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## Standard Guide for Development of Fire Hazard Assessment Standards of Electrotechnical Products<sup>1</sup>

This standard is issued under the fixed designation D5425; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This guide provides guidance on the development of fire hazard assessment standards for electrotechnical products. For the purposes of this guide, products include materials, components, and end-use products.

1.2 This guide is directed toward development of standards that will provide procedures for assessing fire hazards harmful to people, animals, or property.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This fire standard cannot be used to provide quantitative measures.*

1.5 *This standard is used to predict or provide a quantitative measure of the fire hazard from a specified set of fire conditions involving specific materials, products, or assemblies. This assessment does not necessarily predict the hazard of actual fires which involve conditions other than those assumed in the analysis.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- [D1711 Terminology Relating to Electrical Insulation](#)
- [E176 Terminology of Fire Standards](#)
- [E603 Guide for Room Fire Experiments](#)
- [E1546 Guide for Development of Fire-Hazard-Assessment Standards](#)
- [E1776 Guide for Development of Fire-Risk-Assessment Standards](#)
- [E2061 Guide for Fire Hazard Assessment of Rail Transportation Vehicles](#)
- [E2067 Practice for Full-Scale Oxygen Consumption Calorimetry Fire Tests](#)

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.17 on Fire and Thermal Properties.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard

## 2.2 NFPA Codes and Standards:<sup>3</sup>

NFPA 555 Guide on Methods for Decreasing the Probability of Flashover (Withdrawn)

NFPA 556 Guide on Methods for Evaluating Fire Hazard to Occupants of Passenger Road Vehicles

NFPA 901 Uniform Coding for Fire Protection

## 2.3 International Electrotechnical Commission (IEC) Standards:<sup>4</sup>

IEC 60695-1-1 Fire Hazard Testing—Part 1-1: Guidance for Assessing the Fire Hazard of Electrotechnical Products—General guidelines (Withdrawn)

## 2.4 International Organization for Standardization (ISO) Standards:<sup>5</sup>

ISO 13943 Fire Safety: Vocabulary

### 3. Terminology

#### 3.1 Definitions:

3.1.1 For definitions of terms used in this guide and associated with electrical and electronic insulating materials, use Terminology **D1711**.

3.1.2 For definitions of terms used in this guide and associated with fire issues, use Terminology **E176**, ISO 13943, and IEC 60695-1-1 (see 5.1). Where differences exist in definitions, the definitions contained in Terminology **E176** shall prevail.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *electrotechnical product, n*—item that generates or uses electrical power as a source of energy or that is associated with the conduction or transmission of electrical signals or power.

##### 3.2.1.1 Discussion—

Electrotechnical products include the materials insulating electrical wires and cables and the materials enclosing other products that generate or are fed by electricity, as well as the products themselves and all of their parts.

3.2.2 *fire scenario, n*—a detailed description of conditions, including environmental, of one or more of the stages from before ignition to the completion of combustion in an actual fire at specific location, or in a full-scale simulation.

3.2.3 *products, n*—material, component, or end-use product.

### 4. Significance and Use

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<https://standards.iteh.ai/catalog/standards/sist/ab82299c-d4c5-4d98-9a10-be328bbe9901/astm-d5425-23>

4.1 This guide is intended for use by those undertaking the development of fire hazard assessment standards for electrotechnical products. Such standards are expected to be useful to manufacturers, architects, specification writers, and authorities having jurisdiction.

4.2 As a guide, this document provides information on an approach to the development of a fire hazard assessment standard; fixed procedures are not established. Any limitations in the availability of data, of appropriate test procedures, of adequate fire models, or in the advancement of scientific knowledge will place significant constraints upon the procedure for the assessment of fire hazard.

4.3 The focus of this guide is on fire assessment standards for electrotechnical products. However, insofar as the concepts in this guide are consistent with those of Guide **E1546**, the general concepts presented also may be applicable to processes, activities, occupancies, and buildings. Guide **E2061** contains an example of how to use information on fire-test-response characteristics of electrotechnical products (electric cables) in a fire hazard assessment for a specific occupancy (rail transportation vehicle).

