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Plastics — Development and use of intermediate-scale fire tests for plastics products —

Part 1: General guidance

Plastiques — Développement et utilisation des essais au feu à une échelle intermédiaire pour les produits plastiques —

Partie 1: Lignes directrices générales

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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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. www.iso.org/directives

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

This second edition cancels and replaces the first edition (ISO 15791-1:2002), which has been technically revised.

ISO 15791 consists of the following parts, under the general title *Plastics — Development and use of intermediate-scale fire tests for plastics products*:

— *Part 1: General guidance*

Guidance on product fire testing for semi-finished and finished products is to form the subject of a future part 2.

Introduction

Products for many applications are made of or contain substantial proportions of plastics. The fire performance of a product depends on the materials from which it is made, the design of the product and its environment.

Industry needs to test products used for different applications for regulatory, quality control, development and pre-selection purposes.

Numerous regulations and regional, state and local codes make reference to combustibility tests and standards, and ranking of products derived from these tests are the most commonly available means of comparing the various combustion characteristics of products. More than one test and possibly intermediate- or full-scale tests may be necessary to qualify products containing plastics for intended or proposed use or representative product end-use conditions.

Plastics — Development and use of intermediate-scale fire tests for plastics products —

Part 1: General guidance

1 Scope

This part of ISO 15791 provides a framework guide for the development and use of intermediate-scale fire tests for products made of or containing plastics.

The guidance identifies typical applications of plastics products and possible fire scenarios that can arise involving products in these applications. The development and use of intermediate-scale tests is described to ensure their relevance to the end use of the product.

2 Normative references

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.

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

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

3.1
fire scenario
qualitative description of the course of a fire with respect to time, identifying key events that characterize the studied fire and differentiate it

[SOURCE: of ISO 13943:2008, definition 4.129, modified.]

3.2
intermediate-scale fire test
fire test performed on a test specimen of medium dimensions

[SOURCE: ISO 13943:2008, definition 4.200, modified — The note has been omitted.]

3.3
large-scale fire test
fire test that cannot be carried out in a typical laboratory chamber, performed on a test specimen of large dimensions

[SOURCE: ISO 13943:2008, definition 4.205, modified — The note has been omitted.]

3.4
product
manufactured article ready for end use

3.5
material
basic single substance or uniformly dispersed mixture

Note 1 to entry: Metal, stone, timber, concrete, mineral fibre and polymers are examples.

[SOURCE: ISO 5659-2:2012, 3.6]

3.6
semi-finished product
manufactured articles ready for assembly for an end use application

3.7
small-scale fire test
fire test performed on a test specimen of small dimensions

[SOURCE: of ISO 13943:2008, definition 4.292, modified — The note has been omitted.]

3.8
test specimen
item subjected to a procedure of assessment or measurement

[SOURCE: ISO 13943:2008, definition 4.321, modified — The note has been omitted.]

4 Types of plastics and typical products

4.1 Generic types

Products containing materials that are either thermoplastics or thermosets are subject to a fire performance assessment. Such plastics can be elastomers, fibres or foams (cellular materials) and can contain additives (including fibre reinforcements).

4.2 Typical applications

Some typical applications for plastics, which present particular problems in small-scale tests for their fire performance assessment and which may require the use of intermediate-scale fire testing, are listed below:

— semi-finished products;

— housings for electrical appliances;

— profiled sheets, e.g. roofing, or panels for containers;

— profiles, e.g. conduits for electric cables, window-frames, extruded sections;

— weatherproof glazing for agricultural buildings;

— foam pipe-sections;

— pipes, e.g. rainwater drainage and discharge pipes;

— furniture, e.g. chairs;

— pipes for air ventilation systems in e.g. ships, trains, aircraft;

— containers for liquids (e.g. oil, kerosene);

— waste containers (for recycling materials or for rubbish).

NOTE This list is not exhaustive.

