INTERNATIONAL STANDARD

ISO 9239-1

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Reaction to fire tests — Horizontal surface spread of flame on floor-covering systems —

Part 1:
Flame spread using a radiant heat ignition source

Essais de réaction au feu — Propagation superficielle horizontale d'une flamme sur des revêtements de sol —

Partie 1: Propagation de flamme utilisant une source de chaleur radiante

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Contents

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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 approval for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

This International Standard was initiated by ISO/TC 38/SC 19, *Textile floor coverings,* and was progressed to DIS in 1988. ISO/TAG-5 recommended expansion of the scope to include materials other than textiles. In 1992, ISO/TC92/SC1 conducted a ballot for a new work item on flame spread over all types of floor covering. This work item was well supported and the development of flame spread tests for floor coverings, including both textiles and non-textiles, was begun by ISO/TC 92/SC 1 in 1993. It was considered that DIS 9239.1 was a suitable starting point although the fire model used had only been validated for flame spread down a corridor under wind-opposed conditions. It was also recognised that over-emphasis had been placed in DIS 9239.1 on determination of critical radiant flux, which requires observation of flame-out. Since the understanding of fire propagation hazards requires measurements on the rate of flame spread, it was realised that additional test data must be obtained for the early stages of fire growth.

Research conducted after the introduction of the radiant panel test has shown that higher heat fluxes than 11 kW/m^2 may be imposed on floor-coverings in post-flashover situations. Hence, it has been necessary to reappraise the scope of this International Standard to relate mainly to pre-flashover conditions.

International Standard ISO 9239-1 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Reaction to fire*.

Further parts are in preparation.

Annexes A, B and C of this part of ISO 9239 are for information only.

Introduction

ISO/TR 5658-1 describes the development of standard tests for flame spread and explains the theory of flame spread including horizontal flame spread over floor coverings.

Floor coverings are not readily involved in fires but if fire develops due to other contents of a building burning, then floor coverings may ignite and it is necessary to be able to determine whether the floor covering will propagate flames.

This part of ISO 9239 provides a simple method by which horizontal surface spread of flame on a horizontal specimen can be determined for comparative purposes. This method is useful for research, development, quality control purposes and national requirements. Some laboratories use this part of ISO 9239 for measuring the smoke emission from floor-covering systems.

Fire is a complex phenomenon: its behaviour and its effects depend upon a number of interrelated factors. The behaviour of materials and products depends upon the characteristics of the fire, the method of the use of the materials and the environment in which they are exposed. The philosophy of 'reaction to fire' tests is explained in ISO/TR 3814.

A test such as is specified in this part of ISO 9239 deals only with a simple representation of a particular aspect of the potential fire situation typified by a radiant heat source and flame; it cannot alone provide any direct guidance on behaviour or safety in fire.

This test procedure does not rely on the use of asbestos-based materials.

Reaction to fire tests — Horizontal surface spread of flame on floor-covering systems —

Part 1:

Flame spread using a radiant heat ignition source

CAUTION - So that suitable precautions may be taken to safeguard health, the attention of all concerned in fire tests is drawn to the possibility that toxic or harmful gases may be evolved during exposure of test specimens.

1 Scope

This part of ISO 9239 describes a test method for measuring the wind-opposed flame spread behaviour of horizontally mounted floor-covering systems exposed to a radiant heat gradient in a test chamber when ignited with a pilot flame.

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.

This test method provides data suitable for comparing the performance of essentially flat materials, composites and assemblies, which are used primarily as the exposed surfaces of floors.

This test method is applicable to all types of floor covering such as textile carpets, cork, wood, rubber and plastic coverings and coatings.

Results obtained by this method reflect the performance of the total end-use floor covering system. Modifications of the carpet-backing, bonding to a substrate, the type of substrate, underlay or other changes of the system may affect test results.

The test is intended for regulatory purposes, specification acceptance, design purposes, classification, or development and research.

