
**Fire-resistance tests — Door and shutter
assemblies**

Essais de résistance au feu — Assemblages porte et volet

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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
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3008 was prepared by Technical Committee ISO/TC 92, *Fire safety*, Subcommittee SC 2, *Fire containment*.

This third edition cancels and replaces the second edition (ISO 3008:2006), which has been technically revised, specifically with changes to the wording of the Note to Figure 17, to 9.1.2.5 and to the list in 9.2.5, and minor editorial changes to improve consistency of style and clarity.

Introduction

This document contains specific requirements for fire-resistance testing which are unique to the elements of building construction described as doors and shutters. The requirements for these doors and shutters are intended to be applied in appropriate conjunction with the detailed and general requirements contained in ISO 834-1.

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Fire-resistance tests — Door and shutter assemblies

CAUTION — The attention of all persons concerned with managing and carrying out this fire-resistance 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 International Standard, used in conjunction with ISO 834-1, specifies a method for determining the fire resistance of door and shutter assemblies designed primarily for installation within openings incorporated in vertical separating elements, such as

- hinged and pivoted doors,
- horizontally sliding and vertically sliding doors, including articulated sliding doors and sectional doors,
- steel single-skin folding shutters (un-insulated),
- other sliding, folding doors,
- tilting doors,
- rolling shutter doors,
- removable panels in walls.

This method can also be used to determine the fire resistance of non-loadbearing horizontal doors by analogy. However, these are not specifically addressed here and the field of direct application given in Clause 13 is not valid for horizontally oriented doors.

No requirements are included for mechanical conditioning, e.g. “shakedown” or durability as these are included in the relevant product standard or for smoke leakage testing of doors and shutters; for the latter, see ISO 5925-1.

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 834-1:1999, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 834-8, *Fire-resistance tests – Elements of building construction — Part 8: Specific requirements for non-loadbearing vertical separating elements*

ISO 13943, *Fire safety — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 834-1, ISO 13943 and the following apply.

**3.1
associated supporting construction**
specific construction in which the door or shutter assembly is installed as intended for use in practice and which is used to close off the furnace and provide the levels of restraint and thermal heat transfer to be experienced in normal use

**3.2
cill**
member that spans between two frame jambs at the base, which might or might not be set into the floor, and that remains visible

**3.3
door assembly
door set**
complete assembly, consisting of pivoted, hinged or sliding door leaves or leaf including any frame that is provided for closing of permanent openings in separating elements

NOTE This includes all side panels, vision panels or transom panels. The assembly shall be complete with grilles and louvers together with the door hardware and any fire seals, smoke seals, draught seals, acoustic seals that are used in the assembly.

**3.4
door hardware**
items such as hinges, handles, locks, panic bar(s), escutcheons, letter plates, kick plates, sliding gear, closing devices, electrical components, wiring, etc., that are, or can be, used in the door or shutter assembly

**3.5
double action**
action of a fire door leaf that opens in both directions

**3.6
fire seal**
seal fitted to the frame or to the leaf edge for the purpose of extending the period of integrity of the assembly

**3.7
floor**
upper surface of the horizontal element on which the door or shutter assembly is mounted and which extends from the exposed face to the unexposed face of the assembly

**3.8
flush over panel**
fixed panel fitted within the head and jambs above the door leaf without a transom fitted

**3.9
gap**
clearance between two nominally adjacent surfaces and/or edges, e.g. between the edge of a leaf and the frame or face of the leaf and the frame stop

3.10**primary leaf**

leaf of a multi-leaved door assembly that is the largest and/or has the handle attached to it as the preferred leaf for general operation

NOTE If the leaves of a multi-leaved door are the same size and if the handles (or other hardware such as push plates) are fitted to all leaves, then no primary leaf exists for that door assembly.

3.11**shutter assembly**

complete assembly consisting of rolling, folded or sliding curtains, including guides, rollers, tracks, and operating mechanism and housings

3.12**side panel**

fixed panel that is incorporated to one side of a door that is part of the test specimen

3.13**single action**

action of a fire door leaf that opens in only one direction

3.14**smoke seal**

seal fitted to the frame or to the leaf edge for the purpose of restricting the flow of smoke or hot gases

3.15**standard supporting construction**

form of construction used to close off the furnace and to support the door or shutter assembly being evaluated and which has a quantifiable influence on both the thermal heat transfer between the construction and the test specimen and provides known resistance to thermal distortion

3.16**test specimen**

door or shutter assembly that is installed in a standard or associated supporting construction to allow its evaluation

3.17**through connection**

fixing or internal spacer that either penetrates through the door or shutter construction from one face to another or directly connects the faces one to the other

3.18**transom**

member that extends across the frame from jamb to jamb at the head of the leaf and that creates an aperture to house a transom panel

3.19**transom panel**

fixed panel that is incorporated above a door and is bounded on all edges by either the frame head, the jambs or the transom

4 Test equipment

4.1 The test equipment shall be as specified in ISO 834-1. The furnace used shall be related to the orientation of the test specimen. For vertical specimens, the wall testing furnace is suitable, for horizontal specimens, the floor furnace is applicable.

4.2 Measurement of heat flux from the unexposed surface of specimens shall be made as described in 9.5.

5 Test conditions

Test conditions require the application of the heating and pressure conditions of the standard test as defined in ISO 834-1.

6 Test specimen

6.1 Size of specimen

The test specimen and all its components shall be full size. When this is restricted by the size of the opening of the furnace (which is normally 3 m × 3 m), the door or shutter assembly shall be tested at the maximum size possible and the fire resistance of the full sized assembly shall be derived by an extended application analysis. However, the minimum dimensions of supporting construction shall not be less than that prescribed in 7.3.1.

6.2 Number of specimens

The number of test specimens shall be selected as described in ISO 834-1. If testing is carried out from one side only, it shall be stated in the test report whether this is due to the symmetrical nature of the door or because it is required to resist fire from one side only.

6.3 Design of specimen

6.3.1 The design of the test specimen and the choice of supporting construction shall take into account the requirements of 7.3 if the widest field of direct application is to be achieved.

6.3.2 Where the door or shutter assembly incorporates side, transom or flush over panels, whether glazed or unglazed, these shall be tested as part of the door or shutter assembly. The side panel shall always be on the latch side.

6.3.3 The test specimen shall be fully representative of the door or shutter assembly as intended for use in practice, including any appropriate surface finishes and fittings that are an essential part of the specimen and that can influence its behaviour in a test construction.

6.4 Construction

The test specimen shall be constructed as described in ISO 834-1.

6.5 Verification

6.5.1 The sponsor shall provide a specification to a level of detail sufficient to allow the laboratory to conduct a detailed examination of the specimen before the test and to agree on the accuracy of the information supplied. ISO 834-1 provides detailed guidance on verification of the test specimen.

6.5.2 When the method of construction precludes a detailed survey of the specimen without having to permanently damage it, or if it is considered that it will subsequently be impossible to evaluate construction details from a post-test examination, then one of two options shall be exercised by the laboratory:

- either the laboratory shall oversee the manufacture of the door or shutter assembly(ies) subjected to the test,
- or the sponsor shall, at the discretion of the laboratory, be requested to supply an additional assembly or that part of the assembly that cannot be verified (e.g. a door leaf) in addition to the number required for the testing. The laboratory shall then choose freely which of these shall be subjected to the testing and which shall be used to verify the construction.

7 Installation of test specimen

7.1 General

7.1.1 The test specimen shall be installed as intended for use in practice, incorporating all hardware and other items that can influence the performance of the specimen.

7.1.2 The test specimen shall be mounted in a supporting construction, the field of application of which covers the type (see 7.3.1) in which it is intended for use. The design of the connection between the test specimen and the supporting construction, including any fixings and materials used to make the connection, shall be as intended for use in practice and shall be regarded as part of the test specimen.

7.1.3 The whole area of the test specimen, together with at least the minimum dimensions of the supporting construction required by 7.3.1, shall be exposed to the heating conditions.

7.2 Supporting construction

The fire resistance of any supporting construction shall not be determined from a test in conjunction with a test specimen and shall be at least commensurate with that anticipated for the test specimen.

7.3 Test construction

7.3.1 Associated and supporting construction

The space between the specimen and the frame shall be filled with either

- associated construction, or
- supporting construction.

There shall be a minimum zone, 200 mm wide, of supporting construction exposed within the furnace each side and over the top of the aperture into which the test specimen is fixed. The thickness of the supporting construction may be increased outside of the 200 mm zone. The test construction may incorporate more than one test specimen providing that there is a minimum separation of 200 mm between each specimen and between the specimens and the edge of the furnace.

