INTERNATIONAL STANDARD

ISO 12468-1

First edition
2003-03-15

External exposure of roofs to fire —

Part 1: Test method

Exposition des toitures à un feu extérieur —

Partie 1: Méthode d'essais

Reference number
ISO 12468-1:2003(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 12468-1 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

ISO 12468 consists of the following parts, under the general title *External exposure of roofs to fire*

— *Part 1: Test method*

— *Part 2: Classification*

Introduction

This part of ISO 12468 specifies a test method that relates to the effects of fires on roofs. The test method described in this part of ISO 12468 represents the effect of two levels of fire exposure.

— Level A: A large burning brand coming from a nearby building and falling onto the roof. Level A considers the effects of wind and additional radiant heat.

— Level B: A small burning brand transported by the wind from a remote fire and falling onto the roof. Level B considers the effect of wind but without additional radiant heat.

Any national regulation may refer to only one or both of the two levels of fire exposure.

External exposure of roofs to fire —

Part 1:
Test method

CAUTION — The attention of all persons concerned with managing and carrying out this fire test is drawn to the fact that fire testing may be hazardous and that there is a possibility that toxic and/or harmful smoke and gases may be evolved during the test. Mechanical and operational hazards may also arise during the construction of the test elements or structures, their testing and disposal of test residues.

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

1 Scope

This part of ISO 12468 specifies a test method to determine the resistance of roofs to external exposure to fire. This method evaluates the behaviour of the roof when exposed to two types of burning brands combined with wind and with or without heat radiation, concerning:

a) the fire spread across the external surface of the roof;

b) the fire spread within the roof;

c) the fire penetration;

d) the production of flaming droplets or debris falling through the roof, from the underside of the roof or from the exposed surface.

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 13943, *Fire safety — Vocabulary*

3 Terms and definitions

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

3.1
assembly
fabrication of materials and/or composites

EXAMPLE Sandwich panels.

3.2
burned material
material that has been destroyed by combustion or pyrolysis

3.3
composite
combination of materials which are generally recognized in building construction as discrete entities

EXAMPLE Coated or laminated product such as roofing felt.

3.4
continuous deck
deck supporting the roof covering in which the gap between adjacent elements is not greater than 0,5 mm (5,0 mm in the case of wooden planks with plain edges)

3.5
damaged material
material that has been burned, melted or otherwise visually changed by heat but does not include discoloration and soot deposits

3.6
exposed surface
external surface of the calibration element or of the specimen which is subject to the heat conditions

3.7
external fire spread
progression and extent of sustained flaming across the exposed surface of the specimen

3.8
fire penetration
any opening, sustained flaming or glowing due to combustion on the underside that appears during the test and/or the occurrence of any flaming droplets or debris falling through the specimen or from the underside

NOTE Charring or discoloration is not be regarded as fire penetration.

3.9
fire spread within the roof
extent of burned material in each functional layer inside the specimen

3.10
flaming droplets or debris
burning material falling from or through the specimen that continues to burn on the floor for at least 5 s

3.11
internal damage
extent of damaged material in each functional layer inside the specimen

3.12
material
basic single substance or a uniformly dispersed mixture of substances

EXAMPLE Metal, stone, wood, bitumen, concrete or mineral wool.

3.13
measuring zone
area of the specimen within which measurements are made

3.14
opening
any hole greater than 10 mm × 10 mm that appears during the test which penetrates completely through the specimen

3.15
product
material (3.12), composite (3.3) or assembly (3.1) about which information is required

3.16
profile pitch
repeating length between sections of a uniformly corrugated or undulating roof deck

3.17
roof
covering and sealing systems including any insulating layers or vapour barriers with their supporting elements and roof lights or other closures for roof apertures that are intended to provide a weatherproof surface

NOTE Elements with a slope greater than 70° are not considered as roofs in this part of ISO 12468.

3.18
roof covering
material (3.12) attached to the deck

3.19
specimen
representative section of the roof prepared for the purpose of test

3.20
sustained flaming
flaming arising from an observed location, which persists for 5 s or longer

3.21
underside
bottom surface of the specimen

4 Symbols

Symbol	Description	Unit
v_1, v_2, v_3, v_4, v_5, v_6, v_7	Velocity of the air at the measuring points	metres per second (m/s)
α	Pitch (slope)	degrees (°)

5 Selection of test specimen pitch

Roof systems designed for only one pitch shall be tested at the actual design pitch.

Roof systems designed for more than one pitch shall be tested as follows:

a) for pitch (α) less than 5°, test at zero pitch;

b) for pitch (α) from 5° to 20°, test at 15°;

c) for pitch (α) greater than 20°, test at 30°.

