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INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC SAFETY PUBLICATION

PUBLICATION FONDAMENTALE DE SÉCURITÉ

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

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Essais relatifs aux risques du feu –
Partie 1-20: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Allumabilité – Lignes directrices générales

IEC 60695-1-20:2016-01(en-fr)

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FIRE HAZARD TESTING –

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

FOREWORD

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International Standard IEC 60695-1-20 has been prepared by IEC technical committee 89: Fire hazard testing.

This first edition of IEC 60695-1-20 cancels and replaces the first edition of IEC TS 60695-1-20 published in 2008. This edition constitutes a technical revision.

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

a) ISO 5660-1 has been added to the normative references;
b) definitions of “pyrolysis” and “short-circuit” have been added to Clause 3;
c) some text from the introduction has been moved to Clause 5 and is now part of the normative text;

d) Clause 5 now contains several mandatory statements.

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

FDIS	Report on voting
89/1296/FDIS	89/1302/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.

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

In this standard, the terms defined in Clause 3 are printed in bold type.

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

The IEC 60695-1 series, under the general title *Fire hazard testing*, consists of the following parts:

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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

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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 procedures – 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 stability date indicated on the IEC website 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

Fires are responsible for creating hazards to life and property as a result of the generation of heat (thermal hazard), and also as a result of the production of toxic effluent, corrosive effluent and smoke (non-thermal hazard). Fires start with ignition and then can grow, leading in some cases to flash-over and a fully developed fire. Ignition resistance is therefore one of the most important parameters of a material to be considered in the assessment of fire hazard. If there is no ignition, there is no fire.

For most materials (other than metals and some other elements), ignition occurs in the gas phase. Ignition occurs when combustible vapour, mixed with air, reaches a high enough temperature for exothermic oxidation reactions to rapidly propagate. The ease of ignition is a function of the chemical nature of the vapour, the fuel/air ratio and the temperature.

In the case of liquids, the combustible vapour is produced by vaporization of the liquid, and the vaporization process is dependent on the temperature and chemical composition of the liquid.

In the case of solids, the combustible vapour is produced by pyrolysis when the temperature of the solid is sufficiently high. The vaporization process is dependent on the temperature and chemical composition of the solid, and also on the thickness, density, specific heat, and thermal conductivity of the solid.

The ease of ignition of a test specimen depends on many variables. Factors to be considered for the assessment of ignitability are:

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a) the geometry of the test specimen, including thickness and the presence of edges, corners or joints;
b) the surface orientation;
c) the rate and direction of air flow;
d) the nature and position of the ignition source;
e) the magnitude and position of any external heat flux; and
f) whether the combustible material is a solid or a liquid.

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The primary aims are to prevent ignition caused by an electrically energized 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 minimization of any flame spread beyond the product's enclosure and the minimization 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 an overall fire hazard assessment.

This international standard gives an overview of ignitability and its relevance to the fire hazard of electrotechnical products.

FIRE HAZARD TESTING –

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

1 Scope

This part of IEC 60695 provides guidance on the ignitability of electrotechnical products and the materials from which they are formed. It gives guidance on:

a) the principles of ignitability;

b) the selection of appropriate test methods, and

c) the use and interpretation of results.

This part of IEC 60695 is intended for use by technical committees in 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.

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2 Normative references

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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 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

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 TR 60695-1-21, *Fire hazard testing – Part 1-21: Guidance for assessing the fire hazard of electrotechnical products – Ignitability – Summary and relevance of test methods*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

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

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC TS 60695-11-11, *Fire hazard testing – Part 11-11: Test flames – Determination of the characteristic heat flux for ignition from a non-contacting flame source*

IEC 60695-11-20, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test methods*

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, *Fire safety – Vocabulary*

ISO 871:2006, *Plastics – Determination of ignition temperature using a hot-air furnace*

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ISO 2592, *Determination of flash and fire points – Cleveland open cup method*

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ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*

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ISO 5657, *Reaction to fire tests – Ignitability of building products using a radiant heat source*

ISO 5660-1, *Reaction to fire tests – Heat release smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method)*

ISO 10840, *Plastics – Guidance for the use of standard fire tests*

3 Terms and definitions

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

3.1
auto-ignition
spontaneous ignition
self-ignition CA, US
unpiloted ignition CA, US
DEPRECATED: spontaneous combustion
ignition (3.20) resulting from a rise in temperature without a separate **ignition source** (3.22)

Note 1 to entry: The ignition can be caused either by self-heating or by heating from an external source.