7.3.2 Associated construction

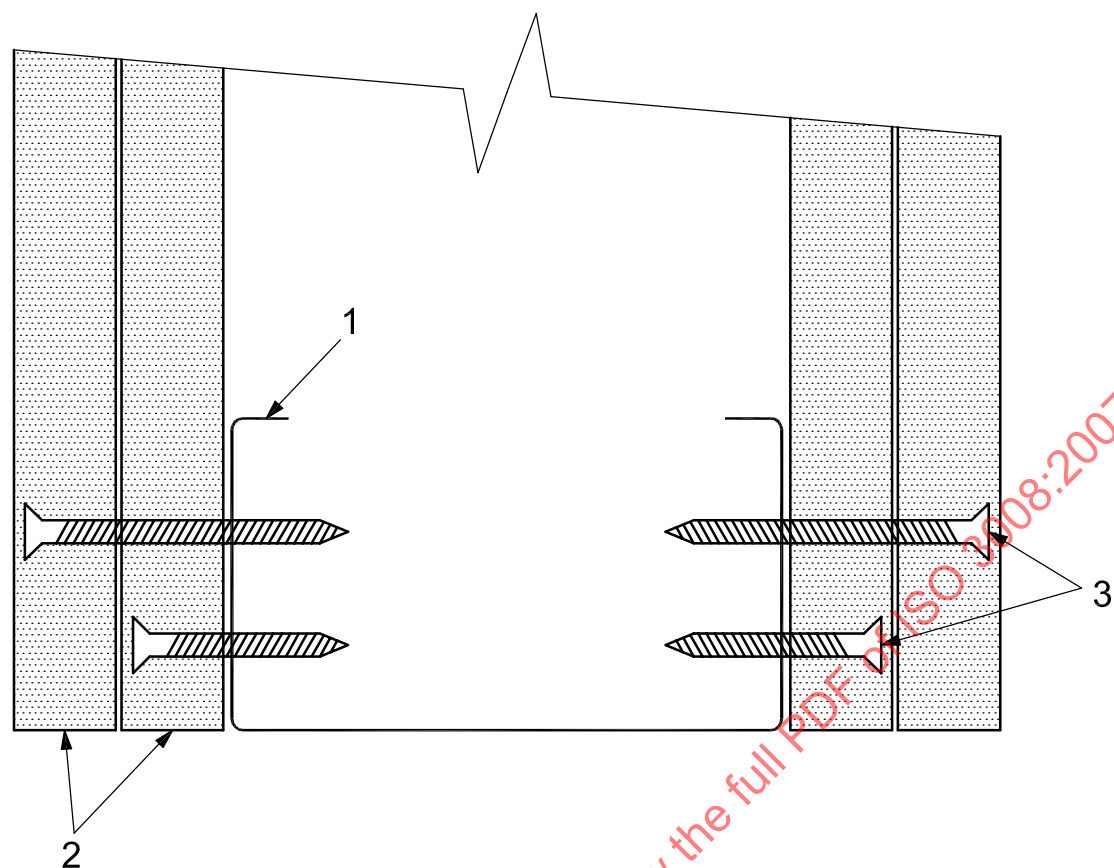
When the test specimen is always installed in a specific, normally proprietary form of construction, that is permanently associated with its intended use in practice, then the specimen shall be installed in a sample of this associated construction.

7.3.3 Supporting construction

7.3.3.1 Where the test specimen is not permanently associated with a specific form of construction, the area between the test specimen and the support frame shall be filled with a rigid or flexible standard supporting construction as specified in ISO 834-8.

7.3.3.2 The choice of standard supporting construction shall reflect the range of intended use for the door or shutter assembly. The rules governing the applicability of the chosen standard supporting construction to other end use situations are given in Clause 13.

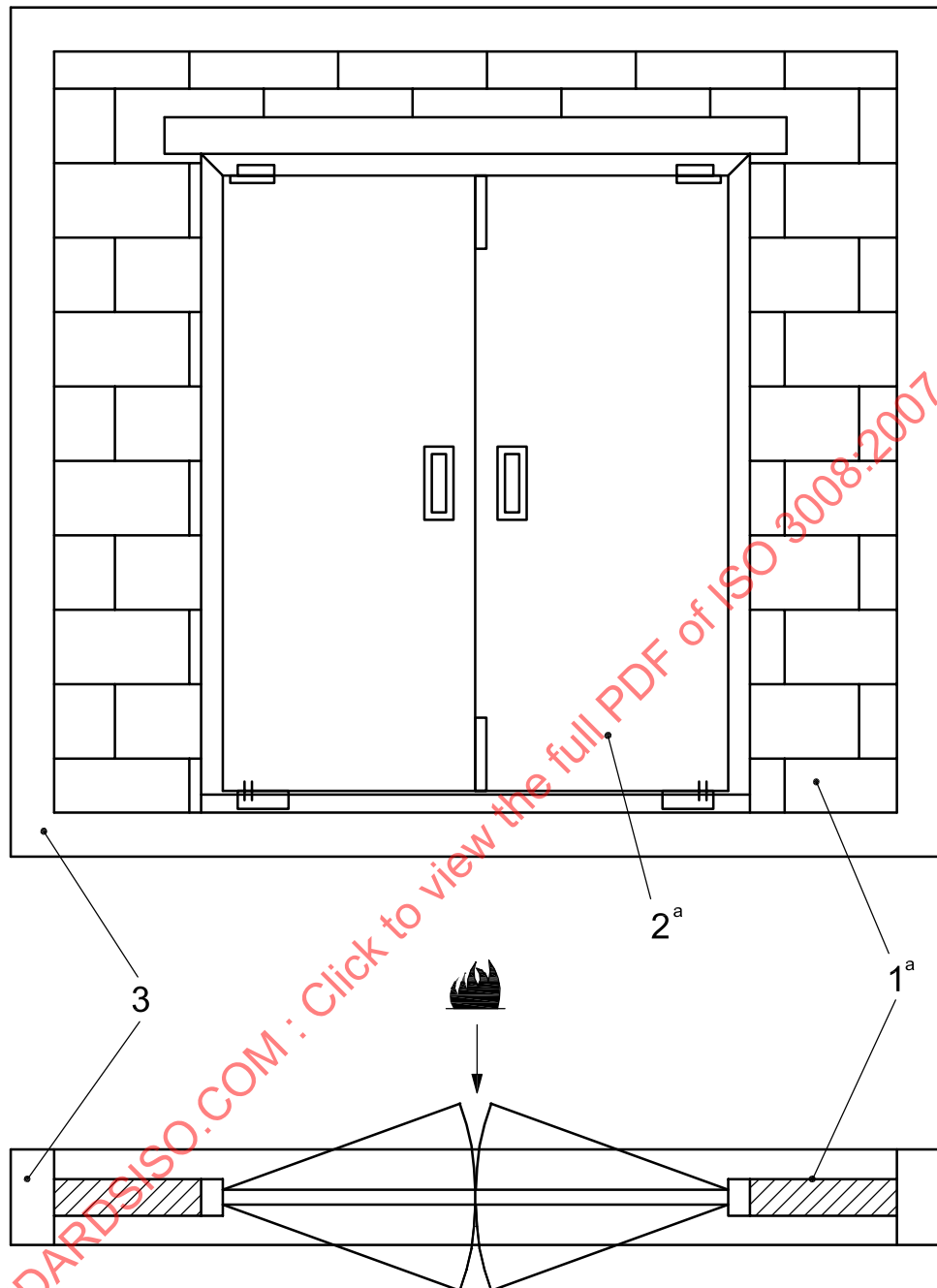
7.3.3.3 Figures 1 to 8 illustrate the use of supporting constructions in conjunction with the mounting of specimens of different types.



Key

- 1 steel vertical "C" stud
- 2 12,5 mm plasterboard
- 3 screws at 300 mm fixing centres

