INTERNATIONAL STANDARD

ISO 9239-1

Second edition
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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

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

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 9239 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 9239-1 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

This second edition cancels and replaces the first edition (ISO 9239-1:1997), 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/m*^{2}

Annex A forms a normative part of this part of ISO 9239. Annexes B and C are for information only.

Contents

Page

Foreword

The text of EN ISO 9239-1:2002 has been prepared by Technical Committee CEN/TC 127 "Fire safety in buildings", the secretariat of which is held by BSI, in collaboration with Technical Committee ISO/TC 92 "Fire safety".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2002, and conflicting national standards shall be withdrawn at the latest by December 2003.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

The measurements in this test method 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.

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.

Safety 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.

Attention is drawn to the possibility that toxic or harmful gases may be produced during exposure of the specimens. In view of the potential hazard from products of combustion, the exhaust system should be designed and operated so that the laboratory environment is protected from smoke and gas. The operator should be instructed to minimize his exposure to combustion products by following sound safety practice, for example ensuring that the exhaust system is working properly, wearing appropriate clothing including gloves, etc.

1 Scope

This European Standard 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 European Standard 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

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

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

EN 60584-1, *Thermocouples* **—** *Part 1: Reference tables (IEC 60584-1:1995)*

EN ISO 13943, *Fire safety — Vocabulary (ISO 13943:2000)*

3 Terms and definitions

For the purposes of this European Standard, the definitions given in EN ISO 13943, together with the following terms and definitions, apply.

3.1
heat flux (kW/m^2)
incident heat power per unit area; this includes both radiant heat flux and convective heat flux

3.2
critical heat flux at extinguishment (CHF)
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 heat flux value reported is based on interpolations of measurements with a non-combustible calibration board

3.3
heat flux at X min (HF-X)
heat flux (kW/m^2) received by the specimen at the most distant spread of flame position observed during the first X minutes 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 with the furthest extent of spread of flame within 30 min)

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

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

3.6
sustained flaming
persistence of flame on or over the surface of the specimen for a period of more than 4 s

3.7
distance of flame spread
furthest extent of travel of a sustained flame along the length of the test specimen within a given time

3.8
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

3.9
substrate
product which is used immediately beneath the product about which information is required. For a flooring, it is the floor on which the flooring is mounted or the material to represent the floor

4 Test apparatus

4.1 The test apparatus shall be placed in a room, at a distance of at least 0,4 m to the walls and the ceiling. It shall have the dimensions shown in Figures 2 to 5. The chamber shall be made of calcium silicate boards of (13 ± 1) mm thickness and 650 kg/m^3 nominal density, with a tightly fitting panel of fire resistant glass with dimensions of (110 ± 10) mm x (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, a tightly closing door shall be provided through which the test specimen platform can be moved in and out.

A steel scale marked with 10 mm and 50 mm intervals starting at the inner edge of the test specimen holder shall be mounted on both sides of the test specimen.

4.2 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 (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.

4.3 The source of radiant heat energy shall be a panel of porous refractory material mounted in a metal frame, with a radiation surface of (30[1] 0 ± 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 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).

4.4 The test specimen holder is fabricated from heat resistant L-profile stainless steel of (2,0 ± 0,1) mm thickness to 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.

1) Propane and/or butane air mixtures have been proved to be suitable but other fuel gas/air mixtures may be utilised as well.

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

4.5 The pilot burner, used to ignite the test specimen, shall be nominal 6 mm ID, 10 mm OD, stainless steel burner having 2 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 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).

4.6 An exhaust system[2)], de-coupled from the exhaust stack, shall be used to extract the products of combustion. With the 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.

4.7 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).

4.8 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 (see 7.1.3 and 8.1).

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

4.9 A 3,2 mm stainless steel sheathed type K thermocouple, in accordance with EN 60584-1 with an insulated and ungrounded hot 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.

4.10 The heat flux meter used to determine the heat flux profile to the test specimen shall be of the Schmidt-Boelter type without 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.

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

4.11 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.

4.12 Smoke measurements, if required, are made using the apparatus described in annex A.

4.13 The output from the radiation pyrometer, the heat flux meter(s) and the smoke measurement system shall be recorded by an appropriate method.

4.14 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 Test specimen

5.1 The test specimens shall be representative of the flooring in its end use.

5.2 Cut six specimens (1 050 ± 5) mm × (230 ± 5) mm, three in one direction (e.g. production direction) and three in a direction perpendicular to the first direction.

NOTE If the thickness of the specimen is more than 19 mm, the length may be reduced to (1025 ± 5) mm.

5.3 The specimen shall be mounted on a substrate that simulates the actual floor (see EN 13238) and shall simulate actual installation practice.