4.4 A standard developed following this guide should not attempt to set a safety threshold or other pass/fail criteria. Such a standard should specify all steps required to determine fire hazard measures for which safety thresholds or pass/fail criteria can be meaningfully set by authorities having jurisdiction.

<sup>3</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

<sup>4</sup> Available from International Electrotechnical Commission (IEC), 3 Rue de Varembe, Case postale 131, CH-1211, Geneva 20, Switzerland, <http://www.iec.ch>.

<sup>5</sup> Available from International Organization for Standardization, P.O. Box 56, CH-1211, Geneva 20, Switzerland or from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

## 5. General Concepts

5.1 It is important to understand and maintain the differences between fire hazard and fire risk.

5.1.1 Fire hazard is defined in Terminology E176 as:

5.1.1.1 *fire hazard, n*—the potential for harm associated with fire.

NOTE 1—A fire may pose one or more types of hazard to people, animals, or property. These hazards are associated with the environment and with a number of fire test response characteristics of materials, products, or assemblies including, but not limited to, ease of ignition, flame spread, rate of heat release, smoke generation and obscuration, toxicity of combustion products, and ease of extinguishment.

5.1.2 Fire hazard is defined in ISO 13943-2017 as:

5.1.2.1 *fire hazard, n*—potential for harm associated with fire.

5.1.2.2 *Discussion*—ISO 13943-2017 also states that, alternatively, fire hazard can be a physical object or condition with a potential for an undesirable consequence from fire.

5.1.2.3 ISO 13943-2017 defines fire hazard assessment (or fire hazard analysis) as “evaluation of the possible causes of fire (3.114), the possibility and nature of subsequent fire growth, and the possible consequences of fire.” It then states further that “other definitions of fire hazard assessment specifically point out a relationship to the (extent of) fire safety measures present or foreseen.” Terminology E176 does not define fire hazard assessment or fire hazard analysis.

5.1.3 Fire risk is defined in Terminology E176 as:

5.1.3.1 *fire risk, n*—an estimation of expected fire loss that combines the potential for harm in various fire scenarios that can occur with the probabilities of occurrence of those scenarios.

NOTE 2—Risk may be defined as the probability of having a certain type of fire, where the type of fire may be defined in whole or in part by the degree of potential harm associated with it or as potential for harm weighted by associated probabilities. However it is defined, no risk scale implies a single value of acceptable risk. Different individuals presented with the same risk situation may have different opinions on its acceptability.

5.1.4 Fire risk is defined in ISO 13943-2017, in a manner very similar to the definition in Terminology E176, as:

5.1.4.1 *fire risk, n*—estimation of expected fire loss that combines the potential for harm in various fire scenarios that can occur with the probabilities of occurrence of those scenarios.

5.1.4.2 *Discussion*—ISO 13943-2017 also states that, alternatively, fire risk is the “combination of the probability of a fire and a quantified measure of its consequence”.

5.2 The primary concern in the fire hazard assessment of electrotechnical products is to minimize the fire hazard resulting when such products ignite. Should a fire start, it is then desirable to limit the fire propagation. Give consideration to external events, such as the outbreak of a fire in the environment. In general, however, disregard deliberate misuse of an electrotechnical product, in the fire hazard assessment.

5.3 Give consideration also to heat release (both rate and amount) and opacity, toxicity, and corrosivity of the smoke from a burning product and any necessary ability to function under fire conditions. These hazards are directly related to the ignition and fire propagation. The emission of gases may also, under certain circumstances, lead to the possibility of explosion.

5.4 Certain electrotechnical products such as large enclosures, insulated cables, and conduits, may in fact replace large portions of surfaces and finishing materials of building construction or may penetrate fire-resisting walls. In these circumstances, the requirements for fire performance of the electrotechnical products, when exposed to an external fire, must ensure that they do not contribute to the hazard of fire to a greater degree than is permitted by the building materials or structures that are replaced.