This part of ISO 9239 is applicable to the measurement and description of the properties of materials, products or assemblies 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 materials, products or assemblies under actual fire conditions.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9239. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9239 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC Guide 52:1990, *Glossary of fire terms and definitions.*
ISO/TR 14697:—[1)], *Reaction to fire tests — Guidance rules on the use of substrates.*

3 Definitions

For the purposes of this part of ISO 9239, the definitions given in ISO/IEC Guide 52 apply, together with the following.

3.1 assembly: Fabrication of materials and/or composites.

3.2 average heat for sustained burning: The average of the values of heat for sustained burning measured at a number of specified positions expressed in units of MJ/m^2.

3.3 backing board: A non-combustible board with the same dimensions as the specimen, used in every test to back the specimen and its substrate (where used).

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

3.5 critical heat flux at extinguishment: Incident heat flux (kW/m^2) at the surface of a specimen at the point where the flame ceases to advance and may subsequently go out. The total heat flux value reported is based on interpolations of measurements with a non-combustible calibration board.

NOTE : This term is often abbreviated to critical radiant flux (CRF).

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

NOTE: For floor-covering systems, the exposed surface is generally the use surface.

3.7 flame front: The furthest extent of travel of a sustained flame along the length of the test specimen.

3.8 flashing: Existence of flame on or over the surface of the specimen for periods of less than 1 s.

3.9 floor covering: An article having a use surface composed of textile or non-textile material and generally used for covering floors.

3.10 floor-covering system: A complete floor covering, comprising a use surface with an attached backing or with any accompanying underlay, interlayment and adhesive.

3.11 flux profile: The curve relating total heat flux on the specimen plane to distance from the zero point.

NOTE: The zero point of the radiant flux profile is specified as the inner edge of the hottest side of the specimen holder.

1) To be published.

3.12 heat for sustained burning: The product of the time from the start of exposure of a specimen to the arrival of the flame front at one of the specified positions and the total heat flux corresponding to that position, measured with a non-combustible calibration board, expressed in units of MJ/m^2.

3.13 interlayment: A thin, flexible layer used beneath a carpet or underlay for various purposes.

3.14 irradiance (at a point of a surface): Quotient of the radiant heat flux incident on an infinitesimal element of surface containing the point, by the area of that element.

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

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

3.17 radiant heat flux: Power emitted, transferred or received in the form of radiation.

NOTE:. The flux profile is measured with a total heat flux meter so that both radiant heat flux and convective heat flux are included.

3.18 radiant heat flux at *X* min (RF-X): The total heat flux (kW/m^2) received by the specimen at the most distant spread of flame position after *X* min of testing.

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

3.20 spread of flame: The propagation of a flame front over the surface of a product under the influence of imposed irradiance.

3.21 substrate: A material which is used or is representative of that used, immediately beneath a surface in end-use, e.g. fibre cement board beneath a floor-covering.

NOTE:. This definition of a substrate is different from that given in ISO 2424:1992. For textile floor coverings, the substrate is considered to be part of the carpet below the use surface. In the context of this fire testing standard, the substrate should be chosen to represent the type of floor on which the textile or non-textile floor covering is placed in the end-use scenario.

3.22 sustained flaming: Existence of flame on or over the surface of the specimen for periods of more than 4 s.

3.23 transitory flaming: Existence of flame on or over the surface of the specimen for periods of between 1 s and 4 s.

3.24 underlay: A resilient layer of textile and/or other material placed between the textile floor covering and the floor (substrate, as defined in 3.21).

3.25 use surface: That part of a floor covering directly exposed to traffic.

3.26 zero point of specimen: The point of initiation of flaming combustion (see 3.11).

4 Principle

The test method consists of mounting conditioned specimens in a well defined field of radiant heat flux and measuring the rate of spread of flame and the position of flame extinguishment.

A test specimen is placed in a horizontal position below a gas-fired radiant panel inclined at 30° where it is exposed to a defined field of total heat flux. A pilot flame is applied to the hotter end of the specimen. See 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 travel to various distances.

The results are expressed in terms of flame spread distance versus time, the critical heat flux at extinguishment and the average heat for sustained burning.

