INTERNATIONAL STANDARD

ISO 15791-1

First edition
2002-08-01

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

Part 1:
General guidance

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

Partie 1: Principes directeurs généraux

Reference number
ISO 15791-1:2002(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

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.ch
Web www.iso.ch

Printed 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15791 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15791-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

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*

— *Part 2: Preparation and mounting of specimens*

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 numerical material rankings 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 a plastic product for intended or proposed use or representative product end-use conditions.

It appears necessary to have a scaled-down test method as a screening or control test when this regulatory testing requires large apparatus with high cost.

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

Part 1: General guidance

1 Scope

This document 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 normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 15791. 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 ISO 15791 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 ISO and IEC maintain registers of currently valid International Standards.

ISO 5658-4, *Reaction to fire tests — Spread of flame — Part 4: Intermediate-scale test of vertical spread of flame with vertically oriented specimen*

ISO 9705, *Fire tests — Full-scale room test for surface products*

ISO 10093, *Plastics — Fire tests — Standard ignition sources*

ISO/TR 13387-2, *Fire safety engineering — Part 2: Design fire scenarios and design fires*

ISO 13784-1, *Reaction-to-fire tests for industrial sandwich panels — Part 1: Intermediate-scale test*

ISO/IEC 13943, *Fire safety — Vocabulary*

ISO/TR 14696, *Reaction to fire tests — Determination of fire parameters of materials, products and assemblies using an intermediate-scale heat release calorimeter (ICAL)*

IEC 61034-2, *Measurement of smoke density of cables burning under defined conditions — Test procedure and requirements*

EN 13823, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item*

3 Terms and definitions

For the purposes of this part of ISO 15791, the terms and definitions given in ISO/IEC 13943 and the following apply.

3.1
material
single substance or uniformly dispersed mixture, for example a polymer

3.2
test specimen
representative piece of the product to be tested, together with any substrate or surface treatment

3.3
product
manufactured article ready for end use

3.4
fire scenario
detailed description of conditions for one or more of the stages from before ignition to the completion of combustion in an actual fire at a specific location

4 Types of plastics and typical products

4.1 Generic types

All of the following types of plastics materials can be involved in a fire performance assessment:

— thermoplastics;

— thermosets;

— fibre-reinforced plastics;

— cellular plastics (both structural foams and low-density insulating foams).

4.2 Typical applications

Some 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:

— 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).

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. Any change in specimen surface position will take the exposed specimen surface into a different heat exposure with regard to the applied ignition sources. For non-planar products, different parts of the specimen will be heated at different flux levels at any given time.

5 Fire scenarios

The fire scenario (see 3.4) should reproduce the conditions in which the hazard exists. Any additional assumptions, such as the environmental conditions, should be defined. Whether the focus of assessment is a material, product or system is determined by an investigation of the contribution to the assumed scenario and the stage of the fire.

An ignition source may pose a variety of risks 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.

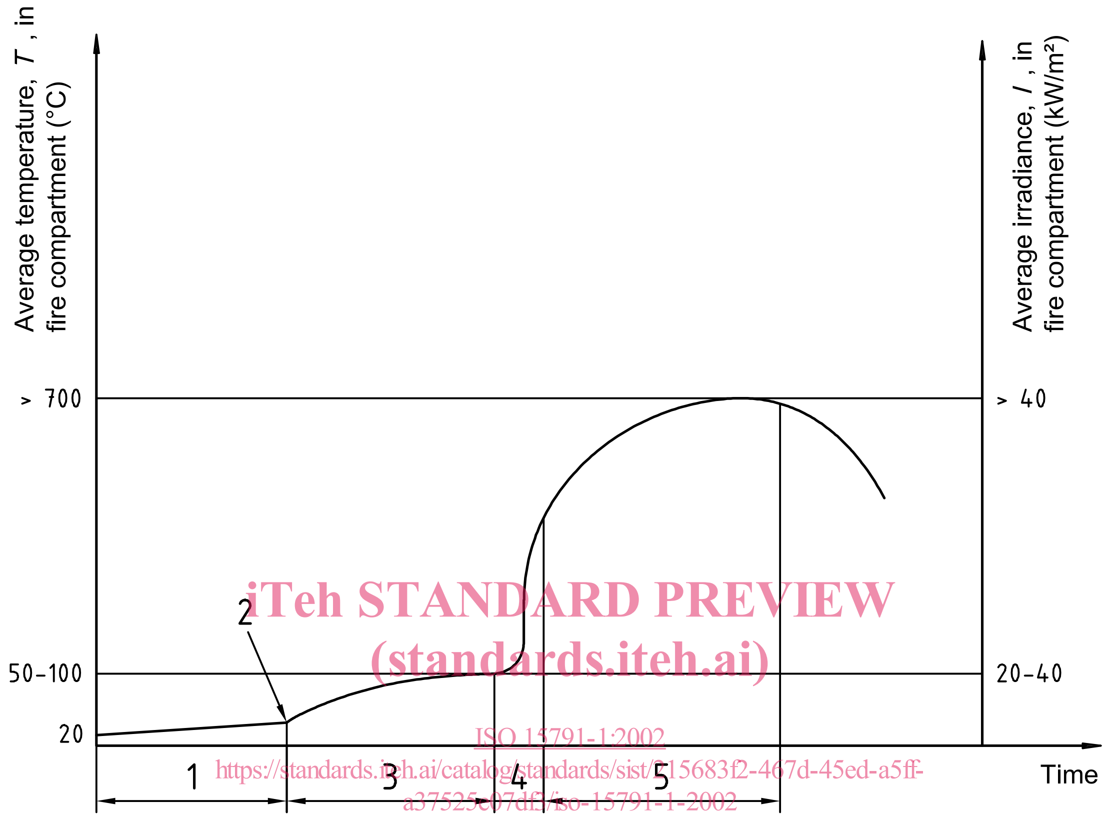
In small rooms, the typical primary ignition source is small, e.g. candles, matches, hot electrical wires. External irradiance is zero for the first ignited item. The relevant parameters for further assessing the fire risk are flame spread and rate of heat release. Combustible materials in the vicinity 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[17]. 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.

In large and ultra-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

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.

Table 2 — Typical heat fluxes

Source	Heat flux kW/m^2
Match flame	18 to 20
Developing fire	20 to 40
Paper bag, wood crib	25 to 50
Oxidative pyrolysis with oxygen concentration of 5 % to 21 %	< 25
Small gas-diffusion flame	30 to 40
Fully developed low-ventilation fire	40 to 70
Premixed-gas burner	50 to 70
Fully developed high-ventilation fire	50 to 150
Premixed-gas blow torch	140 to 150
Peak value for hydrocarbon-fire resistance test	200
Jet fire	350
Theoretical maximum for organic fire	1 500