The adhesive used for the specimens shall be representative of those used in practice. If in practice specific adhesives are used, the specimens shall be prepared, either using each of the specific adhesives or without adhesives.

Underlays used as part of the specimens shall be representative of those used in practice.

If the specimen consists of tiles, it shall be mounted in such a way that a joint is situated 250 mm from the zero point. If the tiles are not glued, the edges of the test specimen shall be secured on the substrate by mechanical means.

Flooring, which due to shrinkage withdraws from the specimen holder frame, can show different results depending on the fixing. Special attention shall therefore be given to the use of good fixing techniques for floorings with a tendency to shrink during the heat exposure.

Additional details for the mounting of the test specimen shall be in accordance with the relevant product specifications.

5.4 Washing and cleaning procedures to examine the durability of the flooring in terms of its fire performance shall be in accordance with any procedures specified in the relevant product specifications for the floorings.

6 Conditioning

The specimens shall be conditioned as specified in EN 13238.

The curing time for flooring, which is glued to the substrate, is at least three days. This time may be part of the conditioning.

7 Test procedure

7.1 Calibration procedure

7.1.1 The following calibration procedure shall be determined after each essential change of the apparatus, or at least once a month. If there are no changes in subsequent calibrations, this interval may be extended to six months.

7.1.2 Position the sliding platform and the mounting frame together with the dummy specimen in the chamber. Measure the airflow rate in the exhaust stack with the exhaust fan on and the access door closed, and if necessary adjust it to (2,5 ± 0,2) m/s. Ignite the radiant panel.

Allow the unit to heat for at least one hour until the chamber temperature has stabilized (see 7.2.2). The pilot burner shall be off during this period.

7.1.3 Measure the heat flux level at the 410 mm point with the total heat flux meter. Insert the heat flux meter in the opening so that its detecting surface is between 2 mm to 3 mm above and parallel to the plane of the dummy specimen. Read its output after 30 s. If the level is (5,1 ± 0,2) kW/m^2, start the heat flux profile determination. If it is not, make the necessary adjustments to the gas/air flows to the panel, in panel fuel flow at least 10 min before a new reading of the heat flux is taken.

7.1.4 Perform the determination of the heat flux profile.

Insert the heat flux meter in each hole in turn, starting with the 110 mm and ending with the 910 mm. Ensure that the detecting plane of the meter and time of measurement agree with 7.1.3. To determine whether the heat flux level has changed during these measurements, check the reading at 410 mm, after the 910 mm reading.

7.1.5 Record the heat flux data as a function of distance along the specimen plane. Carefully draw a smooth curve through the data points. This curve is the heat flux profile curve (see Figure 9).

If the heat flux profile curve is within the tolerances of Table 1, the test equipment is in calibration and the heat flux profile determination is completed. If not, carefully adjust the fuel flow and allow at least 10 min to ensure that the chamber temperature is stabilised. Repeat the procedure until the heat flux profile is within the specification in Table 1.

NOTE To correct the heat flux at the hotter end of the specimen, normally only a change of gas flow is necessary. To correct the heat flux at the colder end of the specimen, it may be necessary to change both gas and air flows.

7.1.6 Remove the dummy specimen and close the door. After 5 min measure the black body temperature of the radiant panel and the temperature of the chamber. Record the results for the daily calibration values.

Table 1 — Required heat flux distribution onto the calibration board

Distance to zero point of specimen mm	Heat flux kW/m^2	Tolerances kW/m^2
110	10,9	± 0,4
210	9,2	± 0,4
310	7,1	± 0,4
410	5,1	± 0,2
510	3,5	± 0,2
610	2,5	± 0,2
710	1,8	± 0,2
810	1,4	± 0,2
910	1,1	± 0,2

7.2 Standard test procedure

7.2.1 Set the air flow in the exhaust stack in accordance with 7.1.2. Remove the dummy specimen and close the door. Ignite the panel and allow the test apparatus to heat for at least one hour until the chamber temperature has stabilized.

7.2.2 Measure the black body temperature of the radiant panel. The black body temperature shall be within ± 5 °C of the black body temperature recorded during the calibration according to 7.1.6. The chamber temperature shall be within ± 10 °C of the chamber temperature recorded during the calibration according to 7.1.6.

If the black body or chamber temperature differs by more than the given limits, adjust the gas/air input to the radiant panel. Allow the test apparatus unit to stabilise for at least 15 min before the temperatures are measured again. When the temperatures are within the limits given, the test apparatus is ready for use.

If required, adjust the smoke measuring system so that its output value is equal to 100 %. Ensure that the measuring system has stabilized before starting the tests. If not, adjust it further. Check the purging air to both the lamp and the detector system and adjust if necessary.