Note 2 to entry: In North America, “spontaneous ignition” is the preferred term used to designate ignition caused by self-heating.

[SOURCE: ISO 13943:2008, 4.18]

3.2
auto-ignition temperature
spontaneous ignition temperature
minimum temperature at which **auto-ignition** (3.1) is obtained in a fire test

Note 1 to entry: The typical units are degrees Celsius (°C).

[SOURCE: ISO 13943:2008, 4.19]

3.3
combustion
exothermic reaction of a substance with an oxidizing agent

Note 1 to entry: Combustion generally emits fire effluent accompanied by **flame**s (3.11) and/or glowing.

[SOURCE: ISO 13943:2008, 4.46]

3.4
fire ⟨general⟩
process of **combustion** (3.3) characterized by the emission of heat and fire effluent and usually accompanied by smoke, **flame** (3.11), 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** (3.5) and **fire** (3.6), 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.

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[SOURCE: ISO 13943:2008, 4.96]

3.5
fire ⟨controlled⟩
self-supporting **combustion** (3.3) that has been deliberately arranged to provide useful effects and is limited in its extent in time and space

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[SOURCE: ISO 13943:2008, 4.97]

3.6
fire ⟨uncontrolled⟩
self-supporting **combustion** (3.3) 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]

3.7
fire hazard
physical object or condition with a potential for an undesirable consequence from **fire** (3.4)

[SOURCE: ISO 13943:2008, 4.112]

3.8
fire point
minimum temperature at which a material ignites and continues to burn for a specified time after a standardized small **flame** (3.11) has been applied to its surface under specified conditions

Note 1 to entry: In some countries the term "fire point" has an additional meaning: a location where fire-fighting equipment is sited, which may also comprise a fire-alarm call point and fire instruction notices.

Note 2 to entry: The typical units are degrees Celsius (°C).

Note 3 to entry: See **flash point** (3.16)

[SOURCE: ISO 13943:2008, 4.119]

3.9
fire retardant, noun
substance added, or a treatment applied, to a material in order to delay **ignition** (3.20) or to reduce the rate of **combustion** (3.3)

Note 1 to entry: The use of (a) fire retardant(s) does not necessarily suppress **fire** (3.4) or terminate **combustion (3.3)**.

Note 2 to entry: See **flame retardant** (3.12)

[SOURCE: ISO 13943:2008, 4.123]

3.10
fire scenario
qualitative description of the course of a **fire** (3.6) 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** (3.20) and fire growth processes, the **fully developed fire** (3.17) stage, the fire decay stage, and the environment and systems that impact on the course of the fire.

[SOURCE: ISO 13943:2008, 4.129]

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3.11
flame, noun
zone in which there is rapid, self-sustaining, sub-sonic propagation of **combustion** (3.3) in a gaseous medium, usually with emission of light

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[SOURCE: ISO 13943:2008, 4.133 – modified – The words "zone in which there is" have been added at the beginning of the definition.]

3.12
flame retardant, noun
substance added, or a treatment applied, to a material in order to suppress or delay the appearance of a **flame** (3.11) and/or reduce the flame-spread rate

Note 1 to entry: The use of (a) flame retardant(s) does not necessarily suppress **fire** (3.6) or terminate **combustion** (3.3).

Note 2 to entry: See fire retardant (3.9).

[SOURCE: ISO 13943:2008, 4.139]

3.13
flaming combustion
combustion (3.3) in the gaseous phase, usually with emission of light

[SOURCE: ISO 13943:2008, 4.148]

3.14
flash-ignition temperature
FIT
minimum temperature at which, under specified test conditions, sufficient flammable gases are emitted to ignite momentarily on application of a pilot **flame** (3.11)

Note 1 to entry: This note applies to the French language only.

