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Fire tests — Full-scale room test for surface products

Essais au feu — Essai dans une pièce en vraie grandeur pour les produits de surface

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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.

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.

International Standard ISO 9705 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Reaction to fire*.

Annex A forms an integral part of this International Standard. Annexes B, C, D, E, F, G and H are for information only.

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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.

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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.

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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 ± 0,05 m;

b) width: 2,4 m ± 0,05 m;

c) height: 2,4 m ± 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 and 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 × 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 ± 0,01 m;

b) height: 2,0 m ± 0,01 m.

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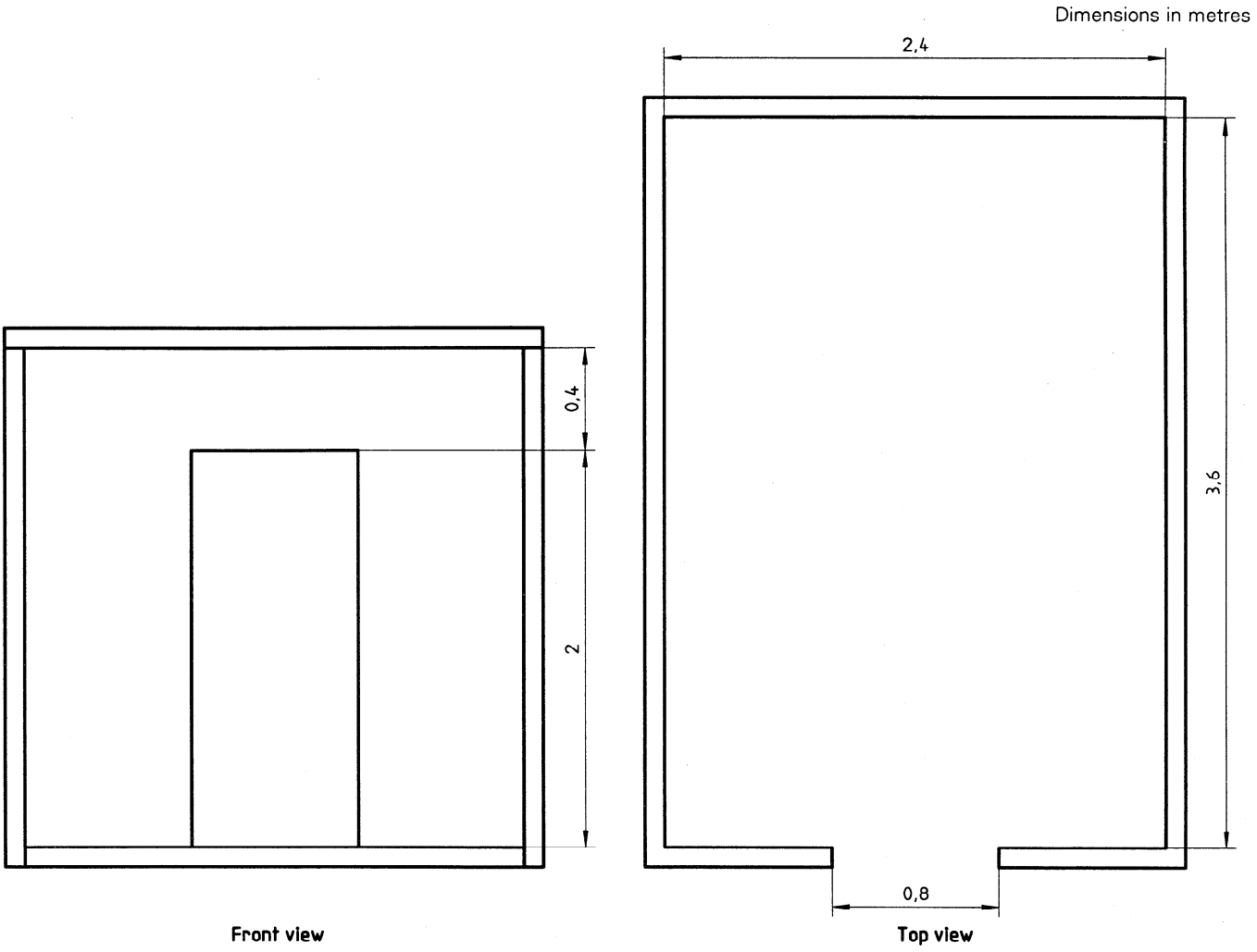

Figure 1 — Fire test room

5.3 The test room shall be constructed of non-combustible material with a density of 500 kg m^{-3} to 800 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.

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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 ± 3 %. The heat output to the burner shall be controlled within ± 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 kW m^{-2}. The target area shall be a flat black surface having a view angle of 180°. The heat flux meter shall have an accuracy of at least ± 3 % and a repeatability within 0,5 %. In operation, the meter shall be maintained at a constant temperature (within ± 5 °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 m^3 s^{-1} at normal pressure and a temperature of 25 °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 ± 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 ± 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 ± 0,1 % (*V/V*) for carbon dioxide and ± 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 %.

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9.3.2 Lamp

The lamp shall be of the incandescent filament type and shall operate at a colour temperature of 2 900 K ± 100 K. The lamp shall be supplied with stabilized direct current, stable within ± 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[1] V (λ)-function (the CIE photopic curve) to an accuracy of at least ± 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.