7.2.3 Insert the test specimen, including any underlay(s) and substrate, into the specimen holder. Place the steel bar clamps across the back of the assembly and tighten the nuts firmly or apply other fixing means. Raise the pile of textile flooring, if applicable, using a vacuum cleaner and mount the test specimen and its holder on to the sliding platform.

Ignite the pilot burner, keeping it at least 50 mm away from the intended zero point of the test specimen. Move the sliding platform into the chamber and immediately close the door. This is the start of the test. Start the timing and recording devices.

After preheating for 2 min with the pilot burner at least 50 mm away from the zero point of the test specimen, bring the pilot burner flames into contact with the test specimen 10 mm from the edge of the holder as specified in 4.5. Leave the pilot burner flames in contact with the test specimen for 10 min, then withdraw the pilot burner to a position at least 50 mm away from the zero point of the test specimen. Extinguish the pilot burner flames. During the test both the gas and airflow to the radiant panel shall be kept constant.

7.2.4 At 10 min intervals from the start of the test and at the flame-out time measure the distances between the flame front and the zero point to the nearest 10 mm. Observe and record any significant phenomena such as transitory flaming, melting, blistering, time and location of glowing combustion after flame-out, penetration of the flame through to the substrate, etc.

Additionally, note the times when the flames reach each 50 mm mark and the most distant point reached at any time during the test, measured to the nearest 10 mm.

The test shall be terminated after 30 min, unless the sponsor requires a longer test duration.

7.2.5 If required, smoke measurements shall be carried out as described in annex A.

7.2.6 Test one specimen in one direction and one specimen in the direction perpendicular to the first. The test which yields the lowest CHF and/or the HF-30 value(s) shall be repeated twice in that direction, i.e. a total of four tests is required.

7.2.7 Do not begin the next test until the black body temperature and the chamber temperature are as specified in 7.2.2. The specimen holder shall be at room temperature prior to mounting a new test specimen.

8 Expression of results

8.1 From the heat flux profile curve, convert the observed distances of flame spread to kW/m^2 and determine the critical heat flux. Read to the nearest 0,2 kW/m^2. Specimens that do not ignite or which spread flame less than 110 mm have a critical heat flux of $\geq$ 11 kW/m^2. Test specimens with flame spread distances longer than 910 mm have a critical heat flux $\leq$ 1,1 kW/m^2. The specimens which are extinguished by the operator at 30 min do not have a CHF value, but only a HF-30 value.

8.2 Report the results from the four tests (see 7.2.6) in terms of CHF and/or HF-30 values with the appropriate directional description. Calculate the mean value for the critical flux from the test data on the 3 specimens with the same directional orientation.

NOTE When calculating the mean value for the critical flux from the above 3 specimens, both CHF and HF-30 values should be included.

8.3 For test durations longer than 30 min record the time of flame extinguishment and the most distant point of flame spread and convert this to CHF.

8.4 Report the time at which the flames reach each 50 mm mark and record the flame spread distance at each 10 min interval as described in 7.2.4 in order to determine HFX value as required, e.g. HF-10, HF-20, HF-30. Record also the extinguishing time and the final maximum flame spread distance.

8.5 If required, report the results of the smoke measurement in accordance with A.6.

9 Test report

The test report shall include the following information as a minimum. A clear distinction shall be made between the data provided by the sponsor and data determined by the laboratory.

a) reference that the test was carried out in accordance with EN ISO 9239-1;

b) any deviations from the test method;

c) name and address of the testing laboratory;

d) date and identification number of the report;

e) name and address of the sponsor;

f) name and address of the manufacturer/supplier, if known;

g) date of sample arrival;

h) identification of the product;

i) description of the sampling procedure, where relevant;

j) a general description of the product tested including density, mass per unit area and thickness, together with the form of construction of the test specimen;

k) details of conditioning;

l) date of test;

m) test results expressed in accordance with clause 8;

n) observations made during the test;

o) the statement ‘The test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use’.

Annex A
(normative)

Smoke measurement

A.1 General

If required, in addition to the requirements stated in the body of the standard, smoke measurement shall be carried out as described in this annex.

A.2 Performance requirements

The optical density of the smoke is determined by measuring the light attenuation with a system consisting of a lamp, lenses, an aperture and a photocell (see Figure A.1). 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 2 %.

The lamp shall be of the incandescent filament type and shall operate at a colour temperature of (2 900 ± 100) K. The lamp shall be supplied with stabilised direct current, stable within ± 0,5 % (including temperature, short-term and long-term stability).

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

The aperture shall be placed at the focus of the lens L_2 as shown in Figure A.1 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.

The detector shall have a spectrally distributed responsivity agreeing with the CIE, $V(\lambda)$-function (the CIE photopic curves) to an accuracy of at least ± 5 %.