4.3 Composites

The following special composites should be considered:

— laminates, e.g. melamine-formaldehyde-covered chipboard;

— laminated film and sheet, e.g. weatherproofing membranes;

— moulded foams, e.g. for packaging;

— structural mouldings, e.g. for ships, lorries, coaches, trains;

— composite panels, e.g. rigid foams faced with metal sheets (especially steel or aluminium sheets) or inorganics (especially gypsum or plasterboard) for thermal insulation;

— fibre-reinforced products.

4.4 End-use conditions

Assessment of structural composite panels, thermoplastic glazing and similar plastics products, etc. can only be done by taking into account their end-use conditions and installations. Orientation of test specimens with respect to the ignition source of the fire test should reflect the actual possible heat exposure at the end use condition. For non-planar products, different parts of the specimen will be heated at different flux levels at any given time.

5 Fire scenarios

5.1 General

The fire scenario (see 3.1) should reproduce the conditions in which the hazard exists. Any additional assumptions, such as the environmental conditions, should be defined. The subject of the assessment, i.e. the material, product or system, should be determined by an investigation of the contribution of the subject in the assumed fire scenario and the stage of the fire.

NOTE Annex B gives examples of standardized reference test scenarios.

5.2 Ignition stage

The ignition source used in the test should represent the fire hazard in end use conditions and may result in different fire responses of the materials and product. The ignition source may pose a variety of hazards dependent on the associated environmental conditions and on a number of characteristic fire test responses of materials, products or assemblies, including ease of ignition, flame spread, rate of heat release, smoke generation, toxicity of combustion products and ease of extinction.

5.3 Fire growth stage

In small rooms, the typical primary ignition source is small, e.g. candles, matches and hot electrical wires. The relevant parameters for further assessing the fire hazard are flame spread and rate of heat release. Combustible materials in the vicinity of the first ignited item are heated by convection and irradiance, and the oxygen content in the room air, almost 21 % initially, begins to decrease. After a certain time, flashover may occur, at which stage the room temperature can exceed 500 °C and the irradiance at floor level can typically exceed 25 kW/m^2 (see Figure 1). In such cases, the oxygen content in small rooms is not normally sufficient for complete combustion.

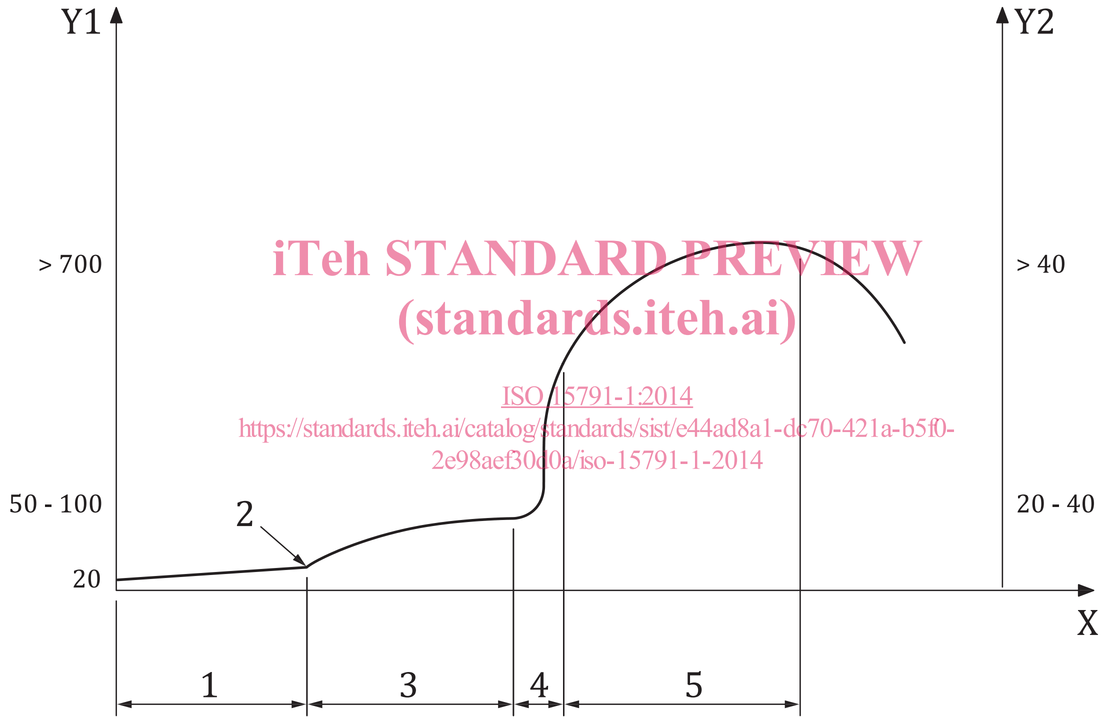
Smouldering fires will not significantly increase room temperatures but may begin to deplete oxygen and cause smoke. Typical ignition sources for smouldering fires can be a cigarette on a mattress or a faulty electric blanket. Smouldering rates can be derived from experiments.

