

# **Fire tests on building materials and structures**

## **Part 33. Full-scale room test for surface products**

ICS 13.220.50

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Fire Standards Policy Committee (FSM/-) to Technical Committee FSM/21, upon which the following bodies were represented:

Association of Building Component Manufacturers  
 Association of Rooflights Manufacturers (ARMS)  
 Association of Specialist Fire Protection Contractors and Manufacturers  
 Autoclaved Aerated Concrete Products Association  
 British Carpet Manufacturers' Association Ltd.  
 British Floor Covering Manufacturers' Association  
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 Suspended Ceilings Association  
 Thermal Insulation Manufacturers' and Suppliers' Association (TISMA)  
 Timber Research and Development Association  
 Warrington Fire Research Centre  
 Wood Panel Products Federation  
 Wood Wool Slab Manufacturers' Association

This British Standard, having been prepared under the direction of the Fire Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 September 1993

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 Published by BSI Standards Limited 2014

The following BSI references relate to the work on this standard:  
 Committee reference FSM/21  
 Draft for comment 90/43557 DC

ISBN 978 0 580 85692 1

## Amendments/corrigenda issued since publication

| Amd. No. | Date       | Text affected                 |
|----------|------------|-------------------------------|
| C1       | March 2014 | Information added to Foreword |
|          |            |                               |
|          |            |                               |
|          |            |                               |

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## National foreword

This part of BS 476 is published by BSI Standards Limited, under licence from The British Standards Institution.

This standard has been superseded by the current BS EN 14390, but it has been retained based on legitimate need for the standards within non-EU markets.

This Part of BS 476 has been prepared under the direction of the Fire Standards Policy Committee. It is identical with ISO 9705 : 1993 *Fire tests — Full-scale room test for surface products* published by the International Organization for Standardization (ISO).

**Cross references.** The Technical Committee has reviewed the provisions of ISO 3261 : 1975 to which normative reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

For general guidance on this type of test, reference should be made to BS 476 *Fire tests on building materials and structures* Part 32 : 1989 *Guide to full scale fire tests within buildings*.

**Textual errors.** When adopting the text of the international standard, the following textual errors were discovered. They have been marked in the text and have been reported to the International Standards Organization in a proposal to amend the text of the international standard.

In 3.7, line 3, 'titles' should read 'tiles'.

In 5.1, the final sentence should read 'In order to facilitate the mounting of the instruments and of the ignition source, the test room may be placed so that the floor can be reached from beneath.'

In 11.6, line 1, 'non-hydroscopic' should read 'non-hygroscopic'.

In D.4, line 6, 'under pressure' should read 'under-pressure'.

In figure D.1, 'Hood 3 m × 3 m' should read 'Hood 3 × 3'.

In clause F.2.2, equation (F.5) should read as follows:

$$\phi = \frac{x_{O_2}^0 (1 - x_{CO_2}) - x_{O_2} (1 - x_{CO_2}^0)}{x_{O_2}^0 (1 - x_{CO_2} - x_{O_2})} \dots (F.5)$$

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

**Compliance with a British Standard cannot confer immunity from legal obligations.**

## Introduction

This method is intended to describe the fire behaviour of a product under controlled laboratory conditions.

The test method may be used as part of a fire hazard assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.



# Fire tests — Full-scale room test for surface products

**WARNING** — So that suitable precautions can be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases can be evolved during combustion of test specimens.

The test procedures involve high temperatures and combustion processes from ignition to a fully developed room fire. Therefore, hazards can exist for burns, ignition of extraneous objects or clothing. The operators should use protective clothing, helmet, face-shield and equipment for avoiding exposure to toxic gases.

Means for extinguishing a fully developed fire should be available.

## 1 Scope

This International Standard specifies a test method that simulates a fire that under well ventilated conditions starts in a corner of a small room with a single open doorway.

The method is intended to evaluate the contribution to fire growth provided by a surface product using a specified ignition source.

A standard ignition source is specified, but other alternatives are allowed. It should, however, be noted that the type, position and heat output of the ignition source will considerably influence the fire growth.

The method is especially suitable for products that for some reason cannot be tested in a small laboratory scale, for example thermoplastic materials, the effect of an insulating substrate, joints, surfaces with great irregularity.

The method is not intended to evaluate the fire resistance of a product.

A test performed in accordance with the method specified in this International Standard provides data for the early stages of a fire from ignition up to flashover.

## 2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3261:1975, *Fire tests — Vocabulary*.

## 3 Definitions

For the purposes of this International Standard, the definitions given in ISO 3261 and the following definitions apply.