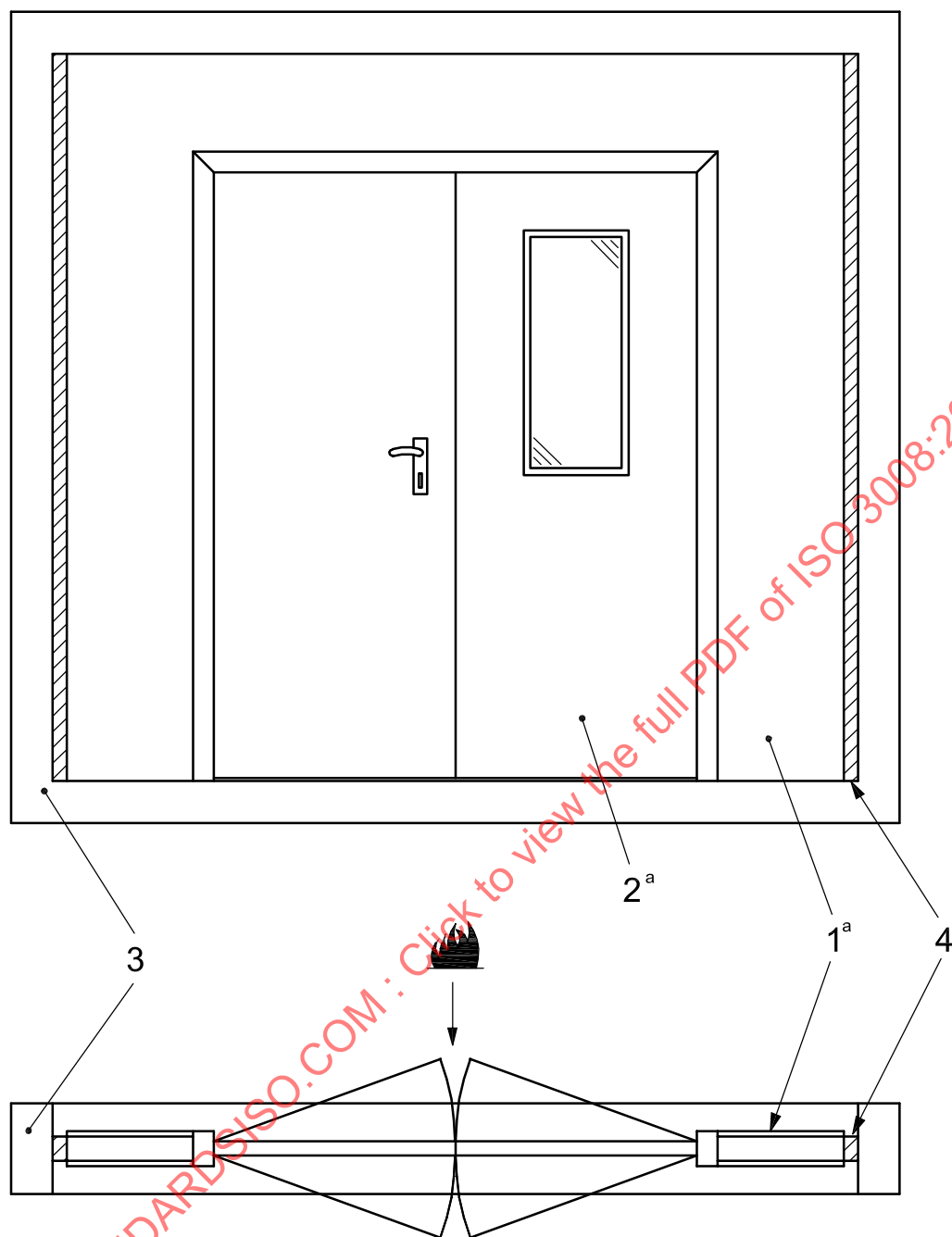
Figure 1 — Example of a horizontal cross-section of a flexible standard supporting construction

**Key**

- 1 standard supporting construction (block wall)
- 2 door assembly (test specimen)
- 3 test frame

^a Key items 1 and 2 form the test construction.

Figure 2 — Example of door assembly in a rigid standard supporting construction



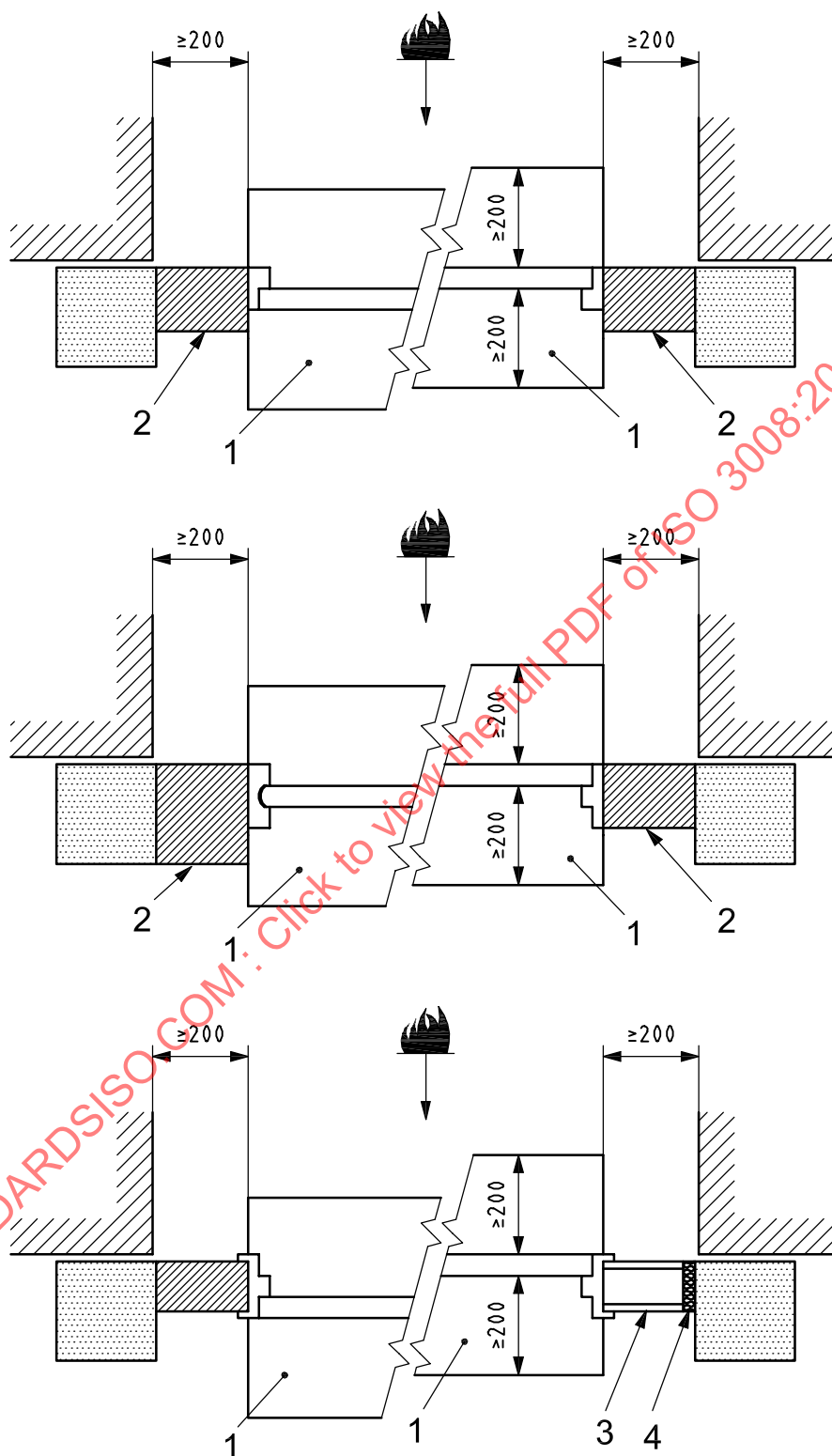
Key

- 1 standard or associated supporting construction
- 2 door assembly (test specimen)
- 3 test frame
- 4 free edge insulation

^a Key items 1 and 2 form the test construction.

Figure 3 — Example of a door assembly in flexible standard or associated supporting construction