Another scenario is a flaming fire caused by primary ignition sources igniting, for example waste-paper baskets, curtains and mattresses. These sources can lead to secondary ignition of other combustible products.

Small ignition sources cause accelerated development of fire when stored combustible liquids result in flashover. In such cases, the heat release can be expressed as the hydrocarbon curve.[29] Relatively high ventilation is necessary for such development, and the CO_2/CO ratio is about 100. Fires with low ventilation are likely to lead to temperatures in the range 600 °C to 900 °C.

5.4 Large room fire

In large rooms such as theatres, open-plan offices, warehouses, supermarkets and sports halls, fires are freely ventilated for a long time. In contrast to small rooms, there are hardly any interrelated effects and development of fire is directly dependent on the successive combustion of the burning items. The scenario can be compared with fires in the open air for a certain period of time. Flashover causes a rapid decrease in the CO_2/CO ratio.



Key

1 time to ignition

2 T > 100 °C, I > 25 kW/m^2 close to ignited item

3 developing fire

4 flashover

5 fully developed fire

X time

Y1 average temperature T in fire compartment (°C)

Y2 average irradiance I in fire compartment (kW/m^2)

Figure 1 — Typical course of a fire in a room

Evaluation of fire development is linked to the quantification of a design fire as described in ISO/TR 13387-2. It is necessary to define design fires and design fire scenarios because the course of real fires varies depending on the nature of the combustibles, the ignition source, the fire load and the conditions in the fire compartment. It is practically impossible to predict the real fire taking into account all these interactions and real boundary conditions.

There are two distinctly different methods of determining the design fire for a given scenario. One is based on knowledge of the amount, type and distribution of combustible materials in the compartment of fire origin. The other is based on knowledge of the type of occupancy, where very little is known about the details of the fire load.

A design fire may be needed for a wide range of design fire scenarios. These may be internal or external fire scenarios. Examples of typical design fire scenarios include:

— large/medium/small-room fires (corner, ceiling, floor, wall);

— corridor fires;

— roofing fires;

— cavity fires;

— staircase fires;

— fires in/on façades;

— single burning item fires (furniture, cable conduits, pipes).

Design fire specifications should be translated into characteristics of the fuel load environment near the initial fire.

These regimes are used to determine the growth of the initial fire as a function of time.

6 Thermal characteristics of ignition sources

Design fires are usually quantified in terms of the heat release rate of the assumed ignition source as a function of time. Once the heat release rate is known, the flame area and height can be estimated. The heating of a second object can then be predicted. Typical ignition source heat release rates are shown in Table 1.

Table 1 — Heat release rates for typical ignition sources

Source	Heat output kW
Match	0,1
Waste-paper basket	10 to 40
Small chair	10 to 300
Upholstered furniture, large wood crib	> 300

If the net heat flux from the surface of actual ignition sources is known, these ignition sources can be simulated by radiant panels. Typical fluxes are shown in Table 2.