NOTE: The test would normally be terminated after 30 minutes. However, at the request of the sponsor the test may be continued until flame-out for the purpose of determining the critical radiant heat flux at extinguishment.

5 Suitability of a product for testing

5.1 Surface characteristics

A product having one of the following characteristics is suitable for evaluation by this method:

a) an essentially flat exposed surface, i.e. all surface irregularities are within ± 1 mm of plane;

b) a surface irregularity which is evenly distributed over the exposed surface provided that:

i) at least 50% of the surface of a representative area 155 mm^2 lies within a depth of 6 mm from a plane taken across the highest points on the exposed surface, and/or

ii) any cracks, fissures or holes do not exceed 8 mm in width or 10 mm in depth and the total area of such cracks, fissures or holes at the surface does not exceed 30% of a representative area 155 mm^2 of the exposed surface.

5.2 Thermally unstable products

The test method may not be suitable for assessing products that react in particular ways under exposure to the specified heating conditions; for example, spalling or disintegration of the product, detachment of the covering from the substrate unless ignition of the exposed surface occurs within the resulting flame front ahead of the inappropriate behaviour.

6 Test specimens

6.1 General

The specimen shall be representative of the floor-covering system (3.10) and simulate actual installation practice as closely as possible or necessary, e.g. adhesives, substrates, joints.

6.2 The exposed surface

The product shall be tested on that face which will normally be exposed in practice, taking account of the following.

a) If it is possible for either or both of the faces to be exposed in use, both faces shall be tested.0

b) If the face of the product contains a surface irregularity that is specifically directional, e.g. corrugations or joints, the product shall be tested in both orientations.

c) If the exposed face contains distinct areas of different surface finish or texture, then the appropriate number of specimens shall be provided for each distinct area of such finish or texture to be evaluated.

d) Textile materials shall be tested for spread of flame in both the warp and the weft directions.

6.3 Number and size of specimens

a) At least six specimens shall be provided for test (see 6.2).

b) Three specimens shall be tested for each different exposed surface, orientation and type of surface finish or texture.

c) The specimens shall be 1050 mm ± 5 mm long by 230 mm ± 5 mm wide and shall be representative of the product.

d) The thickness of specimens of products with irregular surfaces (see 6.2) shall be measured from the highest point of the surface.

e) For floor coverings consisting of tiles the tiles shall be fixed so that a lateral joint occurs at a distance 250 mm from the zero point. When tile lengths are shorter than 250 mm, the tiles shall be fixed to a substrate to represent their end-use condition. If the tiles are not glued, the edges of the joints shall be secured by mechanical means (e.g. clamps or screws) on the substrate.

6.4 Construction of specimens

The floor covering system shall be mounted on a substrate which simulates the actual floor in its anticipated end-use.

If no sample of the end-use substrate is available for test, the following substrates may be used for comparative purposes (see ISO/TR 14697).

a) The substrate representative of all uses on non-combustible floors shall be fibre cement 6 mm ± 1 mm thick and (1800 ± 100) kg/m^3 density (highest level of performance).

b) The substrate representative of all uses on wood or wood-based materials shall be particle board 19 mm ± 3 mm thick and (680 ± 50) kg/m^3 density. When tested in the uncovered condition, this substrate shall have a critical radiant flux at extinguishment of (3 ± 0,5) kW/m^2.

The adhesive used for the specimen shall be the same as used in practice. If in practice different adhesives are used, either specimens with each of the intended adhesives shall be prepared or specimens without adhesives.

Floor covering systems utilising a known underlay or interlayment in the actual end-use shall be tested with this underlay or interlayment on a representative substrate. If the underlay with which the carpet will be used

is not known at the time of testing, then an underlay specified by the floor covering manufacturer (or sponsor) shall be used.

6.5 Conditioning

Condition the specimens previously not exposed to a wet cleaning procedure for a minimum of 6 days at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5)%.

