INTERNATIONAL STANDARD

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Reaction to fire tests for floorings —

Part 1: **Determination of the burning behaviour using a radiant heat source**

Essais de réaction au feu des revêtements de sol —

Partie 1: Détermination du comportement au feu à l'aide d'une source de chaleur rayonnante

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9239-1 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

This third edition cancels and replaces the second edition (ISO 9239-1:2002) which has been technically revised.

ISO 9239 consists of the following parts, under the general title *Reaction to fire tests for floorings*:

— *Part 1: Determination of the burning behaviour using a radiant heat source*

— *Part 2: Determination of flame spread at a heat flux level of 25 kW/m²*

Introduction

The measurements in the test method in this part of ISO 9239 provide a basis for estimating one aspect of fire exposure behaviour of floorings. The imposed radiant flux simulates the thermal radiation levels likely to impinge on the floor of a corridor whose upper surfaces are heated by flames or hot gases or both, during the early stages of a developing fire in an adjacent room or compartment under wind-opposed flame-spread conditions.

Reaction to fire tests for floorings —

Part 1:
Determination of the burning behaviour using a radiant heat source

WARNING — The possibility of a gas-air fuel explosion in the test chamber should be recognized. Suitable safeguards consistent with sound engineering practice should be installed in the panel fuel supply system. These should include at least the following:

- **a gas-feed cut-off which is immediately activated when air and/or gas supply fail;**
- **a temperature sensor or a flame detection unit directed at the panel surface that stops fuel flow when the panel flame goes out.**

The attention of all persons concerned with managing and carrying out this test is drawn to the fact that fire testing may be hazardous and that there is a possibility that toxic and/or harmful gases may be evolved during the test. Operational hazards may also arise during the testing of specimens, such as the possibility of an explosion, and during the disposal of test residues.

An assessment of all the potential hazards and risks to health should be made and safety precautions should be identified and provided. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written instructions at all times.

1 Scope

This part of ISO 9239 specifies a method for assessing the wind-opposed burning behaviour and spread of flame of horizontally mounted floorings exposed to a heat flux radiant gradient in a test chamber, when ignited with pilot flames. Annex A gives details of assessing the smoke development, when required.

This method is applicable to all types of flooring, e.g. textile carpet, cork, wood, rubber and plastics coverings as well as coatings. Results obtained by this method reflect the performance of the flooring, including any substrate if used. Modifications of the backing, bonding to a substrate, underlay or other changes of the flooring may affect test results.

This part of ISO 9239 is applicable to the measurement and description of the properties of floorings in response to heat and flame under controlled laboratory conditions. It should not be used alone to describe or appraise the fire hazard or fire risk of floorings under actual fire conditions.

Information on the precision of the test method is given in Annex B.

2 Normative references

The following referenced documents are indispensable for the application 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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 13943, *Fire safety — Vocabulary*

ISO 14697, *Reaction-to-fire tests — Guidance on the choice of substrates for building and transport products*

ISO 14934-3, *Fire tests — Calibration and use of heat flux meters — Part 3: Secondary calibration method*

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

IEC 60584-1, *Thermocouples — Part 1: Reference tables*

3 Terms and definitions

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

3.1
heat flux
amount of thermal energy emitted, transmitted or received per unit area and unit time

NOTE Heat flux is expressed in kilowatts per square metre (kW/m^2).

3.2
critical heat flux at extinguishment
CHF
incident heat flux, in kW/m^2, at the surface of a specimen at the point where the flame ceases to advance and may subsequently go out

3.3
heat flux at X min
HF-X
heat flux, in kW/m^2, received by the specimen at the most distant spread of flame position observed during the first X min of the test

3.4
critical heat flux
heat flux at which the flame extinguishes (CHF) or the heat flux after the test period of 30 min (HF-30), whichever is the lower value (i.e. the flux corresponding to the furthest extent of spread of flame within 30 min)

3.5
heat flux profile
curve relating the heat flux on the specimen plane to the distance from the zero point

3.6
zero point of heat flux profile
inner edge of the hottest side of the specimen holder

3.7
sustained flaming
persistence of flame on or over the surface of the specimen for a period of more than 4 s

3.8
flame-spread distance
furthest extent of travel of a sustained flaming along the length of the test specimen within a given time

3.9
flooring
upper layer(s) of a floor, comprising any surface finish with or without an attached backing and with any accompanying underlay, interlay and/or adhesive

3.10
substrate
product which is used immediately beneath the product about which information is required

NOTE For a flooring, it is the floor on which the flooring is mounted or the material representing the floor.

