INTERNATIONAL STANDARD

ISO 10093

Third edition
2020-12

Plastics — Fire tests — Standard ignition sources

Plastiques — Essais au feu — Sources d'allumage normalisées

Reference number
ISO 10093:2020(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

This third edition cancels and replaces the second edition (ISO/TR 10093:2018), which has been technically revised.

The main changes compared to the previous edition are as follows:

— mandatory information have been added throughout the document;

— referenced standards have been deleted from the bibliography and moved to the normative references clause (see Clause 2).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Fires are caused by a wide range of possible ignition sources. Statistical analysis of fires has identified the major primary and secondary sources, especially for fires in buildings. The most frequent sources of fires have been found to be as follows:

a) cooking appliances;

b) space-heating appliances;

c) electric wiring, connectors and terminations;

d) other electrical appliances (such as washing machines, bedwarmers, televisions, water heaters);

e) cigarettes;

f) matches and smokers' gas lighters;

g) blow-lamps, blow-torches and welding torches;

h) rubbish burning; and

i) candles.

This list covers the major primary ignition sources for accidental fires. Other sources can be involved in fires raised maliciously. Research into causes of fires has shown that primary ignition sources (e.g. glowing cigarettes or dropped flaming matches) can set fire to waste paper, which then acts as a secondary ignition source of greater intensity.

When analysing and evaluating the various ignition sources for applications involving plastics materials, it is important to answer the following questions on the basis of detailed fire statistics.

1) What is the significance of the individual ignition sources in various fire risk situations?

2) What proportion is attributable to secondary ignition sources?

3) Where does particular attention have to be paid to secondary ignition sources?

4) To what extent are different ignition sources responsible for fatal fire accidents?

The laboratory ignition sources described in this document are intended to simulate actual ignition sources that have been shown to be the cause of real fires involving plastics. Laboratory ignition sources are preferred over actual ignition sources due to their consistency, which results in greater data repeatability within a laboratory and greater reproducibility between laboratories.

These laboratory ignition sources can be used to develop new test procedures.

Plastics — Fire tests — Standard ignition sources

1 Scope

This document describes and classifies a range of laboratory ignition sources for use in fire tests on plastics and products consisting substantially of plastics. These sources vary in intensity and area of impingement. They are suitable for use to simulate the initial thermal abuse to which plastics are potentially exposed in certain actual fire risk scenarios.

This compilation of standard ignition sources describes the ignition sources used by different standards development organizations and contained in standard test methods, specifications, or regulations used to assess the fire properties or plastics and of products containing plastic materials. The ignition sources described in this document are associated with flaming and non-flaming ignition. This document describes the relevant ignition sources and references the associated standard.

This compilation of ignition sources does not discuss the application of the standard referenced in any specific clause in which the ignition source is described, and this compilation is likely not to be a fully comprehensive list of ignition sources.

This document does not address detailed test procedures.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 871, *Plastics — Determination of ignition temperature using a hot-air furnace*

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

ISO 5658-2, *Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building and transport products in vertical configuration*

ISO 5659-2, *Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test*

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

ISO 8191-1, *Furniture — Assessment of the ignitability of upholstered furniture — Part 1: Ignition source: smouldering cigarette*

ISO 8191-2, *Furniture — Assessment of ignitability of upholstered furniture — Part 2: Ignition source: match-flame equivalent*

ISO 9705-1, *Reaction to fire tests — Room corner test for wall and ceiling lining products — Part 1: Test method for a small room configuration*

ISO 11925-2, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test*

ISO 12136, *Reaction to fire tests — Measurement of material properties using a fire propagation apparatus*

ISO 12863, *Standard test method for assessing the ignition propensity of cigarettes*

ISO 12949, *Standard test method for measuring the heat release rate of low flammability mattresses and mattress sets*

ISO 13943, *Fire safety — Vocabulary*

IEC 60332-1-1, *Tests on electric and optical fibre cables under fire conditions — Part 1-1 Test for vertical flame propagation for a single insulated wire or cable — Apparatus*

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*

IEC 60332-3-10, *Tests on electric and optical fibre cables under fire conditions — Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires or cables — Apparatus*

IEC 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 60695-2-10, *Fire hazard testing — Part 2-10: Glowing/hot-wire based test methods — Glow–wire apparatus and common test procedure*

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/TS 60695-2-20, *Fire hazard testing — Part 2-20: Glowing/hot-wire based test methods — Hot wire ignition test — Apparatus, confirmatory test arrangement and guidance (withdrawn)*

IEC/TS 60695-11-2, *Fire hazard testing — Part 11-2: Test flames — 1 kW pre-mixed flame — Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-3, *Fire hazard testing — Part 11-3: Test flames — 500 W flames — Apparatus and confirmational test methods*