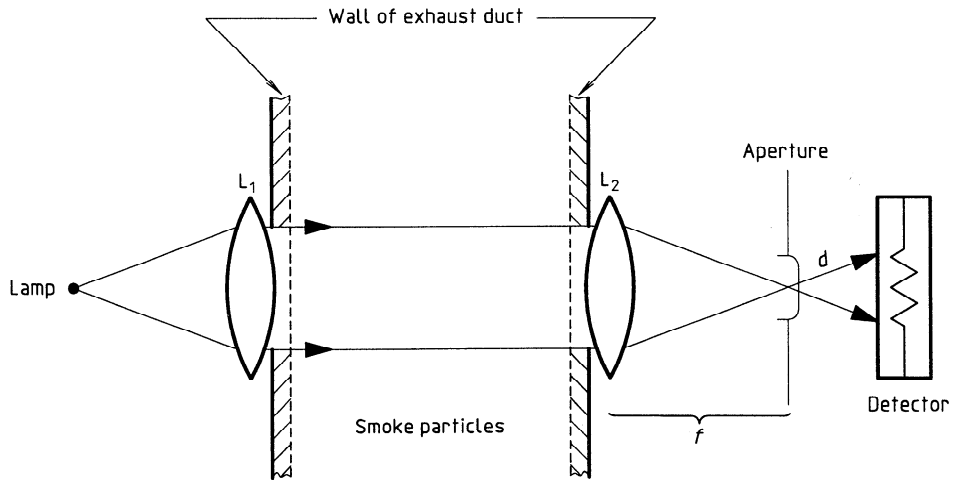

Figure 2 — Optical system

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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 min	Heat output 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 $m^3 s^{-1}$ (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:

a) non-combustible fibre-reinforced silicate board having a dry density of 680 kg m^{-3} ± 50 kg m^{-3};

b) non-combustible board having a dry density of 1 650 kg m^{-3} ± 150 kg m^{-3};

c) chipboard (particle board) having a density of 680 kg m^{-3} ± 50 kg m^{-3} after conditioning in an atmosphere of (50 ± 5) % relative humidity at a temperature of (23 ± 2) °C;

d) gypsum board having a density of 725 kg m^{-3} ± 50 kg m^{-3} after conditioning in an atmosphere of (50 ± 5) % relative humidity at a temperature of (23 ± 2) °C;

e) 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-hygroscopic, specimens shall be conditioned to equilibrium in an atmosphere of (50 ± 5) % relative humidity at a temperature of (23 ± 2) °C. Equilibrium shall be deemed to be reached when a representative piece of the specimen has achieved constant mass.[2)]

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.

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12 Testing

12.1 Initial conditions

12.1.1 The temperature in the fire test room and the surrounding area from the start of the installation of specimens until the start of the test shall be 20 °C ± 10 °C.

NOTE 10 The time between the removal of the specimens from conditioning and the start of the test should be kept to a minimum.

12.1.2 The horizontal wind speed measured at a horizontal distance of 1 m from the centre of the doorway shall not exceed 0,5 m s^{-1}.

12.1.3 The burner shall be in contact with the corner wall. The surface area of the burner opening shall be clean.

NOTE 11 Marking the product with a grid of 0,3 m × 0,3 m squares on those surfaces adjacent to the corner where the burner is located can help in determining the extent of flame spread.

12.1.4 The product shall be photographed or video-filmed before testing.

12.2 Procedure

12.2.1 Start all recording and measuring devices and record data for at least 2 min prior to the burner being ignited.

12.2.2 Adjust the burner to the output level given in annex A within 10 s of ignition of the burner. Continuously adjust the exhaust capacity so that all of the combustion products are collected.

12.2.3 A photographic and/or video recording shall be made of the test. A clock shall appear in all photographic records, giving time to the nearest 1 s.

12.2.4 During the test, record the following observations, including the time when they occur:

a) ignition of the ceiling;

b) flame spread on wall and ceiling surfaces;

c) change of the heat output from the burner;

d) flames emerging through the doorway.

12.2.5 End the test if flashover occurs or after 20 min (source A.1)/15 min (source A.2), whichever occurs first. Continue observation for 2 h, or until signs of visual combustion have ceased, whichever occurs first.

NOTE 12 Safety considerations can dictate an earlier termination.

12.2.6 Note the extent of damage of the product after the test.

12.2.7 Record any other unusual behaviour.

13 Test report

The test report shall contain the following information:

a) name and address of the testing laboratory;

b) date and identification number of the report;

c) name and address of the client;

d) purpose of the test;

e) method of sampling;

f) name of manufacturer or supplier of the product;

g) name or other identification marks and description of the products;

h) density or mass per square unit and thickness of the product;

i) date of supply of the product;

j) description of the specimens and mounting technique;

k) conditioning of the specimens;

l) date of test;

m) test method;

n) test results (see annex F):

   1) time/heat flux incident on the meter at the centre of the floor,

   2) time/volume flow in the exhaust duct,

   3) time/rate of heat release; and if the burner is included, time/heat release from the burner,

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