The detector output shall over an output range of at least 2 decades be linear within 3 % of measured transmission value or 1 % absolute transmission. This shall be calibrated by use of optical filters. Both noise and drift of the system shall be less than 0,5 % of the start value.

Suitable procedures for checking accuracy and stability of the smoke measurement device are given in this annex.

A.3 Apparatus

The light measuring system shall be mounted to measure the light attenuation in the longitudinal axis in the exhaust stack. The photocell and the lamp shall be mounted on a separate frame outside the exhaust system. The frame shall be connected to the exhaust system only at one point. Between the exhaust stack of the test chamber and the wall of the exhaust system steel tubes of internal 50 mm diameter shall be arranged. These tubes shall have connections for introducing purging air. A flow of 25 l/h purging air into each of the steel tubes has been found suitable. The arrangement of the light measuring system is shown in Figures 3 to 5.

NOTE The light measuring system described in DIN 50055: 1989 is suitable.

A.4 Light system calibration

A.4.1 General

The light system calibration shall be performed before tests, after set up, maintenance, repair or replacement of the smoke measurement system holder or other major components of the exhaust system, and at least every six months. The calibration consists of two parts: an output stability check and an optical filter check.

A.4.2 Stability check

Perform the following steps with the measuring equipment operating. The radiating panel shall not be operating.

a) Set the air flow rate of the exhaust to (2,5 ± 0,2) m^3/s.

b) Start the time measurement and record the signal from the light receiver for a period of 30 min.

c) Determine the drift by use of a least squares fitting procedure to fit a straight line through the data points. The absolute value of the difference between the reading at 0 min and at 30 min of this linear trend line represents the drift.

d) Determine the noise by computing the root-mean-square (rms) deviation around the linear trend line.

A.4.3 Optical filters for checking the smoke measurement system

The light system shall be calibrated with at least five neutral density filters in the optical density range of 0,05 to 2,0 (89 – 1 % transmission). Optical density is calculated as follows:

$$d = -\log(I)$$

where I is the transmission expressed as the range 0 to 1 where 1 corresponds to 100 % transmission.

A.4.4 Optical filter check

The light system may be calibrated using the following procedure.

Perform the following steps with the measuring equipment operating.

a) Place a light blocking insert into the filter holder and check the zero.

b) Remove the light blocking insert and adjust the signal from the light receiver to 100 %.

c) Start the measurement and record the signal from the light receiver for a period of two minutes.

d) Introduce each of the neutral density filters and record the corresponding signal for at least one minute.

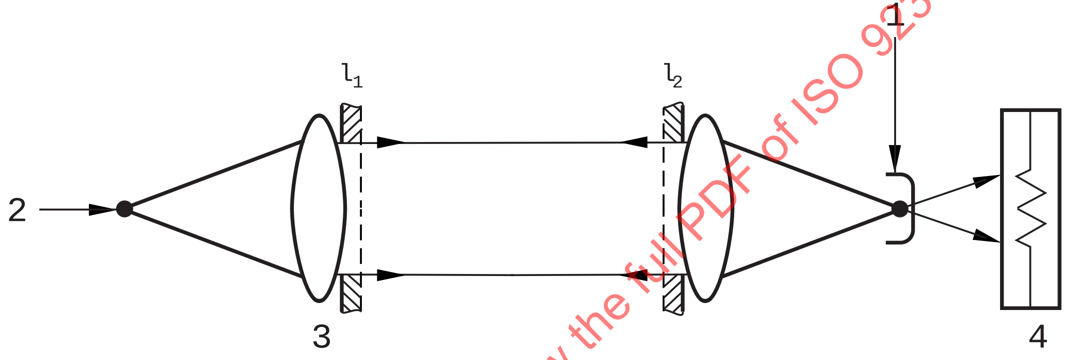
e) Stop the data acquisition and calculate the mean transmission values for each filter.

A.5 Test procedure

Carry out the test, as described in clause 7, and record the light attenuation in the exhaust duct continuously or at intervals not exceeding 10 s during the test.

A.6 Expression of results

Record the maximum light attenuation, the curve of the light attenuation over time and the integrated smoke value calculated as the integral of the smoke obscuration over the testing time and expressed in % × min.



Key

1. Aperture
2. Lamp
3. Smoke particles
4. Detector

Figure A.1 — Optical system

Annex B
(informative)

Precision of test method

In the course of the development of this standard, a round robin exercise on 10 floorings was carried out. 13 laboratories participated in the round robin. The following results were obtained.