[SOURCE: ISO 871:2006, 3.1]

3.15
flashover, ⟨stage of fire⟩
transition to a state of total surface involvement in a **fire** (3.4) of combustible materials within an enclosure

[SOURCE: ISO 13943:2008, 4.156]

3.16
flash point
minimum temperature to which it is necessary to heat a material or a product for the vapours emitted to ignite momentarily in the presence of **flame** (3.11) under specified test conditions

Note 1 to entry: The typical units are degrees Celsius (˚C).

[SOURCE: ISO 13943:2008, 4.154]

3.17
fully developed fire
state of total involvement of combustible materials in a **fire** (3.6)

[SOURCE: ISO 13943:2008, 4.164]

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3.18
glowing combustion
combustion (3.3) of a material in the solid phase without **flame** (3.11) but with emission of light from the combustion zone

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[SOURCE: ISO 13943:2008, 4.169]

3.19
ignitability
ease of ignition
measure of the ease with which a test specimen can be ignited, under specified conditions

[SOURCE: ISO 13943:2008, 4.182]

3.20
ignition, ⟨general⟩
DEPRECATED: sustained ignition
initiation of **combustion** (3.3)

[SOURCE: ISO 13943:2008, 4.187]

3.21
ignition, ⟨flaming combustion⟩
DEPRECATED: sustained ignition
initiation of sustained **flame** (3.11)

[SOURCE: ISO 13943:2008, 4.188]

3.22
ignition source
source of energy that initiates **combustion** (3.3)

[SOURCE: ISO 13943:2008, 4.189]

3.23
lower flammability limit
LFL
minimum concentration of fuel vapour in air below which propagation of a **flame** (3.11) does not occur in the presence of an **ignition source** (3.22)

Note 1 to entry: The concentration is usually expressed as a volume fraction at a defined temperature and pressure, and expressed as a percentage.

[SOURCE: ISO 13943:2008, 4.216]

3.24
minimum ignition temperature
ignition point
minimum temperature at which sustained **combustion** (3.3) can be initiated under specified test conditions

Note 1 to entry: The minimum ignition temperature implies the application of a thermal stress for an infinite length of time.

Note 2 to entry: The typical units are degrees Celsius (°C).

[SOURCE: ISO 13943:2008, 4.231]

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3.25
pyrolysis
chemical decomposition of a substance by the action of heat

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Note 1 to entry: Pyrolysis is often used to refer to a stage of **fire** (3.4) before **flaming combustion** (3.13) has begun.

Note 2 to entry: In fire science, no assumption is made about the presence or absence of oxygen.

[SOURCE: ISO 13943:2008, 4.266]

3.26
short-circuit
unintended connection of two nodes of an electrical circuit

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

3.27
spontaneous-ignition temperature
SIT
minimum temperature at which, under specified test conditions, **ignition** (3.20), is obtained by heating, in the absence of any additional **ignition source** (3.22)

[SOURCE: ISO 871:2006, 3.2]

3.28
thermal inertia
product of thermal conductivity, density and specific heat capacity

EXAMPLES The thermal inertia of steel is $2{,}3 \times 10^8$ $J^2 \cdot s^{-1} \cdot m^{-4} \cdot K^{-2}$. The thermal inertia of polystyrene foam is $1{,}4 \times 10^3$ $J^2 \cdot s^{-1} \cdot m^{-4} \cdot K^{-2}$.

Note 1 to entry: When a material is exposed to a heat flux, the rate of increase of surface temperature depends strongly on the value of the thermal inertia of the material. The surface temperature of a material with a low thermal inertia rises relatively quickly when it is heated, and vice versa.

Note 2 to entry: The typical units are joules squared per second per metre to the fourth power per Kelvin squared ($J^2 \cdot s^{-1} \cdot m^{-4} \cdot K^{-2}$).

[SOURCE: ISO 13943:2008, 4.326]

3.29
upper flammability limit
UFL
maximum concentration of fuel vapour in air above which propagation of a **flame** (3.11) will not occur in the presence of an **ignition source** (3.22)

Note 1 to entry: The concentration is usually expressed as a volume fraction at a defined temperature and pressure, and expressed as a percentage.