3.11
tiles
generally square flooring with linear dimensions of up to 500 mm

4 Principle

The test specimen is placed in a horizontal position below a gas-fired radiant panel inclined at 30° where it is exposed to a defined heat flux. A pilot flame is applied to the hotter end of the specimen. The test principle is illustrated in Figure 1. Following ignition, any flame front which develops is noted and a record is made of the progression of the flame front horizontally along the length of the specimen in terms of the time it takes to spread to defined distances. If required, the smoke development during the test is recorded as the light transmission in the exhaust stack.

The results are expressed in terms of flame-spread distance versus time, the critical heat flux at extinguishment and smoke density versus time.

5 Apparatus

5.1 General

The apparatus shall be as described in 5.2 to 5.8 and shall have the dimensions shown in Figures 2 to 5. The apparatus shall be placed in a room that is sufficiently large that there is a distance of at least 0,4 m between the apparatus and the walls and the ceiling.

5.2 Test chamber

The chamber shall be made of calcium silicate boards of (13 ± 1) mm thickness and 650 kg/m^3 to 750 kg/m^3 nominal density, with a tightly fitting panel of fire-resistant glass with dimensions of (110 ± 10) mm × (1 100 ± 100) mm, situated at the front so that the whole length of the specimen can be observed during the test. The chamber may have an outside metal cladding. Below this observation window, an access door shall be provided through which the test specimen platform can be moved into the chamber for the test and out of the chamber after test.

5.3 Specimen holder

The test specimen holder is fabricated from heat-resistant L-profile stainless steel of (2,0 ± 0,1) mm thickness with the dimensions shown in Figure 6. The test specimen is exposed through an opening (200 ± 3) mm × (1 015 ± 10) mm. The test specimen holder is fastened to the sliding steel platform by means of two bolts on each end.

The test specimen holder shall be provided with a means to secure the specimen (e.g. steel bar clamps); a maximum of eight clamps shall be used. The overall thickness of the holder is (22 ± 2) mm.

5.4 Sliding platform

The bottom of the chamber shall consist of a sliding platform which shall have provision for rigidly securing the test specimen holder in a fixed and level position (see Figure 1). The total air access area between the chamber and the test specimen holder shall be (0,23 ± 0,03) m^2 uniformly distributed on all sides of the test specimen.

5.5 Steel scale

At least one steel scale marked with 10 mm and 50 mm intervals has to be mounted on one side of the test specimen holder. A second steel scale on the other side of the specimen holder may also be used.

5.6 Gas-fired radiant panel

The source of radiant heat energy shall be a panel of porous refractory material mounted in a metal frame, with a radiation surface of (300 ± 10) mm × (450 ± 10) mm.

The panel shall be capable of withstanding temperatures up to 900 °C and use a fuel gas/air mixing system[1)] with suitable instrumentation (see Annex C) to ensure consistent and repeatable operation.

The radiant heat panel is placed over the test specimen holder with its longer dimension at (30 ± 1)° to the horizontal plane (see Figure 5).

5.7 Pilot burner

The pilot burner, used to ignite the test specimen, shall be of nominal internal diameter 6 mm and of outer diameter 10 mm, and be made of stainless steel having two lines of 19 evenly spaced 0,7 mm diameter holes drilled radially along the centre-line and 16 evenly spaced 0,7 mm diameter holes drilled radially 60° below the centre-line (see Figure 7). In operation, the propane flow rate shall be adjusted to (0,026 ± 0,002) l/s. The pilot burner shall be positioned so that the flames generated from the lower line of holes will impinge on the specimen (10 ± 2) mm from the zero point (see Figure 8). The pilot burner tube shall be 3 mm above the edge of the specimen holder when the burner is in the ignition position. When not being applied to the test specimen, the burner shall be capable of being moved at least 50 mm away from the zero point of the test specimen. The gas used shall be commercial-grade propane having a calorific value of approximately 83 MJ/m^3.