If the specimens have been previous exposed to a wet cleaning, dry the specimens according to the Specification of the manufacturer or product Standard and then expose at a temperature of (23 ± 2) °C and a relative humidity of (50 ± 5)% for a minimum of 6 days.

NOTE: For floor-covering systems which are not glued to a substrate, this conditioning time may be shortened by a drying procedure of 2 h at (60 ± 5) °C and by storing at the standard temperature and relative humidity conditions for 24 h. This assumes the substrate has been conditioned separately. For floor-covering systems that are glued to the substrate, the curing time shall be at least 3 days. This can be part of the 6 day conditioning.

Substrates shall be conditioned for at least 12 h before use at a temperature of (23 ± 2) °C and RH of (50 ± 5)%.

7 Apparatus

7.1 The apparatus shall have the dimensions shown in figures 2, 3 and 4. The chamber shall be made of calcium silicate panels of 13 mm ± 1 mm thickness and 650 kg/m^3 nominal density with a tightly fitting panel of fire-resistant glass (110 ± 10) mm by (1100 ± 100) mm in size situated at the front so that the whole length of the specimen can be observed during the test. Below this observation window, provide a tightly closing door through which the specimen platform can be moved in and out. A steel scale marked with 10 mm and 50 mm intervals shall be fixed to the back wall of the chamber or to the back of the specimen platform.

7.2 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. The total air access area shall be 0,23 m^2 ± 0,03 m^2.

7.3 The source of radiant heat energy shall be a panel of porous refractory material mounted in a cast iron or steel frame with a radiation surface of 300 mm ± 10 mm by 450 mm ± 10 mm.

The panel shall withstand temperatures up to 900°C.

NOTE: The panel may also be constructed using a metal fibre burner.

7.4 The combustion gas and air shall be fed to the radiant panel via suitable pressure and flow regulators, safety equipment and flowmeters.

A suitable supply system includes the following:

a) a supply of natural gas, methane or propane of at least 1,0 l/s at a pressure sufficient to overcome the friction losses through the supply lines, regulators, control valve, flow meters, radiant panel etc;

b) an air supply of at least 9 l/s at a pressure sufficient to overcome the friction losses through the supply lines, etc.;

c) separate isolation valves for gas and air;

d) a non-return valve and pressure regulator in the gas supply line;

e) an electrically operated valve to shut off the gas supply automatically in the event of failure of electrical power, failure of air pressure or fall in temperature at the burner surface;

f) a particulate filter and a flow control valve in the air supply;

g) a flowmeter for natural gas, methane or propane suitable for indicating flow of 0,5 l/s to 1,5 l/s at ambient temperature and pressure to a resolution of 1% or better;

h) a flowmeter for air suitable for indicating flow of 5 l/s to 15 l/s at ambient temperature and pressure to a resolution of 1% or better.

NOTE: The flowmeters are used to assist in setting the air and gas flows to a value which gives a suitable panel temperature, and absolute calibration of the flowmeters is unnecessary.

The radiant panel shall be mounted in the chamber with its longer dimension at 30° ± 1° to the horizontal plane (see figure 3).

7.5 The specimen holder shall be fabricated from heat resistant L-profile stainless steel of 2,0 mm ± 0,1 mm thickness to the dimensions shown on figure 5. The specimen shall be exposed through an opening 200 mm ± 2 mm by 1015 mm ± 5 mm. The specimen holder shall be fastened to the sliding steel platform by means of two bolts on each end.

The specimen holder shall be provided with means to secure the specimen (e.g. steel bar clamps). The overall thickness of the holder 19 ±1 mm.

7.6 The pilot burner, used to ignite the specimen, shall be nominal 6 mm ID, 10 mm OD, stainless steel line burner having 19 evenly spaced 0,7 mm diameter holes drilled radially along the centreline and 16 evenly spaced 0,7 mm diameter holes drilled radially 60° below the centreline (see figure 7). In operation the propane flow shall be adjusted to 0,026 l/s ± 0,002 l/s flow rate. The pilot burner shall be positioned no more than 5° from the horizontal so that the flame generated will impinge on the specimen 10 ± 2 mm from the zero point (3.26) (see figures 3, 4 and 8). When not being applied to the specimen the burner shall be capable of being moved at least 50 mm away from the specimen. The gas used in this test shall be commercial grade propane having a heating 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 has been found suitable to remove surface contaminants. Nickel-chromium or stainless steel wire, 0,5 mm outside diameter, is suitable for opening the holes.