6 Test specimens

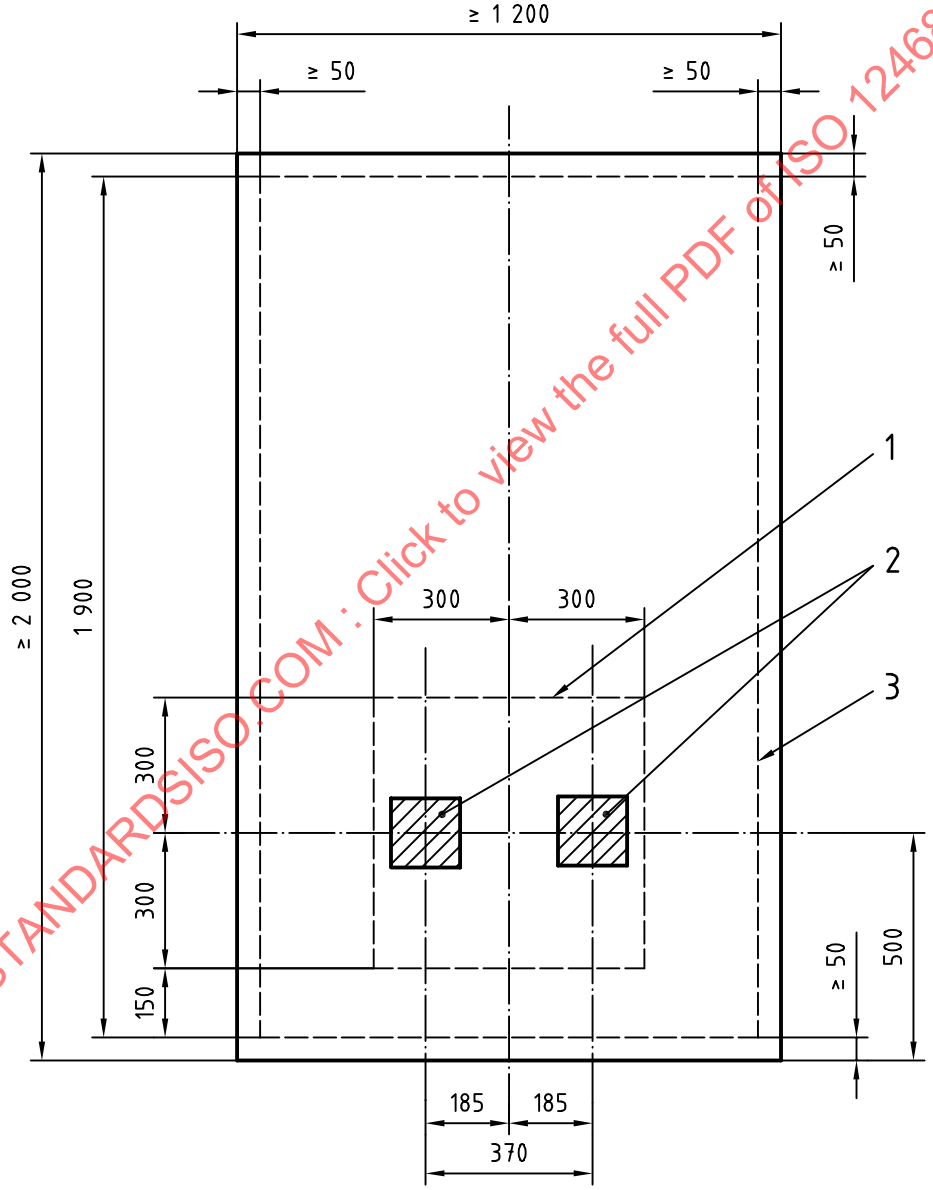
6.1 General requirements

For each level of fire exposure, two specimens shall be tested with dimensions measuring 1 200 mm ± 10 mm in width × 2 000 mm ± 10 mm in length for each test pitch. (See Figures 1 and 2.) When this is not possible due to the size of the roof light or other closure, a larger specimen shall be used.

NOTE Roof lights cause difficulties due to their size, shape, composition and fire behaviour. Further guidance on the testing of roof lights will be presented in the next revision of this part of ISO 12468.

The specimens shall be representative in all details of the roof in practice.

Dimensions in millimetres with tolerances of ± 10 mm

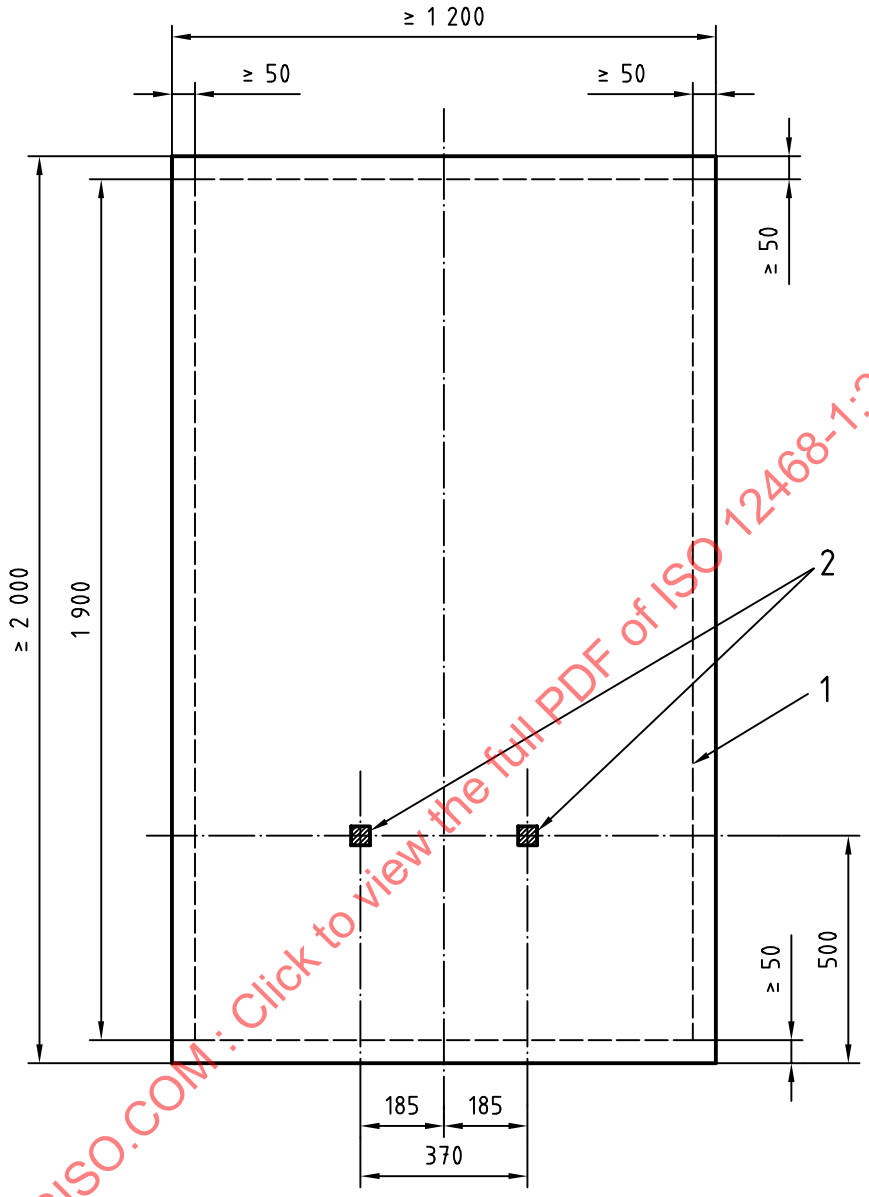


Key

1 radiant panel position
2 A Brands
3 measuring zone

Figure 1 — Measuring zone and position of the brands for Level A

Dimensions in millimetres with tolerances of ± 10 mm



Key

1 measuring zone
2 B Brands

Figure 2 — Measuring zone and position of the brands for Level B

6.2 Selection of standard supporting elements

6.2.1 For continuous decks

6.2.1.1 General

The test deck shall be selected in accordance with the following.

a) In the case of roof coverings intended to be installed over a continuous deck other than a profiled metal deck, a roof deck in accordance with 6.2.1.2 or 6.2.1.4 shall be used.

b) If the materials will only be laid over a profiled metal deck, then a trapezoidal profiled metal deck, in accordance with 6.2.1.3, shall be used as the deck.

6.2.1.2 Wood particleboard decks

6.2.1.2.1 The wood particleboard shall consist of wood particles bonded with polymer adhesive (e.g. urea formaldehyde). This particleboard shall have a density of 680 kg/m^3 ± 50 kg/m^3 and shall not be treated with fire retardants.

6.2.1.2.2 A wood particleboard deck shall be constructed from planks 250 mm wide × 13 mm ± 1 mm thick running parallel to the eaves with plain edges and tightly butt jointed so that the gaps between planks do not exceed 0,5 mm.

6.2.1.2.3 If it is intended also to cover the case of decks made from wooden planks with plain edges, then these gaps shall be 5 mm ± 0,5 mm.

6.2.1.3 Metal decks

The trapezoidal profiled metal deck shall be made of aluminium or steel (subject to the expected field of application) and have the width of the crown approximately equal to 50 % of the profile pitch and a trough depth of approximately 100 mm. The corrugations shall run parallel to the eaves and be open at the ends.

6.2.1.4 Other non-combustible decks

If roofing materials are intended to be laid only on continuous, non-combustible decks with a minimum thickness of 10 mm, then the test roof deck shall consist of 12 mm ± 2 mm thick reinforced calcium silicate board (oven dry density 900 kg/m^3 ± 100 kg/m^3).