**3.1 assembly:** Fabrication of materials and/or composites, for example, sandwich panels.

NOTE 1 An assembly may include an air gap.

**3.2 composite:** Combination of materials which are generally recognized in building construction as discrete entities, for example, coated or laminated materials.

**3.3 exposed surface:** That surface of the product subjected to the heating conditions of the test.

**3.4 material:** Single substance or uniformly dispersed mixture, for example, metal, stone, timber, concrete, mineral fibre, polymers.

**3.5 product:** Material, composite or assembly about which information is required.

**3.6 specimen:** Representative piece of the product which is to be tested together with any substrate or treatment.

NOTE 2 The specimen may include an air gap.

**3.7 surface product:** Any part of a building that constitutes an exposed surface on the interior walls and/or the ceiling such as panels, tiles, boards, wall papers, sprayed or brushed coatings.

## 4 Principle

The potential for fire spread to other objects in the room, remote from the ignition source, is evaluated by measurements of the total heat flux incident on a heat flux meter located on the centre of the floor.

The potential for fire spread to objects outside the room of origin is evaluated by the measurement of the total rate of heat release of the fire.

An indication of the toxic hazard is provided by the measurement of certain toxic gases.

The hazard of reduced visibility is estimated by the measurement of production of light-obscuring smoke.

The fire growth is visually documented by photographic and/or video recording.

NOTE 3 If further information is required, measurements of the gas temperature in the room and the mass flow in and out the doorway may be performed.

## 5 Fire test room

**5.1** The room (see figure 1) shall consist of four walls at right angles, a floor and a ceiling and shall have the following inner dimensions:

- a) length: 3,6 m  $\pm$  0,05 m;
- b) width: 2,4 m  $\pm$  0,05 m;
- c) height: 2,4 m  $\pm$  0,05 m.

The room shall be placed indoors in an essentially draught free, heated space, large enough to ensure that there is no influence on the test fire. In order to facilitate the mounting of the instruments of the ignition source, the test room may be placed so that the floor can be reached from beneath.

**5.2** There shall be a doorway in the centre of one of the 2,4 m  $\times$  2,4 m walls and no other wall, floor or ceiling shall have any openings that allow ventilation. The doorway shall have the following dimensions:

- a) width: 0,8 m  $\pm$  0,01 m;
- b) height: 2,0 m  $\pm$  0,01 m.

