevant aspects of fire behaviour*

This exercise applies to both electrotechnical products and other objects in the environment which may participate in the initiation, growth and development of fire.

The purpose of answering the questions posed is to characterize those hazard aspects which are listed below (see also annex A, flow chart 2, charts 2A to 2F):

- potential to be an ignition source;
- ignitability;
- rate of flame spread;
- glowing, smouldering, melting;
- peak heat-release rate, fire growth rate, total heat release;
- mass loss or fire effluent generation rate;
- opacity of smoke produced;
- corrosivity of fire effluents produced;
- profile of toxic (irritant and asphyxiant) substances produced: rate, total toxic potency;
- maintenance of functions under fire conditions (for example structural integrity, continuity of service, mechanical response);
- quantity of products in use relative to size and type of occupancy.

c) *Use of scenarios to define key parameters*

A test method or calculation procedure will require a number of specifications or input values. For example, a test for rate of heat release of a burning product will require specification of the type of ignition (for example, piloted ignition), the level of incident heat flux, and any requirements for control of oxygen or humidity levels in the combustion atmosphere. Where the product is not the first item ignited, nearby combustibles involved will be important in determining the thermal conditions to which the product is exposed.

Each of the specifications and input values required by the test method or calculation procedure should be determined from the characteristics of the scenario selected. This is likely to require the use of statistics of relevant fires and some documented judgements by experts. In completing these steps, the developer of a fire hazard assessment will need to identify appropriate measurements and calculation procedures capable of characterizing the hazard. A detailed examination of the scenario will provide the parameter specification for these test methods and calculation procedures.

4.2.2.3 Selection of criteria to be used

The intent of this step is to select hazard measures that will provide valid technical information sufficient to estimate and to make decisions on the product's contribution to fire hazard. Actual damage to people and property is always the concern of the fire hazard assessment, but direct measures of damage need not be used if it can be shown that simpler procedures will produce the same results.

a) *Direct life and property loss*

If the contribution of the product to the hazard can be expressed in these terms, it is desirable to do so. It is rare, however, that this can be accomplished, since rarely are the capabilities of the occupants, or the equipment and property known with sufficient certainty that the outcome to the scenario can be forecast quantitatively.

b) *Indirect method of characterizing fire hazard*

It is often possible to relate a measured or calculated product property to the build-up of some aspect of fire hazard in the scenario. For example, the heat release rate of the product may govern the temperature of the compartment and hence affect equipment operation and/or continued human occupation. The rate of release of smoke from a product may influence the escape time available to the occupants. In this approach, the quantitative relationship between the hazard and the product's properties is identified, so that changes in the level of hazard can be traced to changes in properties.

c) *Comparative methods*

Even when it is not possible to express these relationships quantitatively it may be possible to relate the performance of a tested product to a reference level. For example, cables with a known heat release may be considered as providing an acceptably slow build-up of temperature, even though the precise relationship is unknown. Then one measure of the relative hazard is the comparison of the product's heat release rate with the reference level.

4.2.2.4 Interpretation of results

At this point, the fire hazard assessment procedure will have identified which hazard measures are to be used and how they are to be calculated, but the interpretation of the results may still pose additional technical questions.

- a) In assessing the hazard one should specify the procedure to be used in calculating an overall fire hazard comparison between products, or when compared to a baseline. This procedure might be a formula for calculating one overall hazard measure from several, in which case, a scientific rationale will be presented for the formula. The procedure could be a set of decision rules, such as a rule that one product is better than another only if it is better in all hazard measures. However, in the specific case of two products, this rule may not be sufficient to provide a definite comparison as to the overall hazard.
- b) If more than one scenario has been used, it is necessary to specify the procedure to be used in calculating an overall fire hazard. This procedure could be a formula or a set of rules, for example if the scenario can be assigned relative probabilities of occurrence, as in a fire risk assessment, this would be a basis for calculating the overall fire hazard from several scenarios.
- c) If the hazard is not expressed directly in terms of death, injuries or monetary loss, guidance on the other quantitative units and measurements should be provided (i.e. escape time, extent of flame spread, size of fire etc.).

- d) The assessment should specify all the steps required to set a meaningful safety threshold, or pass/fail criteria can be set by those responsible.
- e) The points above relate to overall fire hazard assessment and the part played by electrotechnical products within this assessment.

5 Fire hazard tests

5.1 General

The transmission, distribution, storage and utilization of energy of any type has the potential to contribute to fire in most buildings.

The most frequent causes of ignition are overheating and arcing. The frequency of ignition will depend on the type of materials used in the construction of the system.

Equipment in the electrotechnical field, when operating, involves heat dissipation and in some cases arcing and sparking. These potential risks do not lead to hazardous conditions when they are taken into account initially at the design stage, and afterwards during installation, use and maintenance.

Hazardous conditions which do not arise from the use of electrotechnical equipment can and do involve it. Considerations of this nature are dealt with in the overall hazard assessment.

Contrary to the commonly held belief that most electrical fires are caused by a short circuit, electrical fires may be initiated from one or a combination of circumstances, including external non-electrical sources (see also table 1).

These circumstances can include improper installation, utilization or maintenance conditions (for example, operation under overload for temporary or extended periods, operation under conditions not provided for by the manufacturer or contractor, inadequate heat dissipation, clogged ventilation systems, etc.).

5.2 Hazard assessment

Data available for use in fire hazard assessment may be of any of these types:

- a) test response results, based on application of small-scale test methods or large-scale test protocols;
- b) measurement of, or statistics on, characteristics of historical fires;
- c) documented judgement by experts.

These data may be used directly as hazard measures or may be used as input data to a calculation procedure that produces the final hazard evaluation.

5.3 Types of fire hazard tests

When possible, end-product tests are generally the most reliable test methods as they normally duplicate exactly the conditions occurring in practice. When preparing requirements and test specifications concerning fire and electrotechnical products the types of tests given below should be recognized.