6.2.2 For non-continuous decks

The spacing of roof supports of any type shall be in accordance with the maximum permissible spans proposed by the manufacturer for the particular application but not exceeding the minimum dimensions specified for the specimen in 6.1.

6.3 Positioning of joints

6.3.1 General

The joints shall be representative of practical application. In the case of overlapping layers, the position of the joints shall be considered to be the edge of the upper layer.

6.3.2 Description of specimen types with respect to joints

Where the dimensions of the elements of any of the layers are such that it requires more than four pieces to cover the specimen, or if any of the layers are without joints, then the specimens shall be fabricated such that those layers are representative (see Figures 3 and 4).

Specimens are categorized by the following types.

— **Type 1**: Single central vertical joint in the top layer. Single horizontal joint in the top layer under position of left brand. Single vertical joint in layer next to top layer under position of right brand. Single vertical joint in insulation under position of left brand [see Figure 4 a), Type 1].

— **Type 2**: Single vertical joint in the top layer under position of right brand. Single vertical joint in layer next to insulation under position of left brand [see Figure 4 b), Type 2].

— **Type 3**: One cross joint of the top layer under position of the right brand and, where possible according to the design of the product, a vertical joint in layer under top under the left brand [see Figure 4 c), Type 3].

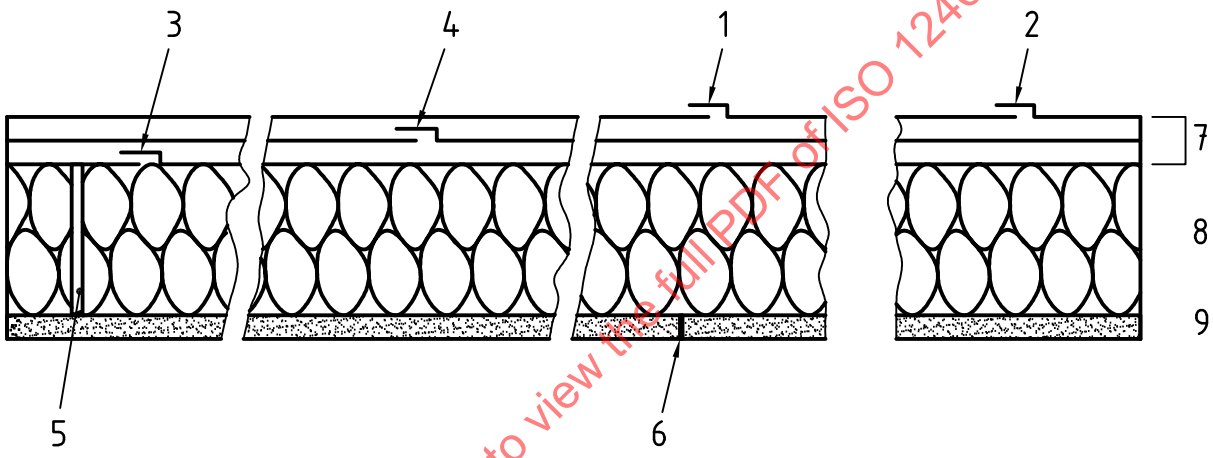
— **Type 4**: Centre of one element of the top layer and, where possible according to the design of the product, a vertical joint of supporting deck, under position of the right brand and in insulation under the left brand [see Figure 4 d), Type 4].

6.3.3 Selection of the specimen types

Either specimen types, Types 1 and 2 or Types 3 and 4, shall be used for each test pitch and for each level of fire exposure.

6.4 Edge detailing

No special measures shall be taken by the sponsor to protect the edges of the specimen.



Key

1	vertical joint in top layer	6	vertical joint in supporting deck
2	horizontal joint in top layer	7	weathering layer
3	joint in layer next to insulation	8	insulation
4	joint in layer next to top layer	9	roof deck
5	joint in insulation		

Figure 3 — Identification of joints in a multilayer roof

7 Test equipment

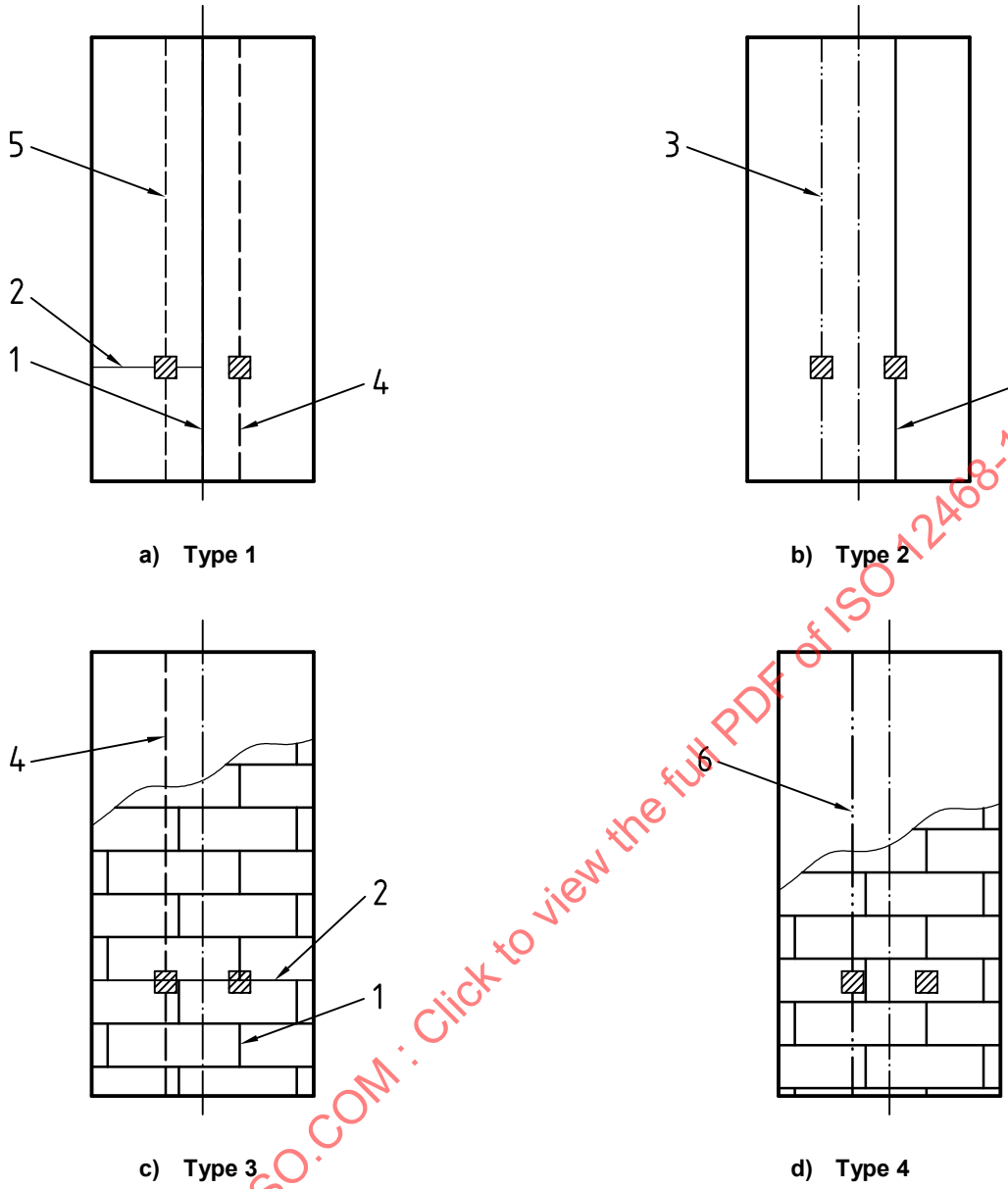
7.1 Exposure levels

Two levels are defined.

a) Level A consists of Brand A combined with wind and additional radiant heat.

b) Level B consists of Brand B combined with wind and without any additional radiant heat.