Dimensions in millimetres

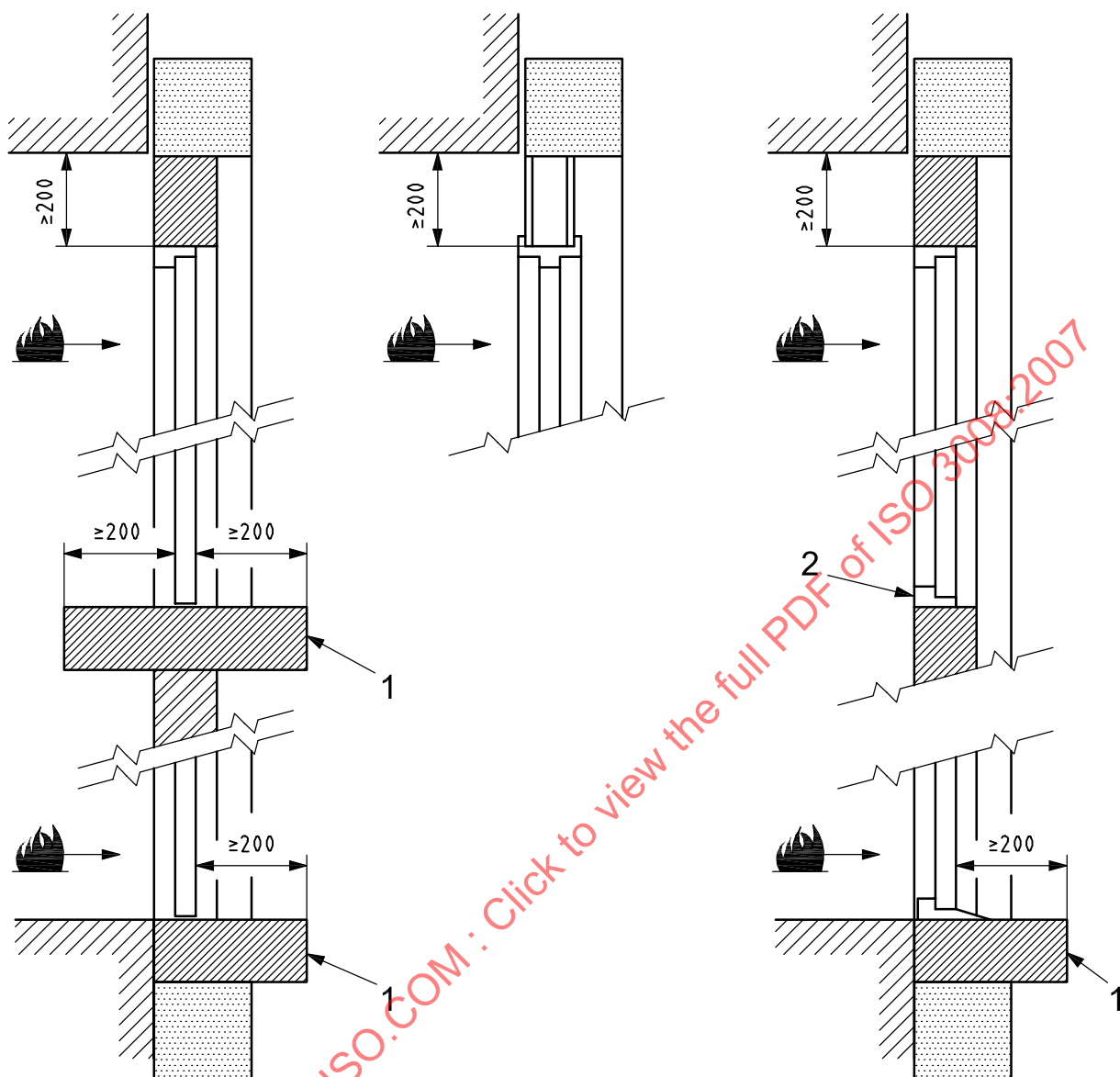


Key

- 1 floor
- 2 standard supporting construction
- 3 associated supporting construction
- 4 free edge insulation

Figure 4 — Example of horizontal sections for mounting hinged door specimens

Dimensions in millimetres

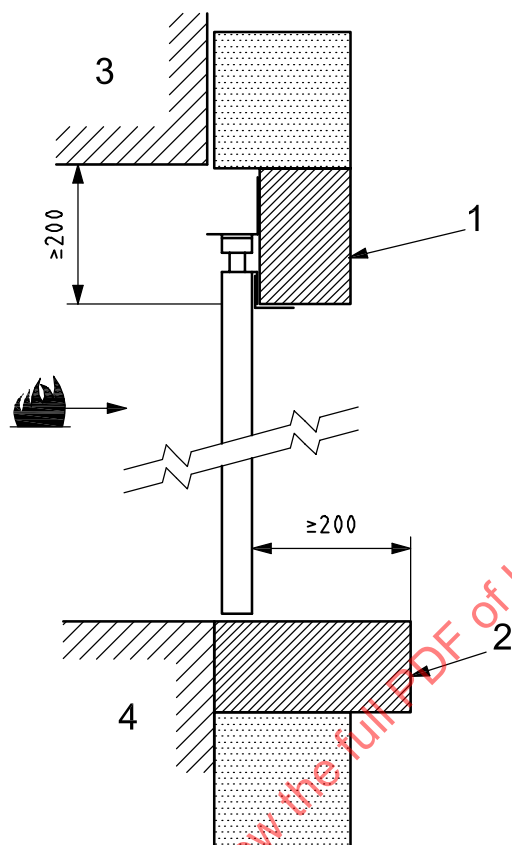


Key

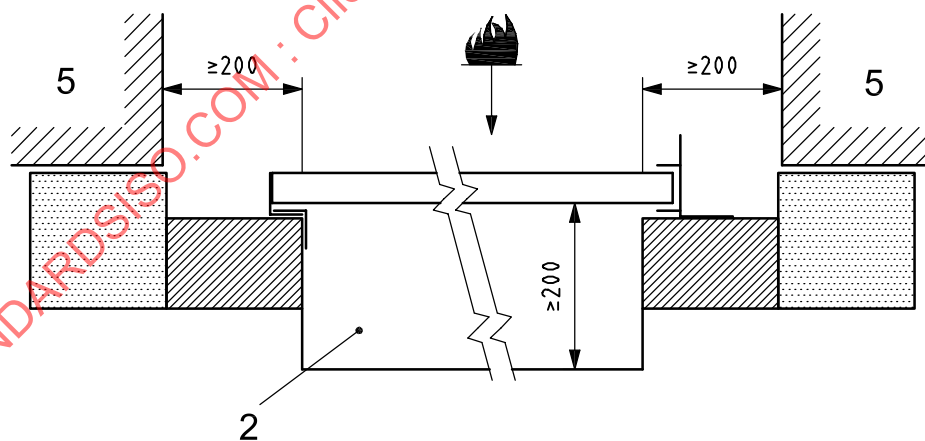
- 1 rigid non-combustible material
- 2 cill

Figure 5 — Examples for mounting hinged door specimens (vertical sections)

Dimensions in millimetres



a) Vertical section

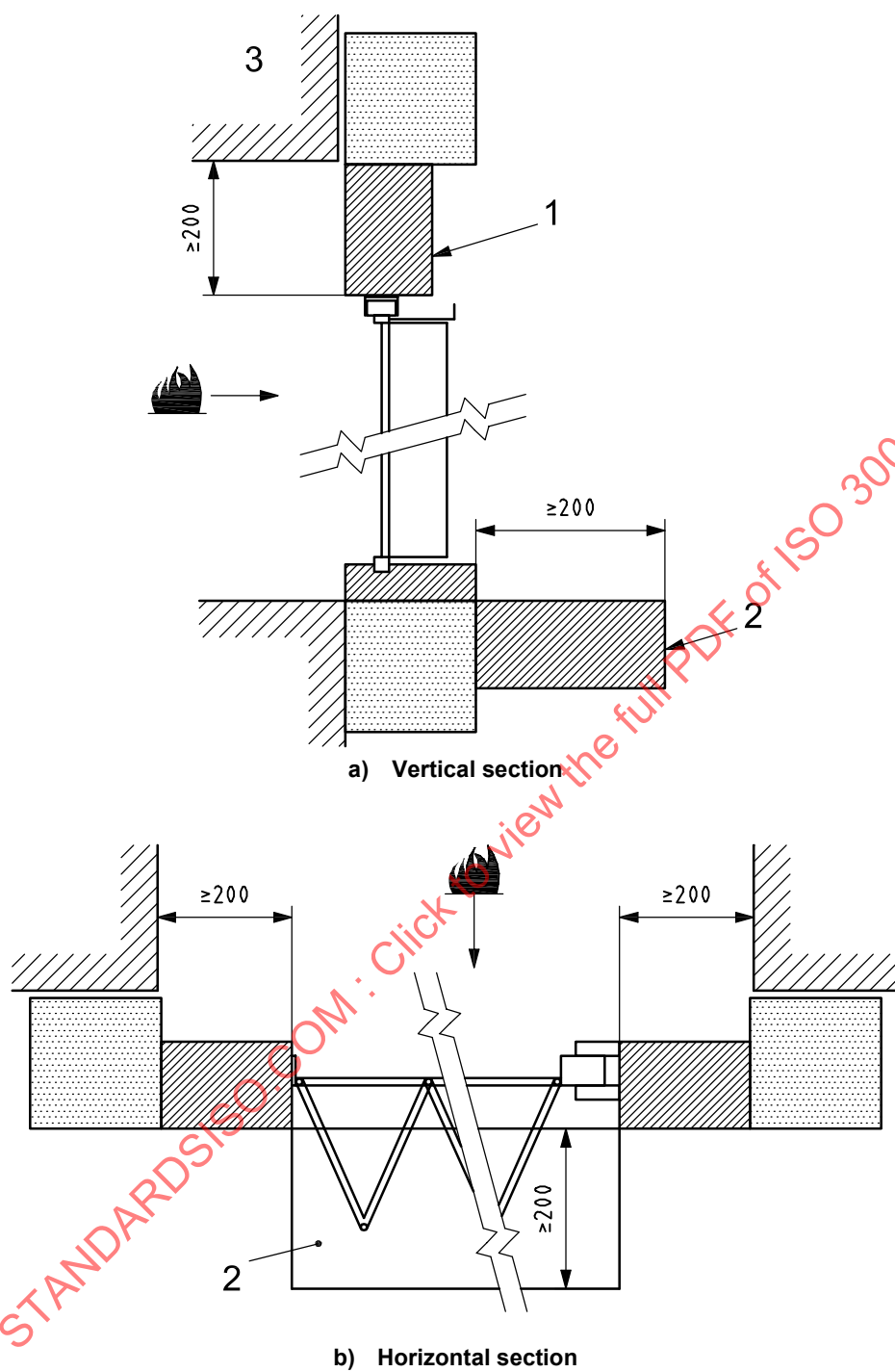


b) Horizontal section

Key

- 1 supporting construction
- 2 floor, rigid non-combustible material
- 3 top of furnace
- 4 bottom of furnace
- 5 side of furnace