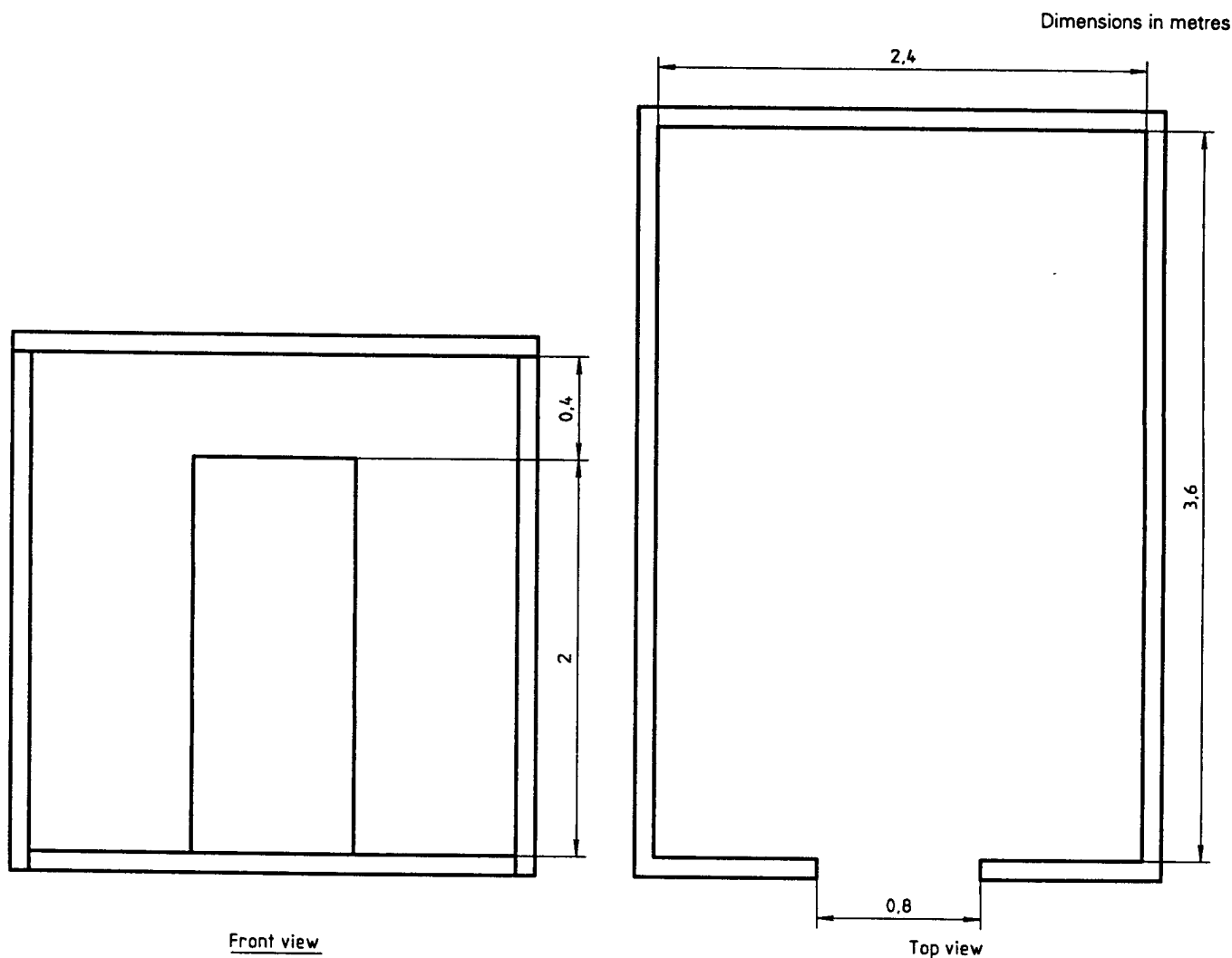


Figure 1 — Fire test room

**5.3** The test room shall be constructed of non-combustible material with a density of  $500 \text{ kg m}^{-3}$  to  $800 \text{ kg m}^{-3}$ . The minimum thickness of the construction shall be 20 mm.

## 6 Ignition source

### 6.1 Recommended sources

It is recommended to use one of the ignition sources specified in annex A to which the following requirements apply.

**6.1.1** The ignition source shall be a propane gas burner having a square top surface layer of a porous, inert material, e.g. sand. The construction shall be such that an even gas flow is achieved over the entire opening area.

The ignition source is a propane gas burner that consumes relatively large amounts of gas. The attention is therefore drawn to the following warning.

**WARNING** — All equipment such as tubes, couplings, flowmeters, etc. shall be approved for propane. The installations shall be performed in accordance with existing regulations.

The burner should, for reasons of safety, be equipped with a remote-controlled ignition device, for example a pilot flame or a glow wire. There should be a warning system for leaking gas and a valve for immediate and automatic cut-off of the gas supply in case of extinction of the ignition flame.

**6.1.2** The burner shall be placed on the floor in a corner opposite to the doorway wall. The burner walls shall be in contact with the specimen.

**6.1.3** The burner shall be supplied with natural grade propane (95 % purity). The gas flow to the burner shall be measured with an accuracy of at least  $\pm 3\%$ . The heat output to the burner shall be controlled within  $\pm 5\%$  of the prescribed value.

## 6.2 Alternative sources

Alternative sources as specified in annex B may also be used.

## 7 Heat flux instrumentation in the fire room

This clause specifies minimum requirements for heat flux instrumentation in the fire room. Additional information and designs can be found in annex C.

### 7.1 Specification

The heat flux meter shall be of the Gardon (foil) or the Schmidt-Boelter (thermopile) type with a design range of about  $50 \text{ kW m}^{-2}$ . The target area shall be a flat black surface having a view angle of  $180^\circ$ . The heat flux meter shall have an accuracy of at least  $\pm 3\%$  and a repeatability within  $0,5\%$ . In operation, the meter shall be maintained at a constant temperature (within  $\pm 5^\circ\text{C}$ ) above the dew point.

### 7.2 Location

The heat flux meter shall be mounted at the geometric centre of the floor. The target area shall be 5 mm to 30 mm above the floor surface. Radiation shall not pass through any window before reaching the target.

### 7.3 Calibration

The calibration of the heat flux meter shall be checked whenever required, by comparison with two instruments held as reference standards and not used for any other purpose. One of the reference standards shall be fully calibrated at yearly intervals.

NOTE 4 An example procedure is given in BS 6809.