The wind is identical for the Levels A and B. The measuring zone, position of the brands and position of the radiant panel are shown in Figures 1 and 2.



a) Type 1

b) Type 2

c) Type 3

d) Type 4

Key

1 vertical joint in top layer
2 horizontal joint in top layer
3 joint in layer next to insulation
4 joint in layer next to top layer
5 joint in insulation
6 vertical joint in supporting deck

Figure 4 — Position of joints and types of specimens

7.2 Brands

7.2.1 General

Two brands are utilized for each specimen. The test brands shall be constructed from Beech (*Fagus* salvatica or *Fagus* grandifolia) having an oven-dry density of 560 kg/m^3 ± 50 kg/m^3.

The mass of the finished brand following conditioning in an oven at 40 °C to 50 °C for at least 24 h shall be 33 g ± 5 g at the time of the test for Brand B and 550 g ± 50 g (less fasteners) at the time of the test for Brand A.

7.2.2 Brands A

The Brands A shall consist of a grid of approximately 150 mm square and 57 mm deep, using nominally 19 mm × 19 mm × 150 mm strips of lumber, placed in three layers of six strips each, placed at right angles to adjacent layers and spaced equidistant from each other within the brand envelope. The strips shall be fastened to this configuration using light nails or staples (see Figure 5).

Dimensions in millimetres with tolerances of ± 2 mm

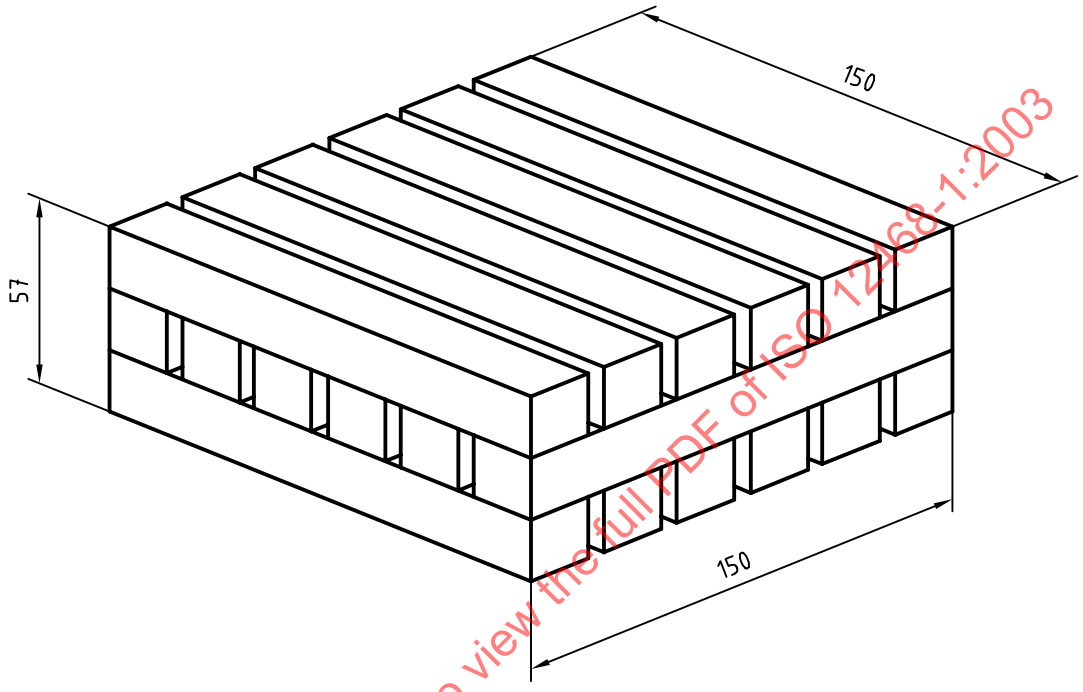


Figure 5 — Brand A

7.2.3 Brands B

The Brands B shall consist of a piece of lumber 40 mm × 40 mm × 40 mm with a saw cut 3 mm wide, half the thickness of the brand across the centre of the top and bottom faces. The saw cuts on opposite face shall be at right angles to each other (see Figure 6).

Dimensions in millimetres with tolerances of ± 2 mm

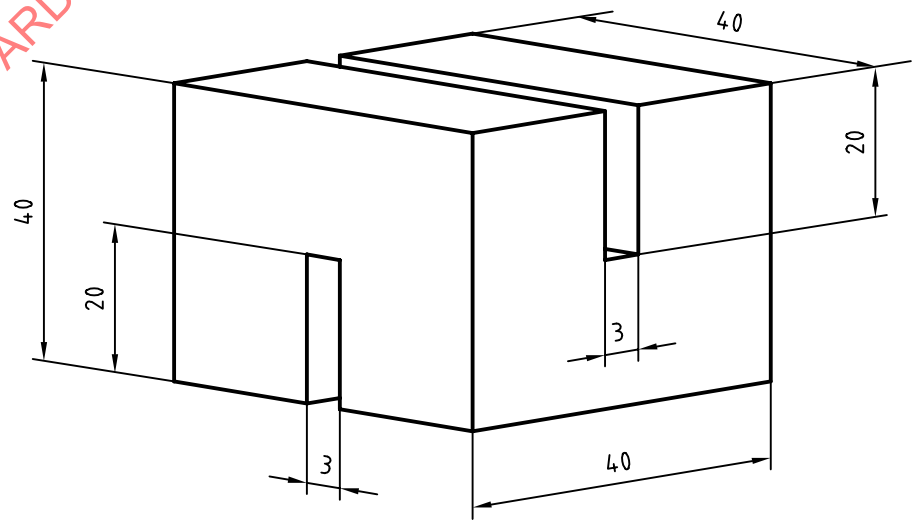


Figure 6 — Brand B

7.3 Wind

7.3.1 Apparatus

A wind generating apparatus capable of applying air across the surface of the calibration element at a temperature of 20 °C ± 15 °C and a velocity as defined in 8.2.3 shall be used. The apparatus shall have a control for the volume rate. The wind outlet section of the tube shall have minimum dimension of 250 mm in height and 1 000 mm in width. The minimum length of the duct shall be 1 200 mm. Baffles and flow smoothers shall be used to avoid turbulence of the flow pattern.

7.3.2 Air velocity

A vane anemometer with a diameter no greater than 25 mm shall be used to measure the air velocity. The instrument shall integrate the average value of the air velocity for a period of 10 s to 30 s at the respective positions (see Figure 7). The air velocity shall be established, parallel to the surface and in the direction of the longitudinal axis of the calibration element.