	HF-30 kW/m^2	Repeatability		Reproducibility	
		Std. dev S_r	S_r/m (%)	Std. dev S_R	S_R/m (%)
Particle board, non-FR	4,4	0,1	3,4	0,6	12,6
Beech parquet	7,8	1,6	19,9	1,9	24,7
PVC, continuous vinyl	10,7	0,2	2,3	0,6	5,6
Rubber	6,4	0,8	13,0	1,5	23,9
Polyamide carpet (textile backing)	3,8	0,4	10,5	0,8	21,3
Polyamide carpet (fire retardant textile backing)	7,6	1,1	14,8	1,8	23,6
Polyamide carpet (latex backing)	3,7	0,8	20,5	1,0	27,1
Polypropylene carpet	2,7	0,2	6,5	0,4	13,4
Polypropylene carpet (needlefelt)	5,2	1,1	21,4	2,4	47,2
Wool/Polyamide carpet (80/20)	7,8	0,8	10,0	1,5	18,9

Annex C
(informative)

Gas and air supplies

The combustion gas and air should 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 0,1 l/s at a pressure sufficient to overcome the friction losses through the supply lines, regulators, control valve, flowmeters, radiant panel etc;

b) an air supply of at least 4,5 l/s at a pressure sufficient to overcome the friction losses through the supply lines, regulators, control valve, flowmeters, radiant panel etc;

c) separate isolation valves for both gas and air supplies;

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

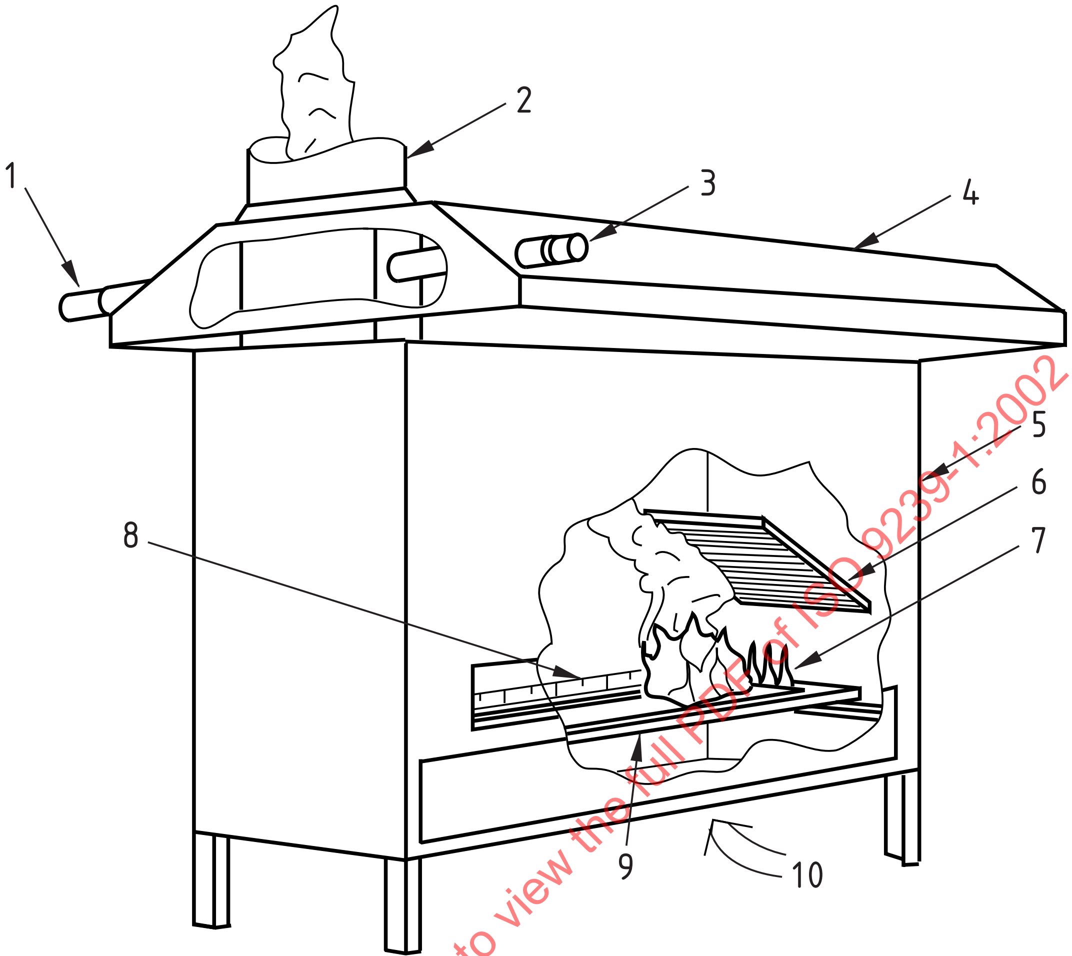
e) an electrically operated valve to shut off the gas supply automatically in the event of failure of electrical power, failure of air pressure or fall in temperature at the burner surface;

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 0,1 l/s to 1,0 l/s at ambient temperature and pressure to a resolution of 1 % or better;

h) a flowmeter for air suitable for indicating flow of 1 l/s to 10 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.