5.5 Following a detailed review of all of the expected hazards as related to a specific fire scenario, the final hazard assessment

standards, as drafted, should include a series of tests or a single test, as appropriate, to address the specific hazard(s) defined. Single test standards are acceptable if they address the major hazard(s) defined or are interrelated to the various components involved.

5.6 In order to design electrotechnical products with acceptable characteristics for minimizing fire hazard, pay careful attention to the permissible mechanical, electrical, and thermal stresses. This should minimize the fire hazard under all conditions of use: normal operation, foreseeable deviations from normal use, and faulty operation conditions. The desired level of fire hazard is achievable by the procedures in 5.6.1 – 5.6.3:

5.6.1 The use of parts or circuit design and protection, or both, which, under overload or failure, are not likely to ignite or to cause ignition;

5.6.2 The use of parts, including enclosures, which are sufficiently resistant to probable ignition sources and heat within an electrotechnical product; or,

5.6.3 The use of designs that will adequately resist the propagation of fire spread and surface spread by fire.

## **6. Types of Fire Tests**

6.1 Technical committees engaged in the preparation of requirements and test specifications with regard to fire involving electrotechnical products should recognize the following types of tests:

### *6.1.1 Fire Simulation Tests:*

6.1.1.1 These tests examine the reaction to fire of electrotechnical products, in a way as representative as possible of the use of the product in practice.

6.1.1.2 When the actual 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 the actual fire hazard, such tests are likely to assess one or more relevant aspects of the fire hazard associated with the use of the product under consideration in a specific scenario. The results of this type of test are thus well suited for use as elements of a fire hazard assessment that takes into account all the factors pertinent to an assessment of the fire hazard of the electrotechnical product in a particular end use.

6.1.1.3 Do not use the results of fire simulation tests for fire hazard assessment when a change of product design is made, or when conditions of use are changed from those simulated in the test.

6.1.1.4 Since such tests are designed specifically for a detailed fire scenario, they often do not become test standards.

### *6.1.2 Fire Resistance Tests:*

6.1.2.1 These tests are intended to assess the ability of an electrotechnical product, or one of its parts, to preserve the various properties necessary for its use, under specified conditions of exposure to fire and for a stated period of time. In other words, these tests measure continuity of operation.

6.1.2.2 They are intended to provide data on the electrical behavior and performance of an electrotechnical product, or finished assembly, under a particular condition of exposure to heat or flame.

6.1.2.3 Recent studies show a need for very careful consideration of the test conditions and comparison with the actual fire situation and to the possible effect of any uncontrolled variables, such as the environment in which the product is placed.

6.1.2.4 It is unlikely that the results of fire resistance tests are directly applicable to fire hazard assessment of the corresponding electrotechnical product.

### *6.1.3 Combustion Characteristic Tests:*

6.1.3.1 These tests examine the reaction to fire of small standardized specimens under controlled conditions. These tests are used to give data on properties related to the burning behavior of the materials, components, or end-use products tested. They are also useful for comparative evaluations. The fire properties measured include, but are not limited to, flammability, ignitability, flame

spread rate, smoke density, fire effluent generation, and heat release rate. Examples of such tests include the application of a number of fire-test-response standards to electrotechnical products.

6.1.3.2 The data provided by such tests are usually not representative of fire performance under conditions other than those to which the specimen is subjected. Combustion characteristic tests are most useful when designed to simulate as closely as possible the situation to which materials, components, or end-use products may be exposed in actual use. They may then lead to the proper selection of materials, components, and end-use products, which will meet the appropriate requirement when testing the complete product.

6.1.3.3 These tests measure responses of electrotechnical materials, components, or end-use products to heat or flame under controlled laboratory conditions. They are a step further away from real fire conditions when compared to fire simulation tests. However, when done appropriately, results from these tests, in combination with those from other tests, may be useful as elements of the fire hazard assessment of an electrotechnical product in a particular end use once all the pertinent factors are taken into account.