So as to minimize the disturbance of the flow pattern in the region of the measuring zone, a supporting device shall be used.

7.3.3 Eave

A simulated eave shall be installed in front of the test specimen to prevent air from flowing underneath the test specimen.

This shall be done in a way so as not to interfere with or obstruct material flowing or falling from the roof surface (see Figures 8 and 9).

7.4 Radiation

A radiant panel of 600 mm ± 10 mm by 600 mm ± 10 mm capable of being mounted in a plane parallel to the surface of the specimen and at a distance of 500 mm ± 10 mm above it shall be provided.

The radiant panel shall be capable of providing a heat flux distribution on the surface of the specimen as defined in 8.2.4, with wind. A flux meter having accuracy equal to or better than 5 % of the target value shall measure the total heat flux.

7.5 Timing device

A timing device with an accuracy better than or equal to 5 s over 1 h shall be provided for the recording of the sequence of events during each test.

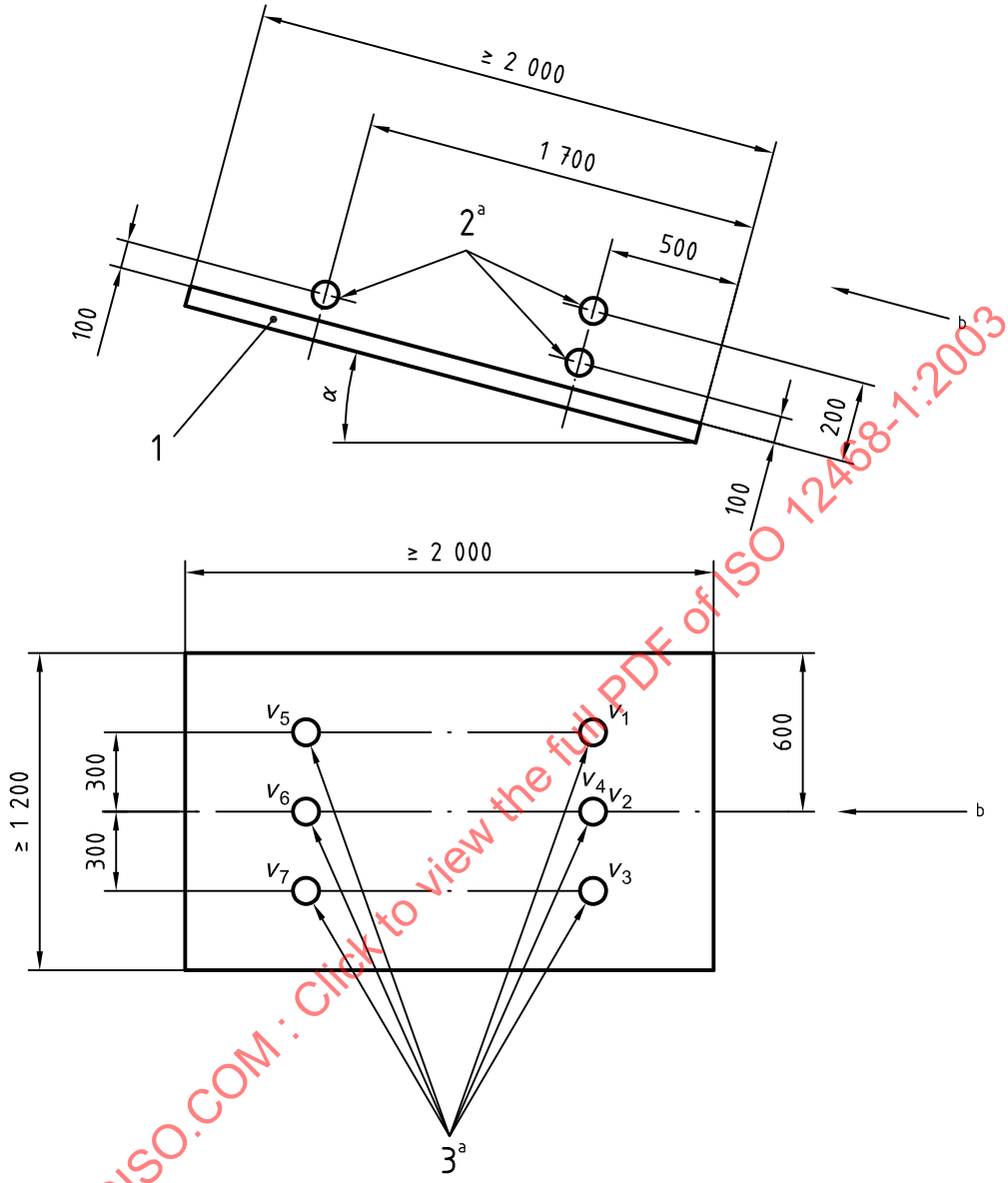
7.6 Calibration element

The calibration element consists of a smooth, flat 12 mm ± 2 mm thick sheet of calcium silicate material having the dimension 1 200 mm × 2 000 mm and a density of 900 kg/m^3 ± 100 kg/m^3.

7.7 Specimen holder

The specimen holder shall be capable of presenting the specimen to the airflow at the required pitch.

Dimensions in millimetres



Key

1 calibration element

2[a] anemometer location (side view)

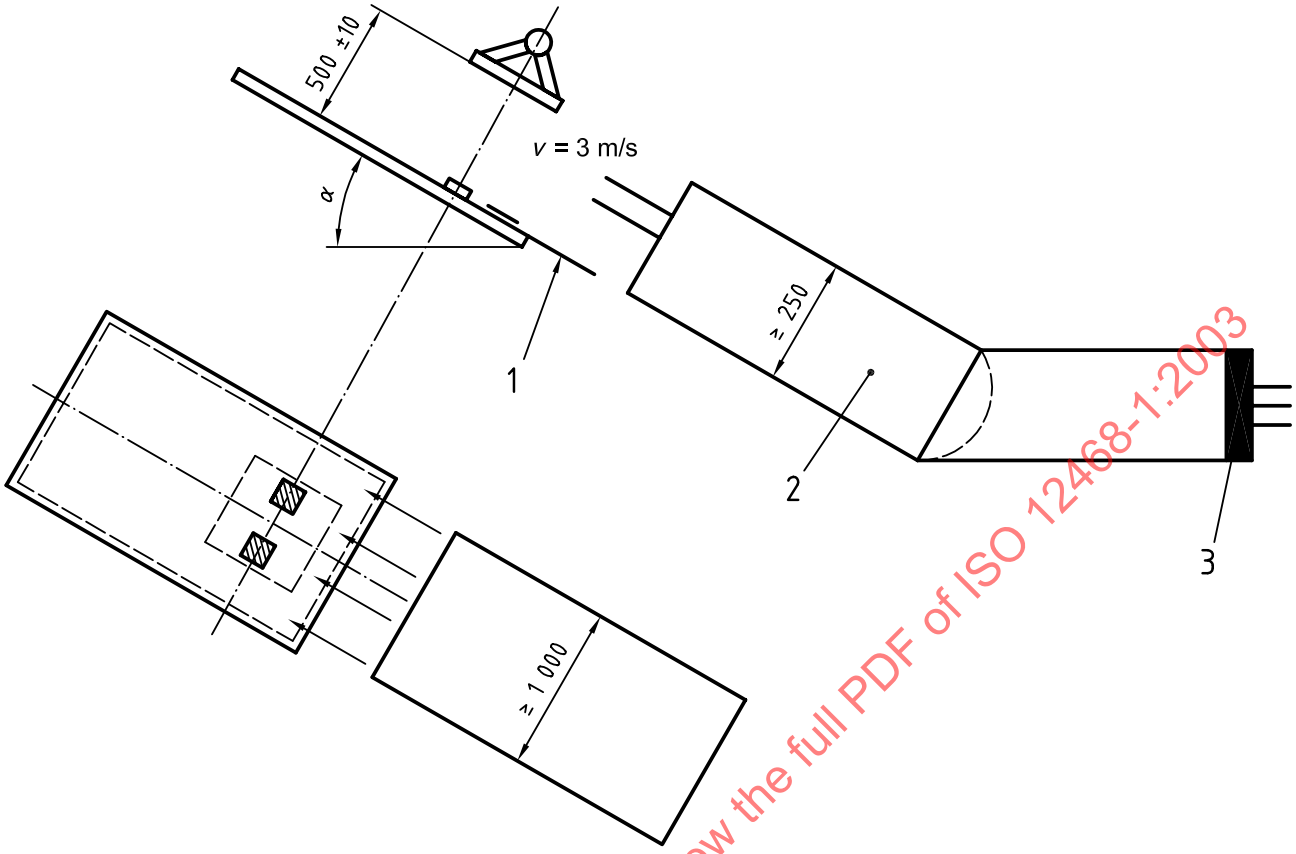
3[a] anemometer location (plan view)