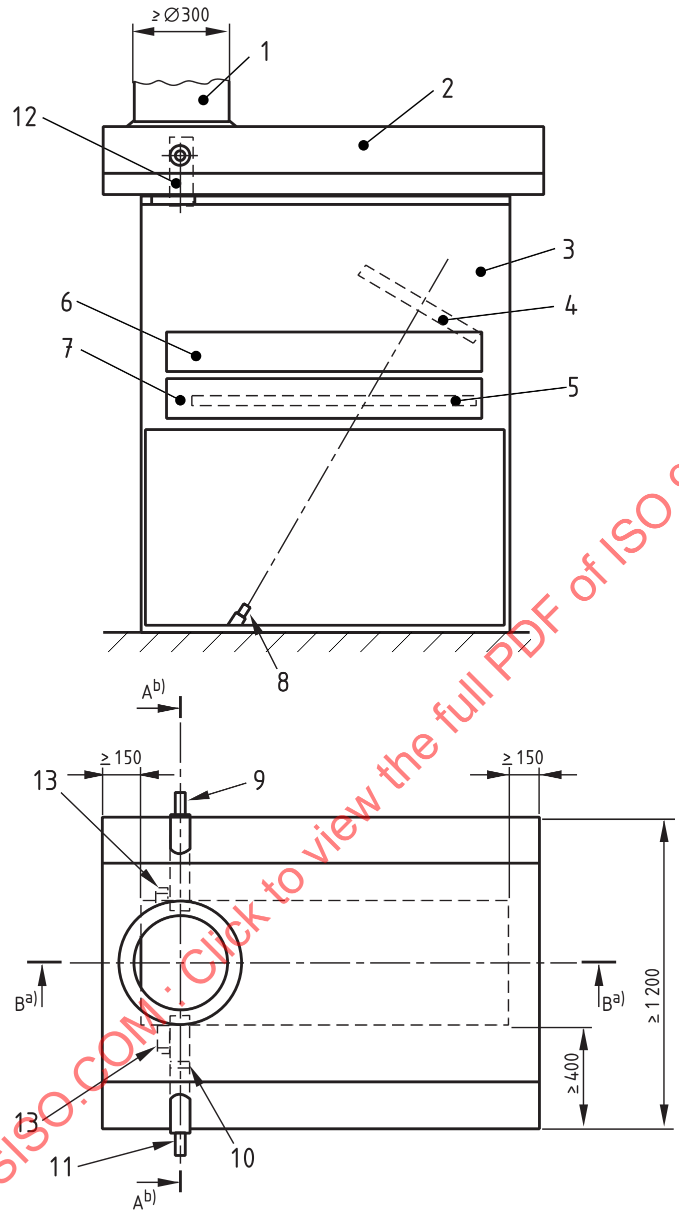


Key

1	Illumination unit
2	Exhaust duct
3	Light receiver
4	Exhaust hood
5	Test chamber
6	Gas fired radiant panel
7	Pilot flames from line burner
8	Scale
9	Specimen holder with specimen together with sliding
10	Air inlet all around specimen at bottom of chamber