## 8 Hood and exhaust duct

The system for collecting the combustion products shall have a capacity and be designed in such a way that all of the combustion products leaving the fire room through the doorway during a test are collected. The system shall not disturb the fire-induced flow in the doorway. The exhaust capacity shall be at least  $3,5 \text{ m}^3 \text{ s}^{-1}$  at normal pressure and a temperature of  $25^\circ\text{C}$ .

NOTE 5 An example of one design of hood and an exhaust duct is given in annex D.

## 9 Instrumentation in the exhaust duct

This clause specifies minimum requirements for instrumentation in the exhaust duct. Additional information and designs can be found in annex E.

### 9.1 Volume flow rate

The volume flow rate in the exhaust duct shall be measured to an accuracy of at least  $\pm 5\%$ .

The response time to a stepwise change of the duct flow rate shall be a maximum of 1 s at 90 % of the final value.

### 9.2 Gas analysis

#### 9.2.1 Sampling line

The gas samples shall be taken in the exhaust duct at a position where the combustion products are uniformly mixed. The sampling line shall be made from an inert material which will not influence the concentration of the gas species to be analysed. (See annex E.)

#### 9.2.2 Oxygen

The oxygen consumption shall be measured with an accuracy of at least  $\pm 0,05\%$  (V/V) oxygen. The oxygen analyser shall have a time constant not exceeding 3 s. (See annex E.)

#### 9.2.3 Carbon monoxide and carbon dioxide

The gas species shall be measured using analysers having an accuracy of at least  $\pm 0,1\%$  (V/V) for carbon dioxide and  $\pm 0,02\%$  (V/V) for carbon monoxide. The analysers shall have a time constant not exceeding 3 s. (See annex E.)

### 9.3 Optical density

#### 9.3.1 General

The optical density of the smoke is determined by measuring the light obscuration with a system consisting of a lamp, lenses, an aperture and a photocell, (see figure 2). The system shall be constructed in such a way as to ensure that soot deposits during the test do not reduce the light transmission by more than 5 %.

### 9.3.2 Lamp

The lamp shall be of the incandescent filament type and shall operate at a colour temperature of  $2\,900\text{ K} \pm 100\text{ K}$ . The lamp shall be supplied with stabilized direct current, stable within  $\pm 0,2\%$  (including temperature, short-term and long-term stability).

### 9.3.3 Lenses

The lens system shall align the light to a parallel beam with a diameter,  $D$ , of at least 20 mm.

### 9.3.4 Aperture

The aperture shall be placed at the focus of the lens  $L_2$  as shown in figure 2 and it shall have a diameter,  $d$ , chosen with regard to the focal length,  $f$ , of  $L_2$  so that  $d/f$  is less than 0,04.

### 9.3.5 Detector

The detector shall have a spectrally distributed responsivity agreeing with the CIE<sup>1)</sup>  $V(\lambda)$ -function (the CIE photopic curve) to an accuracy of at least  $\pm 5\%$ .

The detector output shall be linear within 5 % over an output range of at least 3,5 decades.

### 9.3.6 Location

The light beam shall cross the exhaust duct along its diameter at a position where the smoke is homogenous.

## 10 System performance

### 10.1 Calibration

A calibration test shall be performed prior to each test or continuous test series.

NOTE 6 Equations for calculations are given in annex F.

The calibration shall be performed with the burner heat outputs given in table 1, with the burner positioned directly under the hood. Measurements shall be taken at least every 6 s and shall be started 1 min prior to ignition of the burner. At steady state conditions, the difference between the mean rate of heat release over 1 min calculated from the measured oxygen consumption and that calculated from the metered gas input shall not exceed 5 % for each level of heat output.