[a] All dimensions specifying the positions of the anemometer are in millimetres with tolerances of ± 5 mm. See 8.2.3.

[b] Air flow

Figure 7 — Positions for air velocity measurement

Dimensions in millimetres

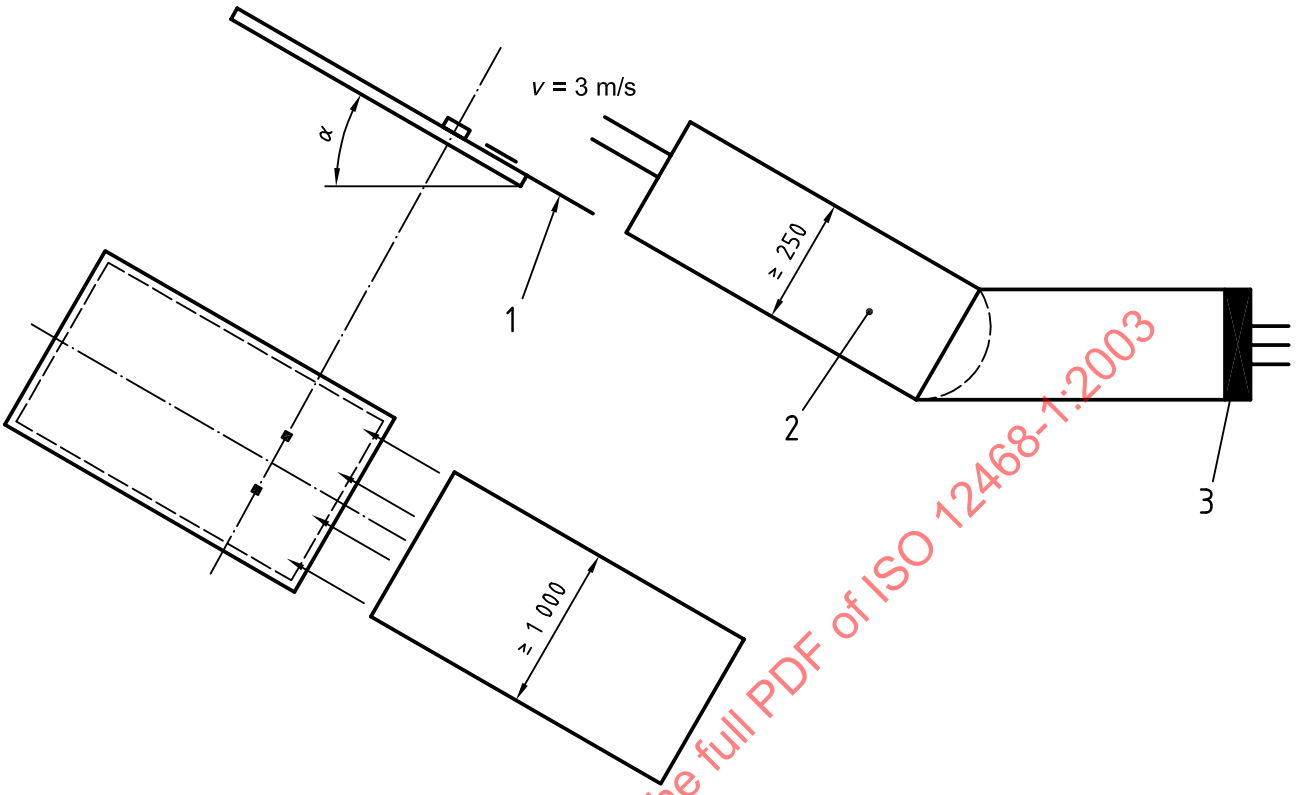


Key

1 eave
2 wind apparatus
3 filter

Figure 8 — Examples for general test arrangement for Level A

Dimensions in millimetres

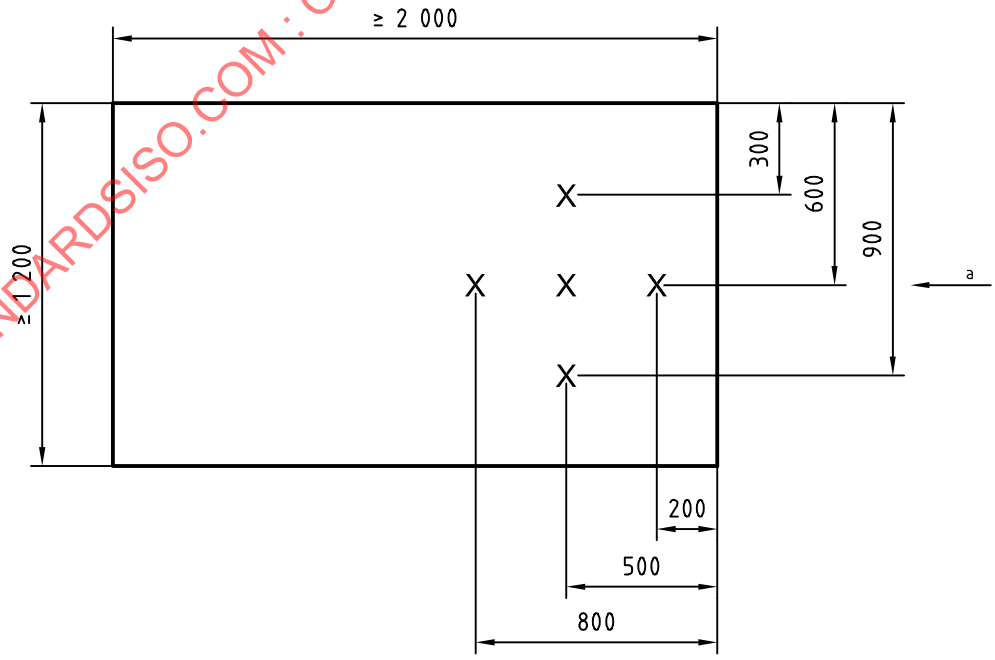


Key

1 eave 2 wind apparatus 3 filter

Figure 9 — Examples for general test arrangement for Level B

Dimensions in millimetres with tolerances of ± 5 mm



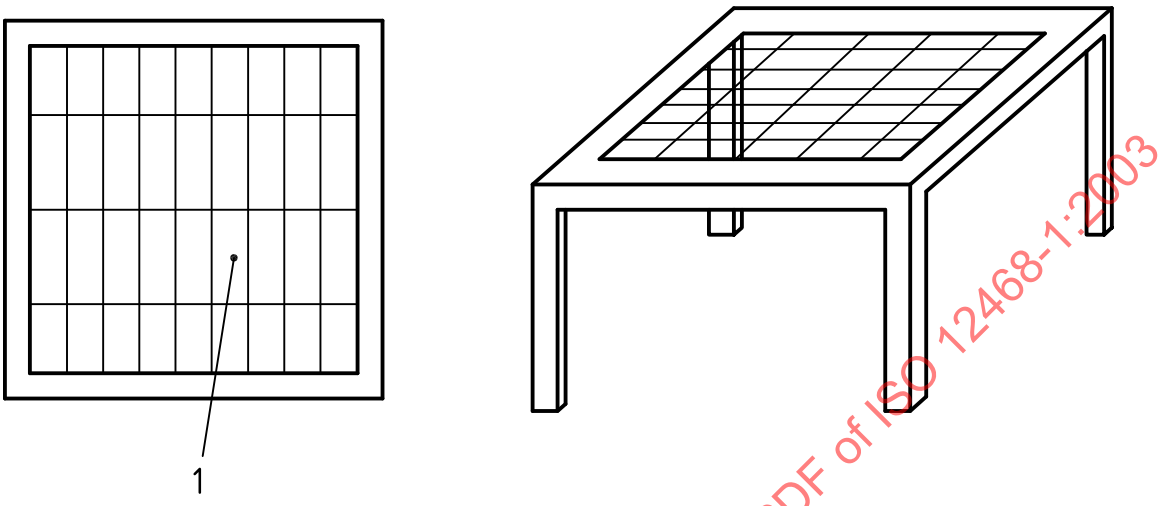
Key

X Positions for heat flux measurement [a] Air flow.

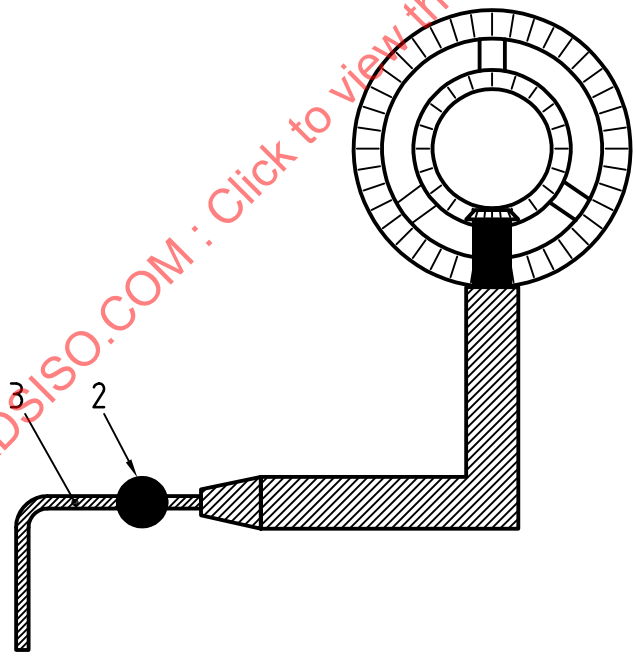
Figure 10 — Positions for heat flux measurements during calibration FIX dimensions

7.8 Gas burner