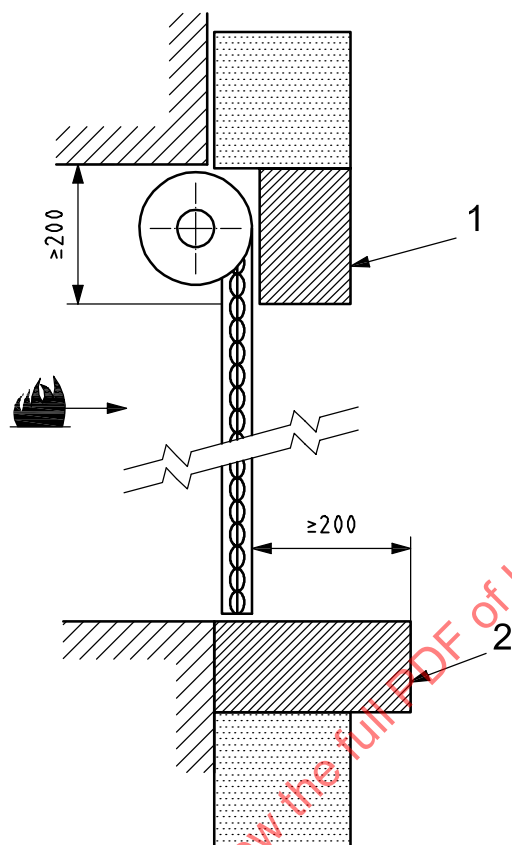
Figure 6 — Example of details for mounting sliding door specimens

**Key**

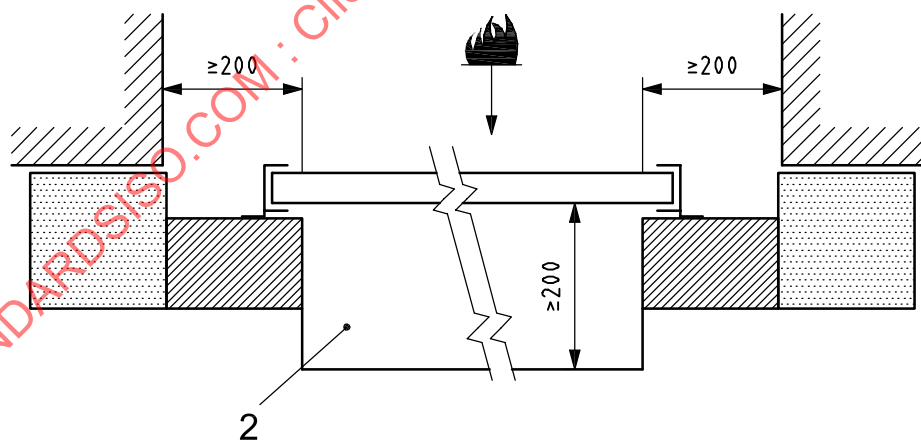
- 1 supporting construction
- 2 floor, rigid non-combustible material
- 3 top of furnace

Figure 7 — Example of details for mounting folding door specimens

Dimensions in millimetres



a) Vertical section



b) Horizontal section

Key

- 1 supporting construction
- 2 floor, rigid non-combustible material

Figure 8 — Example of details for mounting rolling-shutter specimens

7.3.4 Restraint on supporting construction

7.3.4.1 For flexible standard supporting constructions and all associated supporting constructions, the partition or wall shall be erected so that it can distort freely perpendicular to the plane of the construction along the vertical edges, i.e. there shall be a free edge at each end of the construction.

7.3.4.2 For rigid standard supporting constructions, the wall shall be erected with no freedom to distort perpendicular to the plane of the wall along the vertical edges, i.e. it shall be fixed to the inside of the test frame as in normal practice.

7.3.4.3 If the bottom of the test specimen is at floor level in practice, then, at the bottom of the aperture, continuity of the floor shall be simulated using a solid, non-combustible rigid material that has a minimum width of 200 mm on each side of the assembly, i.e. from the exposed to the unexposed face. The furnace floor can be regarded as part of the simulation of the floor continuity provided that it is level with the base of the assembly. If a cill detail is incorporated as part of the door or shutter assembly, this shall be incorporated within, or placed on top of, the extension. If the test specimen is not to be used at floor level, and provided that it has a frame detail to all four sides of the aperture, then it may be mounted simply within the thickness of the wall, without the extension.

If the specimen is tested in conjunction with a non-combustible floor, then this might not represent the situation when the specimen is installed above a combustible flooring such as timber or carpet.

7.4 Gaps

7.4.1 The adjustment of the door leaf, leaves or shutter and gaps shall be within the tolerances of the design values stipulated by the sponsor. These shall be representative of those used as intended for use in practice, so that appropriate clearances exist, e.g. between the fixed and moveable components.

7.4.2 In order to generate the widest field of direct application, the gaps shall be set between the middle value and the maximum value within the range of gaps given by the sponsor.

NOTE A door or shutter assembly with a specified range of gaps from 3 mm to 8 mm is tested with gaps set between 5,5 mm and 8 mm.

Examples of gap measurement are given in Figures 9 to 12.