#### 6.1.4 “Basic Property” Tests:

6.1.4.1 These tests are designed to measure one basic physical or chemical property of a material. They yield information that is, at least to some extent, independent of the testing method. Some examples of such properties are: heat of combustion, heat of vaporization, thermal conductivity, or melting point.

6.1.4.2 In a real fire situation, a number of such properties collectively affect the fire behavior of the electrotechnical product. However, a single basic property measurement will, at most, define only a single aspect of the fire hazard associated with a system. Thus, it is unlikely that the results of these basic property tests are useful elements of a fire hazard assessment.

6.1.4.3 However, eventually, after fire safety engineering develops a firmer technical base, the hope is that the results of combustion characteristic tests may be used to assess a wide range of fire safety situations.

## 7. Fire Hazard Assessment Standards

7.1 Fire hazard assessment standards are to conform in style and content with *Form and Style for ASTM Standards*.<sup>6</sup>

7.2 Fire hazard assessment standards are to include sections labeled Scope, Terminology, Significance and Use, and Procedure, numbered and arranged in that order.

#### 7.3 *Scope*:

7.3.1 State clearly in the *Scope*:

7.3.1.1 The product or class of products of interest,

7.3.1.2 The fire scenario(s) included in the standard,

7.3.1.3 The assumptions used in the standard,

7.3.1.4 The structure of the fire hazard assessment procedure, including test methods, models, other calculation procedures, data sources, hazard measures, and evaluation criteria or procedures used,

7.3.1.5 Any limitations on the application of the standard, and

7.3.1.6 Include also, in accordance with *Form and Style for ASTM Standards*, F2.2.2.2, the following caveat: “This standard may be used to predict or provide a quantitative measure of the fire hazard from a specified set of fire conditions involving specific materials, products, or assemblies. This assessment does not necessarily predict the hazard of actual fires which involve conditions other than those assumed in the analysis.”

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<sup>6</sup> *Form and Style for ASTM Standards*, March 2014, available from ASTM International Headquarters, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.

#### 7.4 *Terminology:*

7.4.1 Define clearly any terms unique to the fire hazard assessment standard. Use standard terms as defined in Terminology E176 whenever possible.

7.4.2 If appropriate, refer to Terminology D1711 when addressing issues associated with electrical or electronic insulation materials.

#### 7.5 *Significance and Use:*

7.5.1 Describe clearly the major uses and any limitations of the standard fire hazard assessment procedure, and

7.5.2 State clearly the significance of the assessment to users.

#### 7.6 *Detailed Procedure:*

7.6.1 Include in this section detailed descriptions of the fire hazard assessment procedure and its component parts, including test methods, calculation procedures, scenario description, data sources, and evaluation criteria or procedures.

### **8. Development Process For Developing Fire Hazard Assessment Standards**

#### 8.1 *Overview of Elements of Fire Hazard:*

8.1.1 The fire hazard of an electrotechnical product (for example, an electronic component, an enclosure, wire or cable) depends on its properties, on how it is used, and on the environment in which it is used, including the number and type of people and the value and fragility of property possibly exposed to a fire involving it. Therefore, a fire hazard assessment procedure for a particular product must describe the product, how it is used, and its environment.

#### 8.2 *Development of a Fire Hazard Assessment Standard:*

8.2.1 Listed below are the seven basic steps to follow in developing a fire hazard assessment standard:

8.2.1.1 Define the scope (for example, the product range of interest) and context (for example, where and how the products are used),

8.2.1.2 Identify the scenario(s) of concern,

8.2.1.3 Identify the measure of harm to be assessed (for example, deaths, injuries, business loss, property loss),

8.2.1.4 Identify the test methods or calculation procedures needed to produce the measures of fire hazard,

8.2.1.5 Use the scenarios to define key parameters of the test methods or calculation procedures,

8.2.1.6 Identify the types and sources of data required to support the selected test methods and calculation procedures, and

8.2.1.7 Identify the criteria or procedures to evaluate the fire hazard measures.

#### 8.3 *Basic Steps:*

##### 8.3.1 *Defining the Scope and Context:*

8.3.1.1 The first step involves defining the range of products to which the fire hazard assessment standard is to apply (that is, the scope), and examining the points of variability and commonality in the product range and its uses which may be used to define the parameters of the fire hazard assessment procedure. This may be done by answering the following questions:

8.3.1.2 *Products*—What are the range of products to be covered?