A gas burner of such size that during the procedure of ignition, the brands are enveloped in the burner flame. The burner shall be shielded from draughts. The flame temperature of the igniting flame shall be 900 °C ± 50 °C measured 60 mm ± 5 mm above the top of the burner. An example of a suitable burner is shown in Figures 11 and 12.



a) Stand

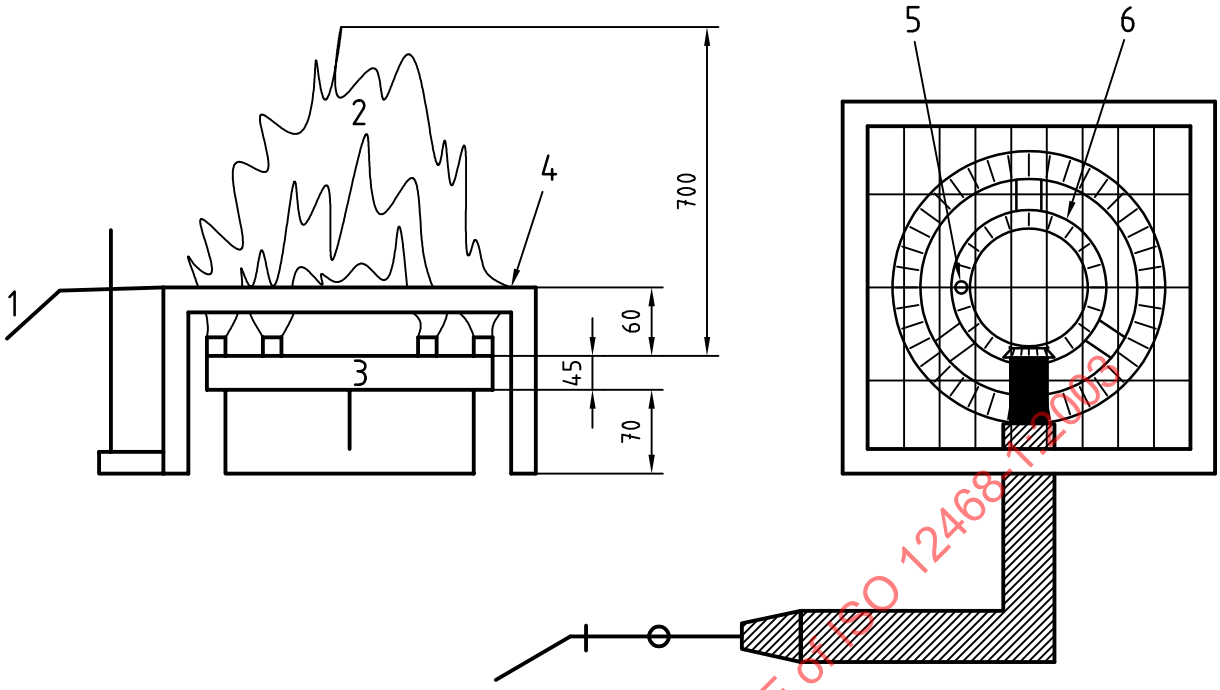


b) Burner

Key

1 wire bars
2 valve
3 gas supply

Figure 11 — Example of suitable stand and burner



Key

1 thermocouple
2 flame
3 burner
4 stand
5 stacked thermocouple 3 mm off centre
6 inner ring

[a] General tolerances ± 5 mm

[b] Thermocouple is directly over the inner ring, just 3 mm off centre. The thermocouple is 63 mm ± 2 mm above the inner ring

Figure 12 — Example of suitable installation of stand and burner with thermocouple

7.9 Stand

A stand designed to support the brand during the period of ignition at a distance of 60 mm ± 5 mm above the top of the burner shall be provided. An example of a suitable stand is shown in Figures 11 and 12.