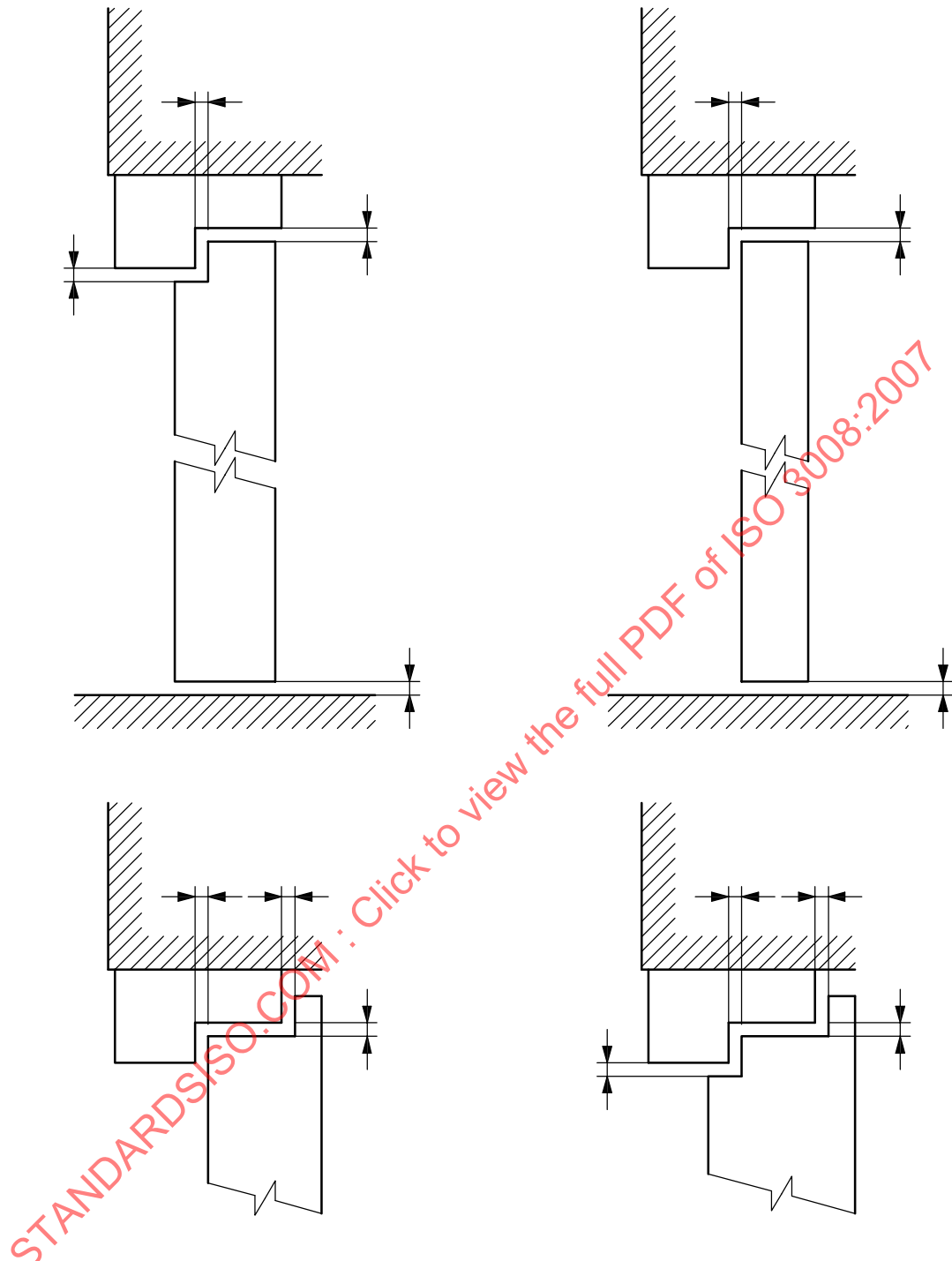
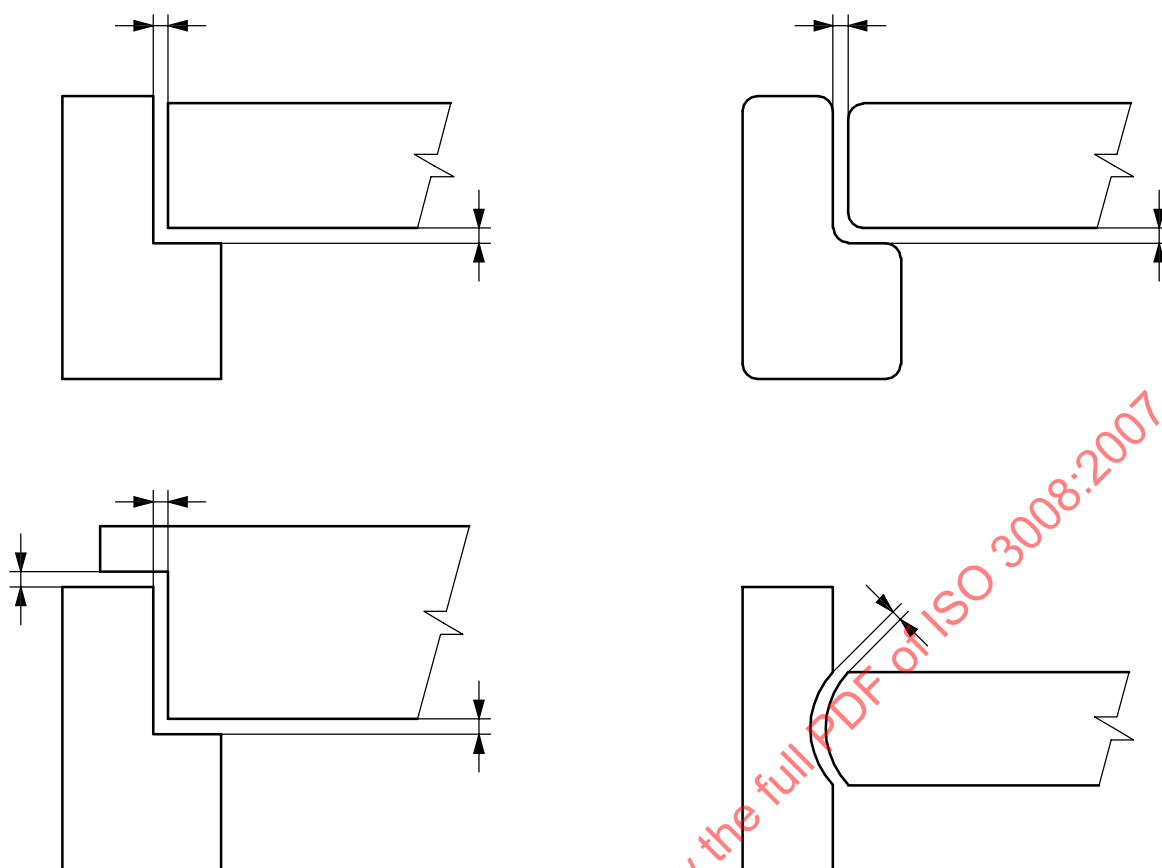
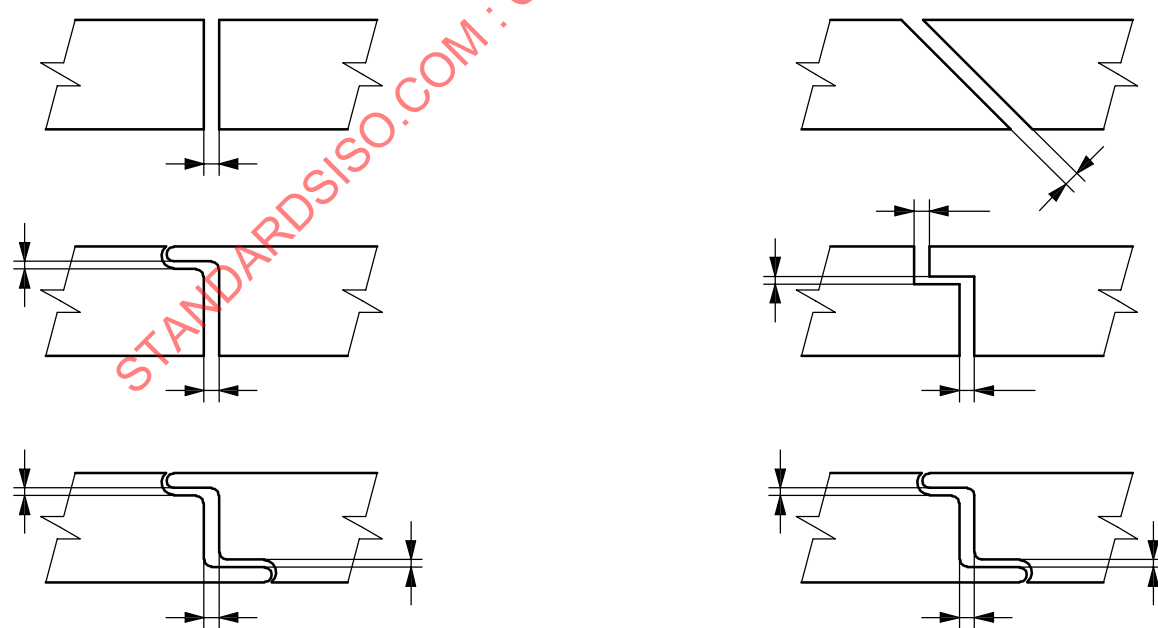


Figure 9 — Examples of clearance gap measurements for hinged and pivoted doors — Vertical sections