NOTE 2: With the gas flow properly adjusted and the pilot burner in the test position, the pilot flame will extend from approximately 60 mm to approximately 120 mm across the width of the burner (see figure 7).

A gas-supplied single flame pilot burner (about 10 mm diameter) may be used as an alternative to the line burner. If this alternative burner is used, it shall be clearly stated in the test report (clause12. h). This burner shall produce a flame which in operation has an overall length of (50 ± 2) mm with an inner core length of about 15 mm. The point of flame impingement shall be (10 ± 2) mm from the inner edge of the end of the specimen holder. It shall be possible to swing the burner from the ignition position so that the flame is horizontal and at least 50 mm above the specimen holder plate.

7.7 Use an exhaust system, decoupled from the chimney of the chamber by at least 50 mm, to extract the products of combustion; see CAUTION before the Scope. If smoke opacity measurements are required, the light beam and smoke detector apparatus illustrated in figures 1 to 4 may be used.

With the panel turned off and the dummy specimen in place, the air flow rate through the chimney shall be 2,5 m/s ± 0,2 m/s when measured with a hot wire anemometer about 30 s after insertion of the probe into the centre of the chimney opening at a distance of 250 mm from the top of the chamber.

NOTE 1: Adjustment of the air flow rate may be achieved by modifying the extent of decoupling of the exhaust system from the chimney of the chamber. Alternatively, the extent of decoupling may be fixed and control achieved by adjusting the speed of the extract fan.

NOTE 2: The dimensions of the room in which the tests are carried out are not critical provided it is large enough. A room of volume 50 m^3 with a ceiling height of not less than 2,0 m and an appropriate fume exhaust system has been found suitable (see figure 2).

The fume exhaust system should be installed above the canopy and should have a capacity of at least 0,5 m^3/s.

8 Additional equipment and instrumentation

8.1 Total heat flux meter (THFM)

At least three total heat flux meters of the Schmidt-Boelter (thermopile) type with a nominal range of 0 kW/m^2 to 15 kW/m^2 and a time constant of not more than 3 s (corresponding to a time to reach 95% of final output of not more than 10 s) shall be provided, one to form a working instrument and two to be retained as reference standards.

NOTE 1: Suitable instruments are commercially available, sometimes referred to as 'total heat flux transducers', or 'total heat flux gauges'.

The target sensing THFM shall be flat, shall occupy an area not more than 10 mm diameter, and shall be coated with a durable matt black finish. It shall be contained within a water-cooled body whose front face shall be flat, circular, 25 mm in diameter and coincident with the plane of the receiving face and the target. Radiation shall not pass through a window before reaching the target. The temperature of the cooling water should be controlled so that the heat flux meter body temperature remains within a few degrees of room temperature.

NOTE 2: Water cooling of the heat flux meter is required to standardise and define the measurement and to safeguard the heat flux meter. Failure to supply water cooling may result in overheating and damage to the receiver and loss of calibration of the heat flux meter. In some cases repairs and re-calibration are possible.

If heat flux meters of diameter smaller than 25 mm are used, these shall be inserted into a copper sleeve of 25 mm outside diameter in such a way that good thermal contact is maintained between the sleeve and the water-cooled heat flux meter body. The end of the sleeve and the receiving face of the heat flux meter shall lie in the same plane.

The heat flux meters shall be robust, simple to set up and use, insensitive to draughts and stable in calibration. They shall have an accuracy of within ± 2% and a repeatability within ± 0,5%.

The calibration of the working heat flux meter shall be checked every 2 months by comparison with the two reference standard heat flux meters (see annex A), which shall be kept securely and not used for any other purpose.