[SOURCE: ISO 13943:2008, 4.349]

4 Principles of ignitability

4.1 Gases

4.1.1 Overview

Ignition of a gas depends on how the gas is mixed with air. If the gas is mixed with air before ignition, the subsequent reaction is known as premixed combustion. In a burner, the combustion is controlled, but if a large volume of a gas/air mixture is ignited, a gas explosion results.

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In most fires, ignition results in the development of diffusion flames where combustible gas comes in contact with air without being previously mixed.

IEC 60695-1-20:2016
https://standards.iteh.ai/catalog/standards/sist/7a874329-ddfb-4c16-b8d7-660c445025d6/iec-60695-1-20-2016

Gas mixtures can be ignited in two basic ways:

a) auto-ignition – where the temperature of all the gas mixture is raised, and
b) piloted ignition – where a local source of heat is introduced, e.g. a flame or an electrical spark.

Some fires are the result of the ignition of a material which is already in the gaseous state, but combustible gases can also be produced by the vaporization of liquids (see 4.2) or by the pyrolysis of solids (see 4.3).

4.1.2 Flammability limits

Flame propagation cannot occur in a fuel/air gas mixture if the fuel concentration is too low or too high. The limiting concentration values are known as the lower flammability limit (LFL) and the upper flammability limit (UFL). These limits arise because flames need a minimum temperature to exist. Too much air or fuel prevents the temperature being maintained at a sufficiently high level. Flammability limits are normally expressed as the percentage of fuel, by volume, in the fuel/air mixture.

4.1.3 Arc fires

Faults in some electrical equipment such as junction boxes and power transformers can result in disruptive electrical discharges (electric arcs) which can pyrolyse insulation materials to produce high temperature combustible gases. Such gases expand rapidly and in contact with air can result in an explosion (see 5.3.4.4).

4.2 Liquids

4.2.1 Overview

With the exception of some unstable or reactive substances, bulk liquids do not generally ignite. Normally it is combustible vapour which ignites. The combustible vapour is produced by vaporization of the liquid, and the vaporization process is dependent on the temperature and chemical composition of the liquid.

4.2.2 Ignition parameters

Temperature is normally used to define the ignitability of a liquid. Three different temperatures are used. These are the auto ignition temperature (see 3.2), the fire point (see 3.8) and the flash point (see 3.16). Auto-ignition refers to ignition in the absence of a localized heat source. Flash point concerns momentary ignition. Fire point concerns sustained combustion after ignition.

Several different test methods are used to measure these characteristic temperatures. The measured temperature depends on the particular details of the test apparatus used. It is therefore important to define the test method when quoting these parameters.

4.2.3 Insulating liquids

4.2.3.1 Flash point measurement

ISO 2719 (Pensky-Martens closed cup method) is cited in IEC standards for the measurement of the flash point of insulating liquids. It measures the flash point in a confined space and is intended to detect minor amounts of volatile material. An alternative method is ISO 2592 (Cleveland open cup method) which is used to measure the flash point over an open liquid surface. The flash point measured by ISO 2592 is significantly lower than that measured by ISO 2719.

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4.2.3.2 Cone calorimeter measurements

IEC 60695-8-3 was developed to measure the quantity of heat released from burning insulating liquids. The test specimen is exposed to a uniform heat flux in the presence of a spark ignition source. Ignition related properties can be defined as the time to ignition at a specified heat flux, or the minimum incident heat flux that will support ignition.

NOTE IEC 60695-8-3 is to be withdrawn. The ISO intends to develop a related test method with a wider scope.

4.3 Solids

4.3.1 Overview

With some exceptions (see below) solids do not generally ignite. Normally, the material that ignites is in the gas phase and can be a mixture of gases, aerosols and suspended particles. The combustible vapour is produced by pyrolysis of the solid, and the vaporization process is dependent on the temperature and chemical composition of the solid.

The exceptions to this general statement are:

– metals (see 4.3.3);
– some non-metallic elements, for example carbon (see 4.3.4), sulphur and phosphorous;
– certain reactive substances (see 4.3.5); and
– dust clouds (see 4.3.6).