IEC 60695-11-4, *Fire hazard testing — Part 11-4: Test flames — 50 W flame — Apparatus and confirmational test method*

IEC 60695-11-5, *Fire hazard testing — Part 11-4: 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 60695-11-20, *Fire hazard testing — Part 11-20: Test flames — 500 W flame test method*

ASTM D635, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position*

ASTM D1929, *Standard Test Method for Determining Ignition Temperature of Plastics*

ASTM D3874, *Standard Test Method for Ignition of Materials by Hot Wire Sources*

ASTM D5025, *Standard specification for a laboratory burner used for small-scale burning tests on plastic materials*

ASTM D5424, *Standard Test Method for Smoke Obscuration of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration*

ASTM D5537, *Standard Test Method for Heat Release, Flame Spread, Smoke Obscuration, and Mass Loss Testing of Insulating Materials Contained in Electrical or Optical Fiber Cables When Burning in a Vertical Cable Tray Configuration*

ASTM D6194, *Standard Test Method for Glow-Wire Ignition of Materials*

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 °C*

ASTM E662, *Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials*

ASTM E906/E906M, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using a Thermopile Method*

ASTM E1321, *Standard Test Method for Determining Material Ignition and Flame Spread Properties*

ASTM E1354*Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*

ASTM E1537, *Standard Test Method for Fire Testing of Upholstered Furniture*

ASTM E1590, *Standard Test Method for Fire Testing of Mattresses*

ASTM E1822, *Standard Test Method for Fire Testing of Stacked Chairs*

ASTM E1995, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber, With the Test Specimen Oriented Horizontally*

ASTM E2058, *Standard Test Methods for Measurement of Material Flammability Using a Fire Propagation Apparatus (FPA)*

ASTM E2187, *Standard Test Method for Measuring the Ignition Strength of Cigarettes*

ASTM E2257, *Standard Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies*

ASTM E2574/E2574M, *Standard Test Method for Fire Testing of School Bus Seat Assemblies*

NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture*

NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes*

NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*

NFPA 270, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber*

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*

NFPA 287, *Standard Test Methods for Measurement of Flammability of Materials in Cleanrooms Using a Fire Propagation Apparatus (FPA)*

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*

UL 1666, *Standard for Test for Flame Propagation Height of Electrical and Optical-Fibre Cables Installed Vertically in Shafts*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13943 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
afterflame
flame (3.8) that persists after the ignition source has been removed

[SOURCE: ISO 13943:2017, 3.11]

3.2
afterflame time
length of time for which an *afterflame* (3.1) persists under specified conditions

[SOURCE: ISO 13943:2017, 3.12]

3.3
afterglow
persistence of glowing combustion after both removal of the ignition source and the cessation of any flaming combustion

[SOURCE: ISO 13943:2017, 3.13]

3.4
afterglow time
length of time for which an *afterglow* (3.3) persists under specified conditions

[SOURCE: ISO 13943:2017, 3.14]

3.5
combustion
exothermic reaction of a substance with an oxidizing agent

[SOURCE: ISO 13943:2017, 3.55, modified — note has been omitted.]

3.6
ease of ignition
measure of the ease with which a test specimen can be ignited, under specified conditions

[SOURCE: ISO 13943:2017, 3.212]

3.7
exposed surface
surface of a test specimen subjected to the heating conditions of a fire test

[SOURCE: ISO 13943:2017, 3.106]

3.8
flame, noun
rapid, self-sustaining, sub-sonic propagation of *combustion* (3.5) in a gaseous medium, usually with emission of light

[SOURCE: ISO 13943:2017, 3.159]

3.9
flame, verb
produce *flame* (3.8)

[SOURCE: ISO 13943:2017, 3.160]

3.10
flaming debris
burning material separating from a burning item and continuing to *flame* (3.9) on the floor, during a fire or fire test

Note 1 to entry: Alternatively, flaming debris can be burning material, other than drops, which has detached from a test specimen during a fire or fire test and continues to burn.

Note 2 to entry: Compare with the terms *flaming droplets* (3.11).

[SOURCE: ISO 13943:2017, 3.176]

3.11
flaming droplets
flaming molten or flaming liquefied drops which fall from the test specimen during the fire test and continue to burn on the floor

Note 1 to entry: Compare with the term *flaming debris* (3.10).