8.3.1.3 *Environment*—What is the range of environments in which the product will be used? What does information on the product’s environment indicate about the number of persons or quantity and value of property that potentially could be exposed to a fire involving the product, the special capabilities or limitations of the occupants, and the special characteristics or vulnerabilities of the property? What is known about the condition and local environment of the product as it affects the likely conditions of the product’s involvement in fire? Is the product always located in an exposed or enclosed space? What types of fire barriers separate the product from other spaces? Is the product used in areas where building systems or other features could contribute to transport of the product’s fire effects to remote parts of the property? Is the product typically used as a single unit or as a component of an assembly? Are there other products normally associated with the product in question or installation procedures that may affect the fire hazard development of the product? The classification of property contained in NFPA 901 may be useful for this purpose.

8.3.1.4 *Product Involvement in Fire*—When and how does the product tend to become involved in fire? Is there a particular role in fire that is a primary point of concern for this product range? Based on this information, is it possible to isolate validly a subset of the fire-test-response, and other characteristics listed in (I) through (II), as the only ones providing significant variation in fire hazard for this product range?

- (1) Ignitability,
- (2) Flame spread rate,
- (3) Heat release—peak rate, rate of rise in rate (fire growth rate), total heat released,
- (4) Mass loss or smoke generation rate,
- (5) Opacity of smoke produced,
- (6) Corrosivity of smoke produced,
- (7) Profile of toxic (irritant and asphyxiant) species produced—rate, total, toxic potency,
- (8) Thermal decomposition rates,
- (9) Endurance under fire conditions—structural integrity, thermal conductivity, mechanical response (for example, melting, collapsing),
- (10) Ease of extinguishment, and
- (11) Quantity of product in use relative to size and type of occupancy.

### 8.3.2 *Identify Scenario(s):*

8.3.2.1 A scenario is a detailed description of the conditions at all of the stages from before ignition to completion of combustion in an actual fire, or in a full scale simulation. Those details are chosen to correspond to a set of real fires whose relative hazards should be reflected by the test method, fire model, or calculation procedure. Because the focus of the assessment is an electrotechnical product, the most important scenario dimensions typically will be those that either define the fire conditions that cause the product to become involved in fire or indicate the point in the fire when the product’s contribution will have the greatest consequence for hazard. To determine this, it is necessary to answer questions like the following:

- (1) Is the product a likely first item ignited?
- (2) Is the product a potential significant fuel source even if not the first item ignited?
- (3) Is the product a potential avenue of flame spread?
- (4) How close is the exposed population (or the most critical property) to the fire, and what does this imply about the most critical stage of the product’s fire involvement?
- (5) If one of these situations can be identified as the greatest concern, then that may mean that one product fire performance characteristic is of greatest importance, such as the product’s ability to generate a significant hazard quickly, its total hazard capacity (for example, the quantity in use), or the persistence of its hazard during and after suppression operations. Use the determinations to define test methods or calculation procedures that measure the product’s contribution to fire hazard at those stages of the fire.

8.3.3 *Identify Measures of Fire Hazard to be Used*—There are several types of measures or criteria useful to assess fire hazard:

8.3.3.1 *Direct Criteria*—Deaths, injuries, or property damage are the measures most directly related to the ultimate concerns of fire impact on people and property.

8.3.3.2 *Fire-Test-Response Characteristics*—Use them individually or as elements in a fire-characteristic profile. These criteria come directly from test methods, which may reduce their uncertainty, and tend to be based on tests involving only the product, which may simplify the process of isolating differences between products. These are advantages of such profiles. However, establish the relative importance, interaction, and even relevance of the fire-test-response characteristics, individually and collectively, to the hazard posed by the product by comparison to more thorough assessments, such as established scientific laws,