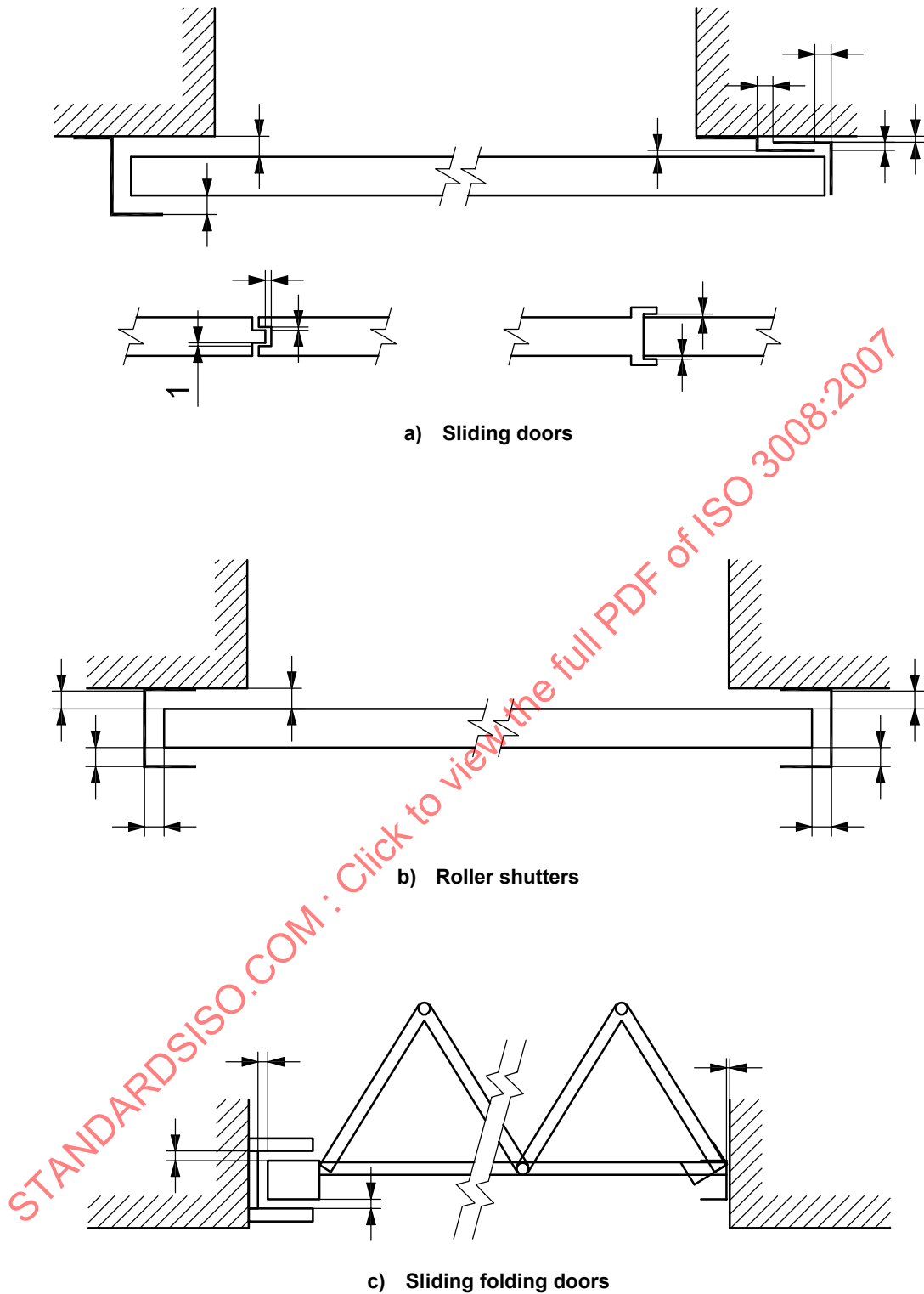


a) Single doors



b) Meeting edge for double doors

Figure 10 — Examples of gap measurements for hinged and pivoted doors

**Key**

1 junction between two leaves

Figure 11 — Examples of gap measurements — Horizontal sections

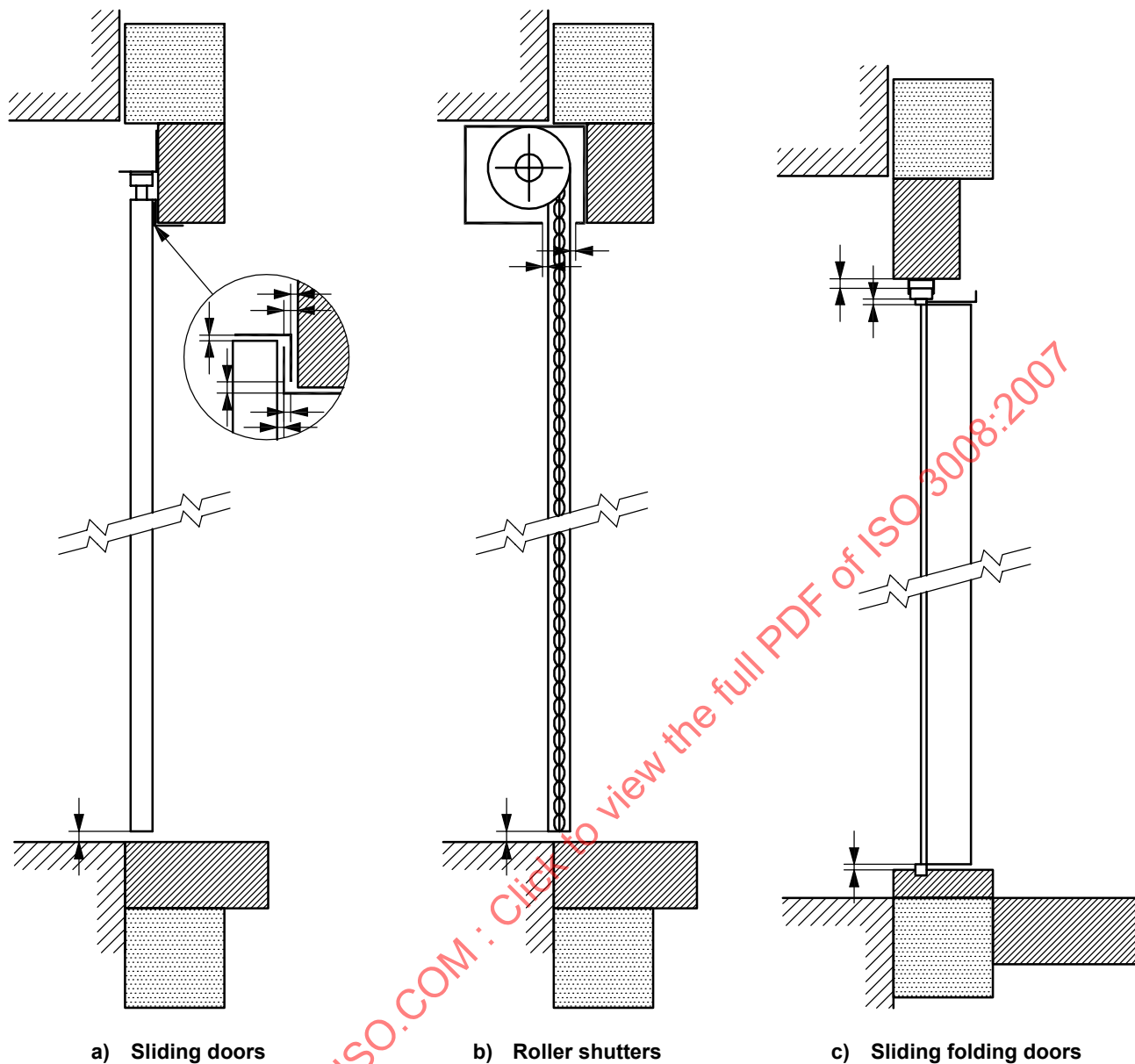


Figure 12 — Examples of gap measurements — Vertical sections

8 Conditioning

8.1 Moisture content

The test specimen shall be conditioned in accordance with ISO 834-1. Requirements for conditioning of supporting constructions are given in Annex A.

8.2 Mechanical

Some product standards exist for certification purposes that require mechanical testing before the start of the fire test. Durability requirements are given in the relevant product standard.

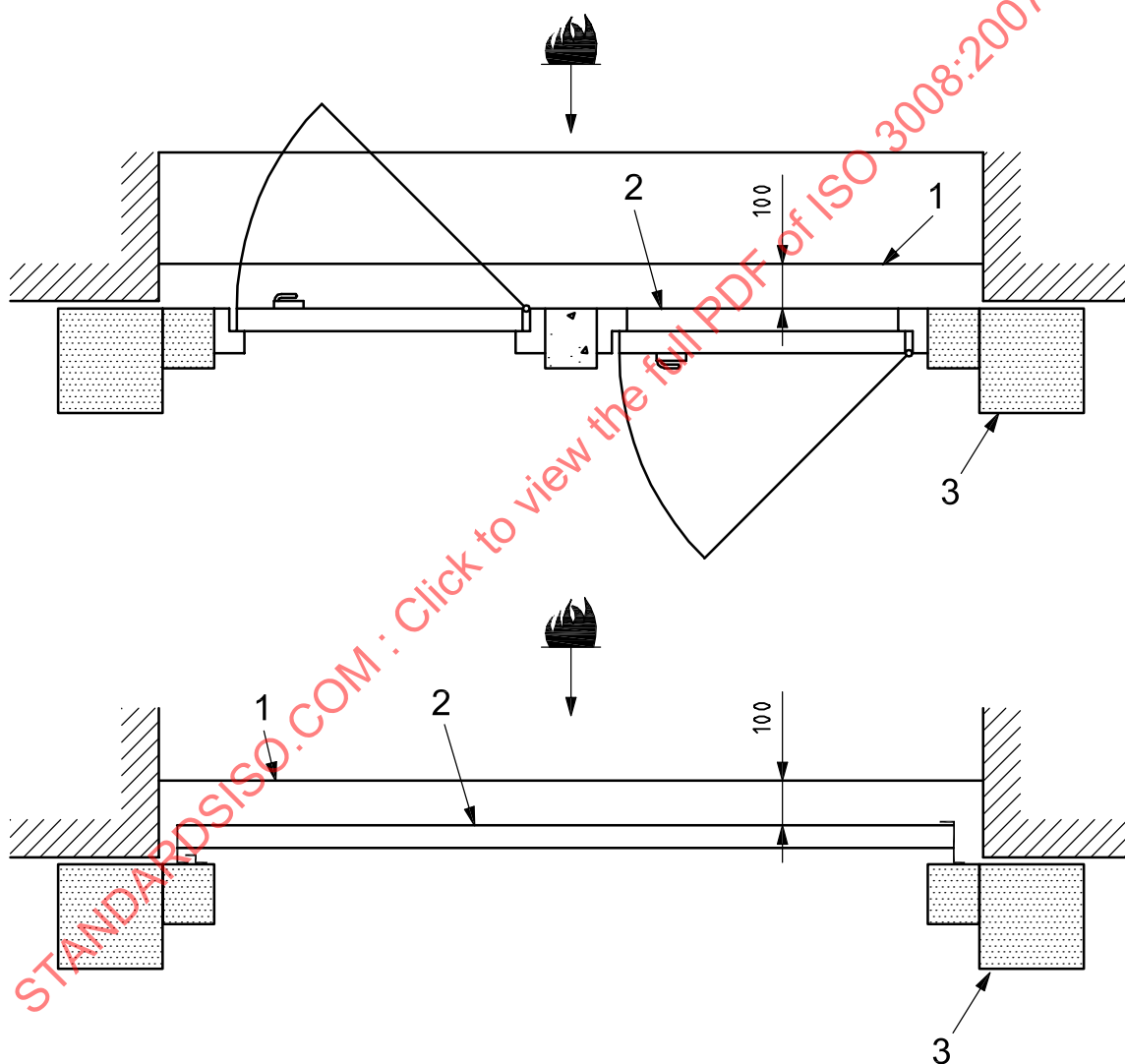
9 Application of instrumentation

9.1 Temperature measurements

9.1.1 Furnace-temperature measuring instrument

Plate thermometers shall be provided in accordance with ISO 834-1. They shall be evenly distributed over a vertical plane 100 mm from the nearest plane of the test construction; see Figure 13. There shall be at least one plate thermometer for every 1,5 m² of the exposed surface area of the test construction, subject to a minimum of four. The plate thermometer shall be oriented so that “side A” faces the back wall of the furnace.