[SOURCE: ISO 13943:2017, 3.177]

3.12
glowing combustion
combustion (3.5) of a material in the solid phase without *flame* (3.8) but with emission of light from the combustion zone

[SOURCE: ISO 13943:2017, 3.197]

3.13
ignitability
measure of the ease with which a specimen can be *ignited* (3.14), under specified conditions

[SOURCE: ISO 13943:2017, 3.212]

3.14
ignite, transitive verb
initiate *combustion* (3.5)

[SOURCE: ISO 13943:2017, 3.215]

3.15
ignite, intransitive verb
catch fire with or without the application of an external heat source

[SOURCE: ISO 13943:2017, 3.214]

3.16
ignition
initiation of *combustion* (3.5)

[SOURCE: ISO 13943:2017, 3.217]

3.17
ignition source
source of energy that initiates *combustion* (3.5)

[SOURCE: ISO 13943:2017, 3.219]

3.18
ignition time
duration of exposure of a test specimen to a defined *ignition source* (3.17) required for the initiation of sustained *combustion* (3.5) under specified conditions

[SOURCE: ISO 13943:2017, 3.220]

3.19
irradiance
ratio of the radiant flux incident on a small but measurable element of surface containing the point, by the area of that element

[SOURCE: ISO 13943:2017, 3.236]

3.20
minimum ignition temperature
minimum temperature of a material at which sustained *combustion* (3.5) can be initiated under specified test conditions

[SOURCE: ISO 13943:2017, 3.327]

3.21
primary ignition source
first applied *ignition source* (3.17)

3.22
punking
propagation of a smouldering *combustion* (3.5) front after removal of the *ignition source* (3.17)

3.23
secondary ignition source
heat source which is activated following *ignition* (3.16) from a primary source

3.24
sustained flaming
flame (3.8), on or over the surface of a test specimen, which persists for longer than a defined period of time

Note 1 to entry: Compare with the term *transitory flaming* (3.25).

[SOURCE: ISO 13943:2017, 3.380]

3.25
transitory flaming
flame (3.8), on or over the surface of a test specimen, which persists for a defined short period of time

Note 1 to entry: Compare with the term *sustained flaming* (3.24).

[SOURCE: ISO 13943:2017, 3.408]

4 Ignition processes

4.1 When plastics are exposed to thermal energy, flammable vapours are often generated from their surface. Under suitable conditions (especially high temperatures), it is possible for a critical concentration of flammable vapour to form and spontaneous ignition to result. If a flame is present as the sole energy source, or as a supplementary source, the ignition process is then assisted; this mechanism is sometimes known as piloted ignition.

4.2 A specimen of plastic is regarded as ignited when flames appear on the surface of the plastic or when glowing combustion is evident.

4.3 After ignition has occurred, some burning plastics create additional fire hazards by forming flaming debris or drips. If this flaming debris falls on to combustible material, it is possible for a secondary ignition to occur and for the fire to spread more rapidly.

4.4 The localized application of a heat source to some plastics results in glowing combustion. With some thermoplastic foams and foams from thermosetting materials, the localized application of a heat source results in punking which produces a carbonaceous char.

5 Characteristics of ignition sources

5.1 The following factors are the main characteristics describing ignition sources and their relation to the test specimen:

a) intensity of the ignition source, which is a measure of the thermal load on the specimen resulting from the combined conduction, convection and radiation effects caused by the ignition source;

b) area of impingement of the ignition source on the specimen;

c) duration of exposure of the specimen and whether it is continuous or intermittent;

d) presentation of the ignition source to the specimen and whether or not it impinges;

e) orientation of the specimen in relation to the ignition source;

f) ventilation conditions in the vicinity of the ignition source and exposed surface of the specimen.

NOTE Factors c) to f) are often a function of the specific fire test conditions.

5.2 Several of the ignition sources provide a range of intensities and areas of impingement to be considered for use in fire tests of plastics.

5.3 IEC 60695-1-21 provides guidance on ignition sources relevant to the fire testing of electrotechnical products.

6 General principles

6.1 Flaming ignition sources

6.1.1 Diffusion flame ignition sources

To form a diffusion flame ignition source, a gas (usually propane, methane or butane) flows through metallic tubes without ingress of air prior to the base of the flame. These flames simulate natural flames well, but they often fluctuate and are not convenient to direct if it is necessary to point any angular presentation toward the specimen.

6.1.2 Premixed flame sources

To form a premixed flame source, a gas burner (usually using propane, methane or butane) fitted with air inlet ports or an air intake manifold is used. Premixed flame sources are typically more directional than diffusion flame sources and are generally hotter than diffusion flame sources.

6.1.3 Issues associated with flaming ignition sources

Gas burners are always set up to conform to precise gas flow rates and/or flame heights. Periodic checks of flame temperature or heat flux precede the setup, but criteria on these parameters are not necessarily an essential part of the laboratory procedure. After setting up the burner for a particular test (i.e. often