8 Test conditions

8.1 Test environment

Tests shall be carried out in a draught free enclosure of no less than 150 m^3 in volume. The lower edge of the specimen shall be 750 mm ± 250 mm above the floor. The floor can be simulated by a horizontal platform of non-combustible material located at the correct height with respect to the lower edge of the specimen. The temperature in the enclosure shall be 20 °C ± 15 °C prior to the fire test. If any measures are taken to remove products of combustion from the test laboratory, they shall be in operation during the calibration period and maintained during the test.

8.2 Calibration procedure

8.2.1 Frequency

The interval between calibration and test shall not exceed seven days. A new calibration shall be done each time the pitch is changed.

8.2.2 Method

With the non-combustible calibration element placed on it, the test specimen holder shall be elevated to its required pitch with respect to the horizontal.

8.2.3 Wind

Before igniting the radiant panel, a uniform airflow shall be established using the equipment described in 7.3.1.

The anemometer shall be positioned at seven locations.

Four locations shall be 500 mm ± 5 mm from the bottom edge with three locations (v_1, v_2, v_3) 100 mm ± 5 mm above the calibration element with v_2 on the central axis and v_1 and v_3 located 300 mm ± 5 mm on either side of the central axis and one location (v_4) on the central axis 200 mm ± 5 mm above the calibration element. See Figure 7.

Three locations (v_5, v_6, v_7) shall be 1 700 mm ± 5 mm from the bottom edge and 100 mm ± 5 mm above the calibration element. v_6 shall be on the central axis and v_5 and v_7 located 300 mm ± 5 mm on either side of the central axis. See Figure 7.

The target velocities are:

— $v_1 = v_2 = v_3 = v_4 = (3{,}0 \pm 0{,}2)$ m/s

— $v_6 > 2{,}0$ m/s

— $|v_5 - v_7| < 0{,}2$ m/s

The temperature and relative humidity of the air used in generating the wind shall be measured and recorded to the nearest degree Celsius and percent relative humidity respectively.

8.2.4 Radiation

With the calibration element in position and the wind speed correctly set, the radiant panel shall be adjusted such that the flux at the central position is (12,5 ± 0,5) kW/m^2 and the minimum at the four locations on the major axes, as depicted in Figure 10, is (10 ± 0,5) kW/m^2.

9 Conditioning and test preparation

9.1 Conditioning

At the time of the test, the moisture content of the specimen shall approximate the condition expected in normal service. If the specimen contains or is liable to absorb moisture, it shall not be tested until it has reached an air-dry condition. This condition shall be considered as that which would be established at equilibrium resulting from drying in an ambient atmosphere of 50 % relative humidity at 23 °C.

One method of achieving this is to store the specimen in an enclosure (minimum 15 °C, maximum relative humidity 75 %) for the time needed to reach moisture equilibrium. This is attained 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 specimen.

Accelerated conditioning is permissible provided the method does not alter the properties of component materials. In general, high temperature conditioning should be below the temperature critical for the materials.

If, after conditioning, it is not possible to achieve the specified moisture content, but the design strength of the absorptive component has been attained, the specimen may then be subjected to the fire test.

Representative samples may be used for moisture content determination and conditioned with the specimens. These should be so constructed as to represent the loss of water vapour from the specimen by having similar thickness and exposed faces.

Standards for specific elements may contain additional or alternative rules for obtaining moisture equilibrium.

9.2 Protection of the edges

It may be necessary for the laboratory to take measures to prevent failure due to flames passing around the edges of the specimen. These measures should not affect the fire behaviour within the measuring zone or within the specimen and shall be fully described in the test report (see Figure 1). If it is necessary to protect the lower edge, this shall be done in a way so as not to interfere with or obstruct material flowing or falling from the roof surface.

10 Test procedure

10.1 General

For non flat surfaces (e.g. corrugated products or tiles), the uppermost part of the specimen shall be used as the reference plane for determining the position of the specimen with respect to the radiant panel and wind machine.

10.2 Commencement of the test

10.2.1 Test at Level A

The wind velocity and radiant heat flux shall be controlled using the same settings as for the most recent calibration. The laboratory conditions shall be as specified in 8.1.

The test procedure is as follows:

a) Make sure the wind machine is operating.

b) Ignite the radiant panel and allow it to stabilize.

c) Place the specimen at the required slope on the specimen holder.

d) Ignite both brands (see 10.3.2.1).

e) Move the specimen into the correct position with respect to the radiant panel and wind machine 3,5 min after commencement of ignition of the brands.

f) Place the brands on the specimen immediately after they are ignited.

g) Start the timing device the moment the brands are placed on the specimen. This is considered the start of the test.

10.2.2 Test at Level B

The wind velocity shall be controlled using the same settings as for the most recent calibration. The laboratory conditions shall be as specified in 8.1.

The test procedure is as follows:

a) Make sure the wind machine is operating.

b) Place the specimen at the required slope on the specimen holder.

c) Ignite both brands (see 10.3.3.1).

d) Place the brands on the specimen immediately after they are ignited.

e) Start the timing device the moment the brands are placed on the specimen. This is considered the start of the test.

10.3 Ignition and positioning of the brands

10.3.1 General

The brands shall be ignited and positioned in accordance with the procedures given in 10.3.2 to 10.3.3.

The general tolerance for the position of the brands is ± 10 mm.

10.3.2 Brand A

10.3.2.1 Ignition

Expose Brands A to the flame for 240 s ± 10 s, during which time they are to be rotated to present each surface to the flame as follows:

a) each 150 mm × 150 mm face for 30 s;

b) each 57 mm × 150 mm face for 30 s;

c) each 150 mm × 150 mm face again for 30 s.

10.3.2.2 Positioning

Position the brands with their centre 500 mm from the lower edge of the specimen and 370 mm apart and equidistant from the specimen's longitudinal centreline. Orient the brands such that the top strips in one brand are parallel and in the other brand normal to the bottom edge of the test specimen. The position of the brands may be maintained by wires anchored to the edges of the specimen. If the roof surface is not uniform, place the brands 500 mm from the lower edge and in positions at least 200 mm on either side of the longitudinal centreline. The exact positions are determined by the test laboratory as those expected to give the most onerous result (see Figure 1).

10.3.3 Brand B

10.3.3.1 Ignition

Expose Brands B to the flame for 120 s ± 10 s, during which time they are to be rotated so as to present each of the grooved faces to the flame for 60 s.