NOTE 1 It is important to keep the holes in the pilot burner clean. A soft wire brush is suitable to remove surface contaminants. Nickel-chromium or stainless-steel wire, 0,5 mm in diameter, is suitable for opening the holes.

NOTE 2 With the propane gas flow properly adjusted and the pilot burner in the test position, the pilot flame will vary in height from approximately 60 mm to approximately 120 mm across the width of the burner (see Figure 8).

5.8 Exhaust system

An exhaust system[2)], connected to the exhaust duct and de-coupled from the exhaust stack of the test apparatus, shall be used to extract the products of combustion. With the gas-fired radiant panel turned off, the dummy specimen in place and the access door closed, the air velocity in the exhaust stack shall be (2,5 ± 0,2) m/s.

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1) Propane and/or butane/air mixtures have been proven to be suitable, but other fuel gas/air mixtures may also be used.

2) An exhaust capacity of 39 m^3/min to 85 m^3/min (at 25 °C, 1 bar) has proved to be suitable.

5.9 Anemometer

An anemometer with an accuracy of ± 0,1 m/s shall be provided for measuring the air velocity in the exhaust stack. It shall be fitted in the exhaust stack, in such a way that its measuring point coincides with the centre-line of the exhaust stack at (250 ± 10) mm above the lower edge of the exhaust stack (see Figure 4).

5.10 Radiation pyrometer

In order to control the thermal output of the radiant panel, a radiation pyrometer with a range of 480 °C to 530 °C (black-body temperature) and an accuracy of ±5 °C suitable for viewing a circular area 250 mm in diameter at a distance of about 1,4 m shall be used.

The sensitivity of the pyrometer shall be substantially constant between the wavelengths 1 µm and 9 µm.

5.11 Thermocouples

A 3,2 mm stainless-steel sheathed type K thermocouple, in accordance with IEC 60584-1 with an insulated measuring junction, shall be mounted in the flooring radiant test chamber. It shall be located in the longitudinal central vertical plane of the chamber, 25 mm down from the top and 100 mm back from the inside wall of the exhaust stack (see Figures 4 and 5).

A second thermocouple may be inserted centrally in the exhaust stack, at a distance of (150 ± 2) mm from the top of the exhaust stack. The thermocouples shall be cleaned after each test.

5.12 Heat flux meter

The heat flux meter used to determine the heat flux profile to the test specimen shall be of the Schmidt-Boelter type without a window and with a diameter of 25 mm. Its range shall be from 0 kW/m^2 to 15 kW/m^2, and shall be calibrated over the operating heat flux level range from 1 kW/m^2 to 15 kW/m^2. A source of cooling water with a temperature of 15 °C to 25 °C shall be provided for this instrument.

The heat flux meter shall have an accuracy of ±3 % of the measured value, and shall be calibrated in accordance with ISO 14934-3.

5.13 Dummy specimen

The dummy specimen used for calibration shall be made of (20 ± 1) mm thick uncoated calcium silicate board of (850 ± 100) kg/m^3 density. It shall be (250 ± 10) mm wide and (1 050 ± 20) mm long (see Figure 6), with (26 ± 1) mm diameter holes centred on and along the centre-line at 110 mm, 210 mm through to 910 mm locations, measured from the zero point of the test specimen.

5.14 Recording equipment

Recording equipment shall be suitable for recording the output from the radiation pyrometer and the heat flux meter.

5.15 Timing device

A timing device capable of recording elapsed time to the nearest second and with an accuracy of 1 s in 1 h shall be used.

5.16 Smoke measurements

The apparatus described in Annex A shall be used if smoke measurements are required.