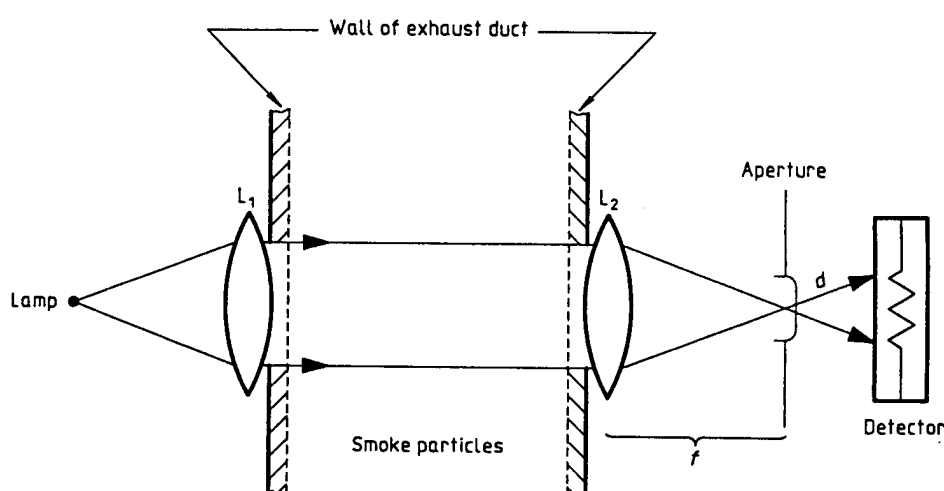


Figure 2 — Optical system

1) Commission internationale de l'éclairage

## 10.2 System response

The time delay for a stepwise change of the heat output from the burner, when placed centrally 1 m below the hood, shall not exceed 20 s and shall be corrected for in test data. The time delay shall be determined by measuring the time taken to reach agreement to within 10 % of the final measured heat release value, when going through the stepwise procedure given in table 1, taking measurements at least every 6 s.

**Table 1 — Burner heat output profile**

| Time<br>min | Heat output<br>kW |
|-------------|-------------------|
| 0 to 2      | 0                 |
| 2 to 7      | 100               |
| 7 to 12     | 300               |
| 12 to 17    | 100               |
| 17 to 19    | 0                 |

## 10.3 Precision

The precision of the system at various volume flow rates shall be checked by increasing the volume flow in the exhaust duct in four equal steps, starting from  $2 \text{ m}^3 \text{ s}^{-1}$  (at 0,1 MPa and 25 °C) up to maximum. The heat output from the burner shall be 300 kW. The error in the mean rate of heat release, calculated over 1 min, shall be not more than 10 % of the actual heat output from the burner.

## 11 Preparation of test specimens

**11.1** The product to be tested shall, as far as possible, be mounted in the same way as in practical use.

NOTE 7 In the standard specimen configuration, three walls and the ceiling are covered with the product. Alternative specimen configurations are given in annex G.

**11.2** In cases where the product to be tested is in board form, the normal width, length and thickness of the boards shall be used as far as possible.

**11.3** The product shall be attached either to a substrate or directly to the interior of the fire room. The mounting technique (for example, nailing, gluing, using a support system) shall, as far as possible, conform to that used for the product. The mounting technique shall be clearly stated in the report, particularly if the mounting technique used improves the physical behaviour of the specimen during the test.

**11.4** Thin surface materials, thermoplastic products that melt, paints and varnishes shall, depending on their end use, be applied to one of the following substrates:

- non-combustible fibre-reinforced silicate board having a dry density of  $680 \text{ kg m}^{-3} \pm 50 \text{ kg m}^{-3}$ ;
- non-combustible board having a dry density of  $1\,650 \text{ kg m}^{-3} \pm 150 \text{ kg m}^{-3}$ ;
- chipboard (particle board) having a density of  $680 \text{ kg m}^{-3} \pm 50 \text{ kg m}^{-3}$  after conditioning in an atmosphere of  $(50 \pm 5) \%$  relative humidity at a temperature of  $(23 \pm 2) \text{ °C}$ ;
- gypsum board having a density of  $725 \text{ kg m}^{-3} \pm 50 \text{ kg m}^{-3}$  after conditioning in an atmosphere of  $(50 \pm 5) \%$  relative humidity at a temperature of  $(23 \pm 2) \text{ °C}$ ;
- the actual substrate if its thermal properties differ significantly from those of substrates a) to d), for example, steel, mineral wool.

NOTE 8 A suitable thickness for substrates a) to d) is 9 mm to 13 mm.

**11.5** Paints and varnishes shall be applied to one of the substrates listed in 11.4 at the application rate specified by the client.

**11.6** Unless non-hydroscopic, specimens shall be conditioned to equilibrium in an atmosphere of  $(50 \pm 5) \%$  relative humidity at a temperature of  $(23 \pm 2) \text{ °C}$ . Equilibrium shall be deemed to be reached when a representative piece of the specimen has achieved constant mass.<sup>2)</sup>

NOTE 9 For wood-based products and products where vaporization of solvents can occur, a conditioning time of at least four weeks can be required.

2) Constant mass is considered to be reached when two successive weighing operations, carried out at an interval of 24 h, do not differ by more than 0,1 % of the mass of the test piece or 0,1 g, whichever is the greater.