Figure C.1 — Perspective view showing test principle

Dimensions in millimetres

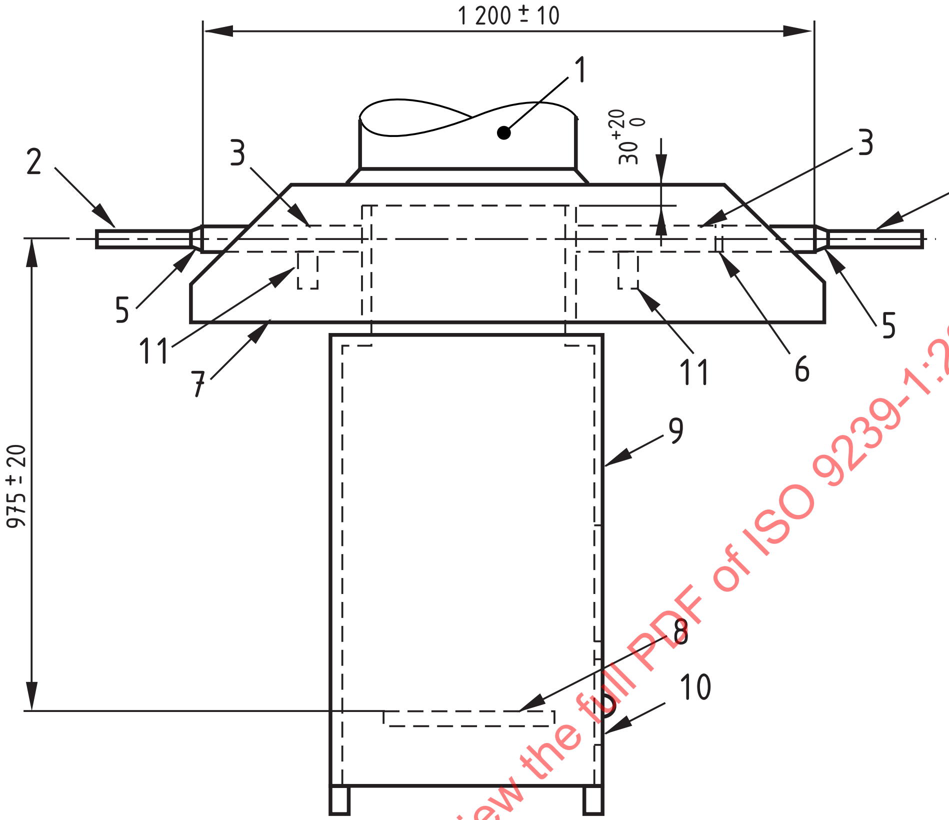


Key

1 Exhaust duct
2 Exhaust hood
3 Test chamber
4 Gas fired radiant panel
5 Specimen holder with specimen
6 Observation window
7 Door for insertion and removal of specimen
8 Pyrometer
9 Illumination unit
10 Slot for calibration filters
11 Light receiver
12 Exhaust stack
13 Tubes for purging air supply
a) Section B-B see Figure 5
b) Section A-A see Figure 4

Figure C.2 — Side (B-B) and plan view of test equipment

Dimensions in millimetres

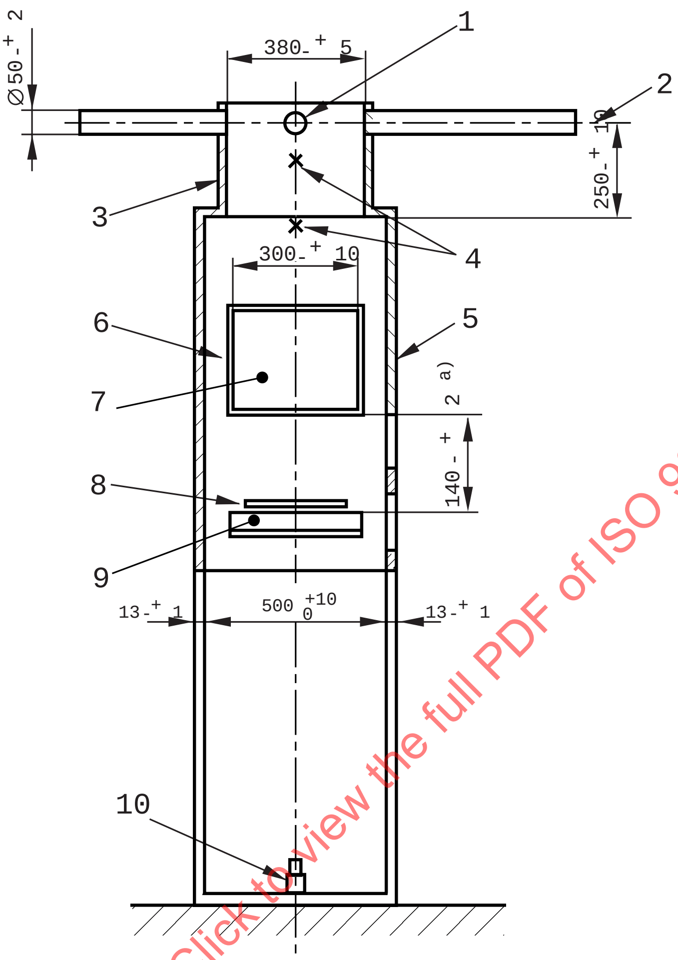


Key

1	Exhaust duct
2	Illumination unit
3	Steel tubes for light measuring system
4	Light receiver
5	Collar or rubber rings
6	Slot for calibration filters
7	Exhaust hood
8	Specimen holder with specimen
9	Test chamber
10	Door for insertion and removal of specimen
11	Tubes for purging air supply

Figure C.3 — End view (A-A) of test equipment (see Figure 2)

Dimensions in millimetres



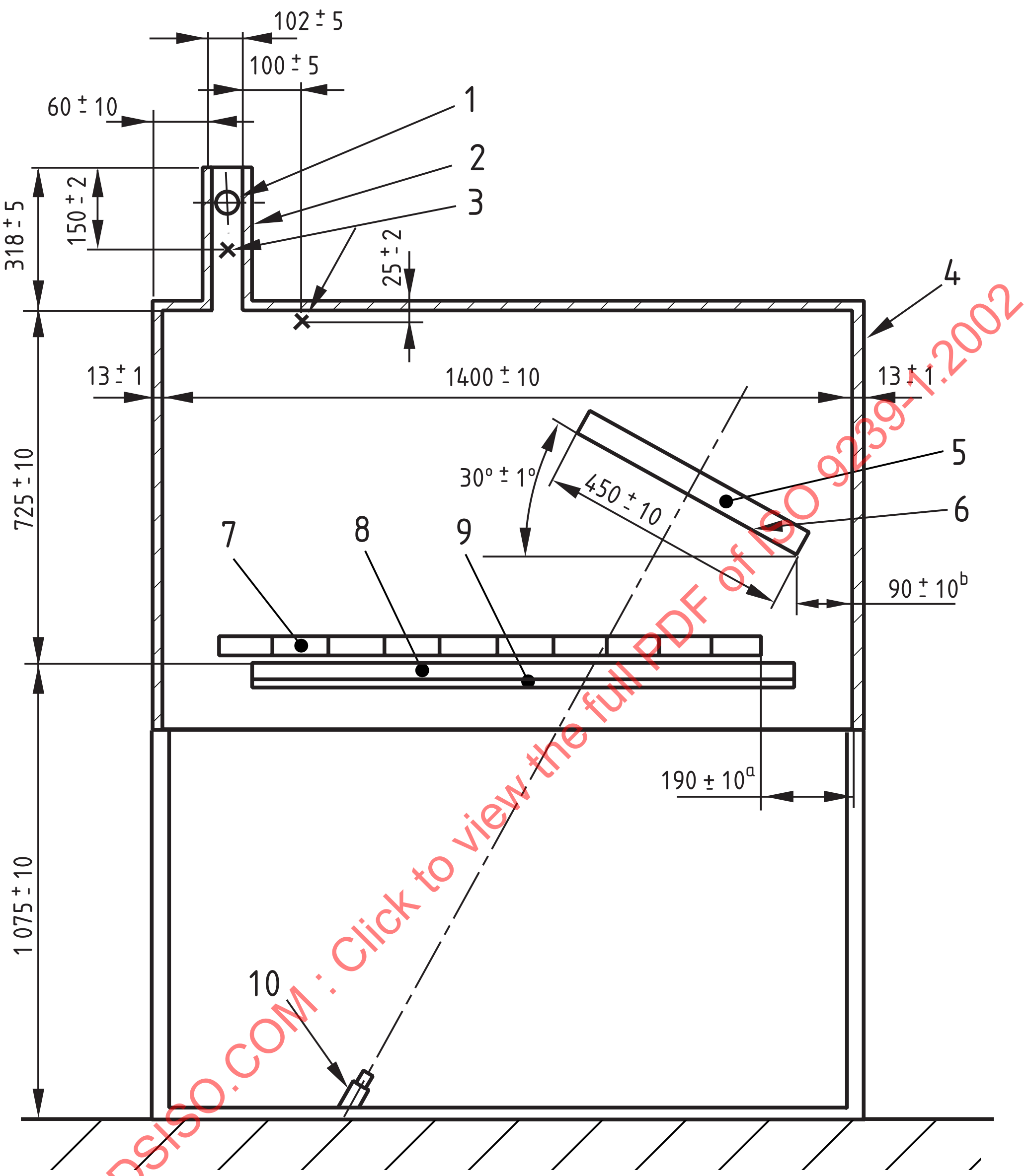
Key

[a] dimension measured from the exposed surface of the specimen to the bottom edge of the radiating panel

1 Position for anemometer
2 Light measuring beam
3 Exhaust stack
4 Thermocouples
5 Test chamber
6 Gas fired radiant panel
7 Radiating surface
8 Pilot burner
9 Specimen holder with specimen
10 Pyrometer

Figure C.4 — Section A - A of test equipment

Dimensions in millimetres



Key

1 Opening for light measuring system
2 Exhaust stack
3 Thermocouples
4 Test chamber
5 Gas fired radiant panel
6 Radiating surface
7 Scale
8 Specimen holder with specimen
9 Specimen transport system
10 Pyrometer

[a] Dimension measured from the zero point (the inner edge of the specimen holder) to the inner surface of the chamber wall

[b] Dimension measured from the bottom edge of the radiating panel to the inner surface of the chamber wall

Figure C.5 — Section B - B of test equipment