Dimensions in millimetres



Key

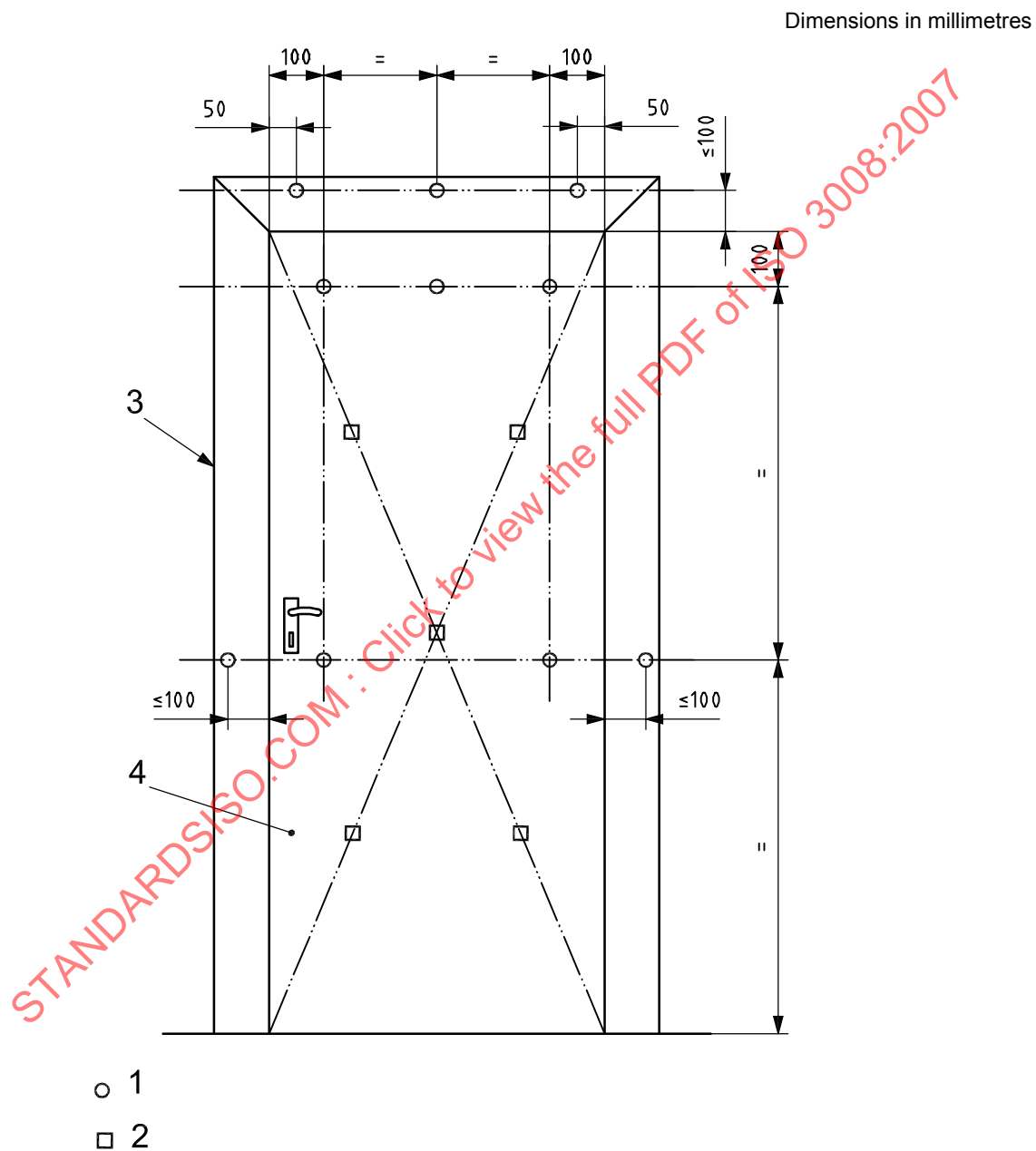
- 1 plane of furnace
- 2 nearest plane of test construction
- 3 test frame

Figure 13 — Example of positions of furnace-temperature measuring devices (plate thermometer) — Horizontal section

9.1.2 Unexposed-face thermocouples

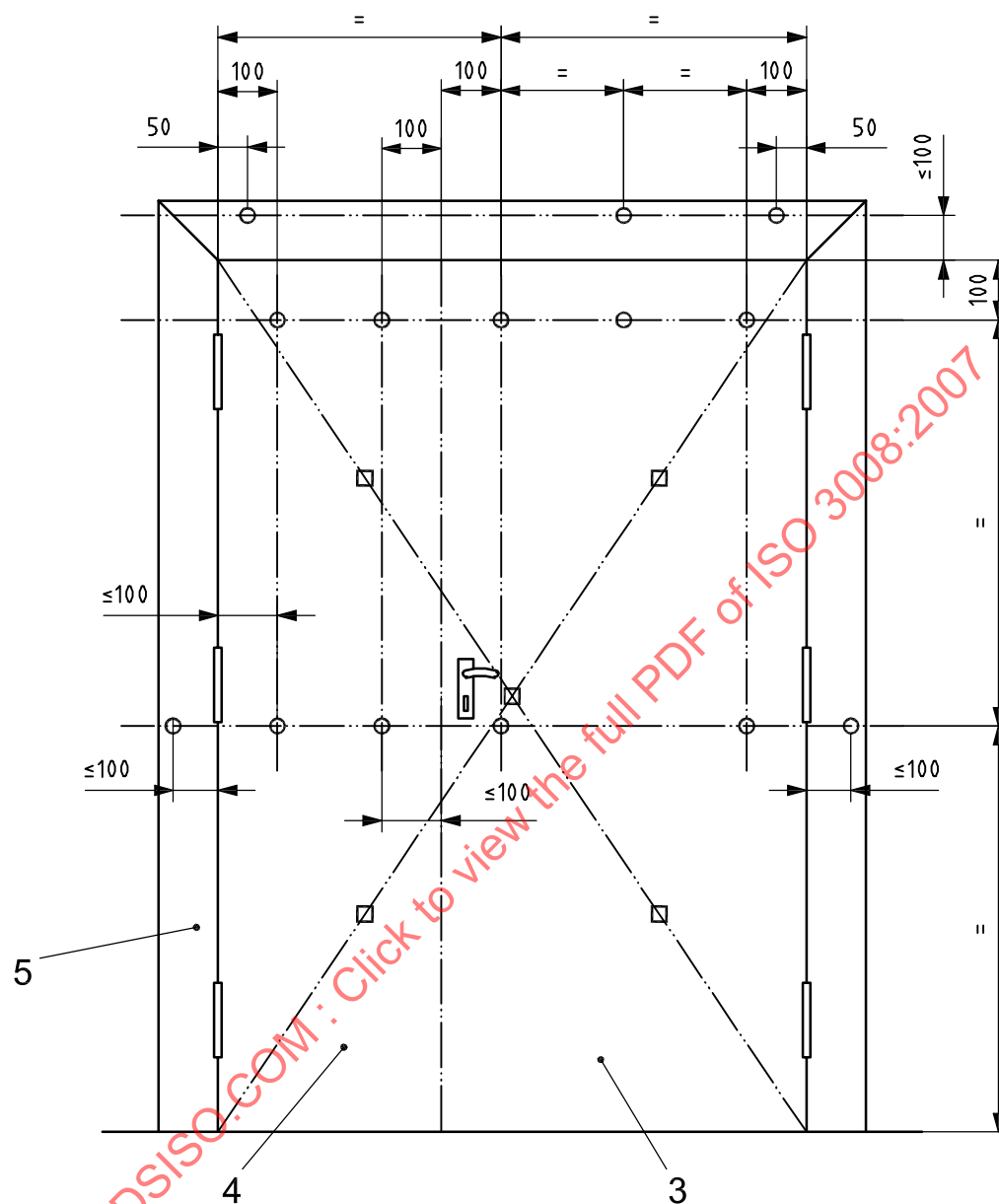
9.1.2.1 Where no evaluation against the insulation criteria is required of the door or shutter assembly, or any part thereof, no temperature measurements are required.

9.1.2.2 Where it is required to evaluate compliance with the insulation criteria, thermocouples of the type specified in ISO 834-1 shall be attached to the unexposed face for the purpose of obtaining the average and maximum surface temperatures. Examples of the location of unexposed-face thermocouples are shown in Figures 14 to 27.



**Figure 14 — Example of locations of unexposed-face thermocouples —
General arrangement — Single-leaf door, 1 200 mm**

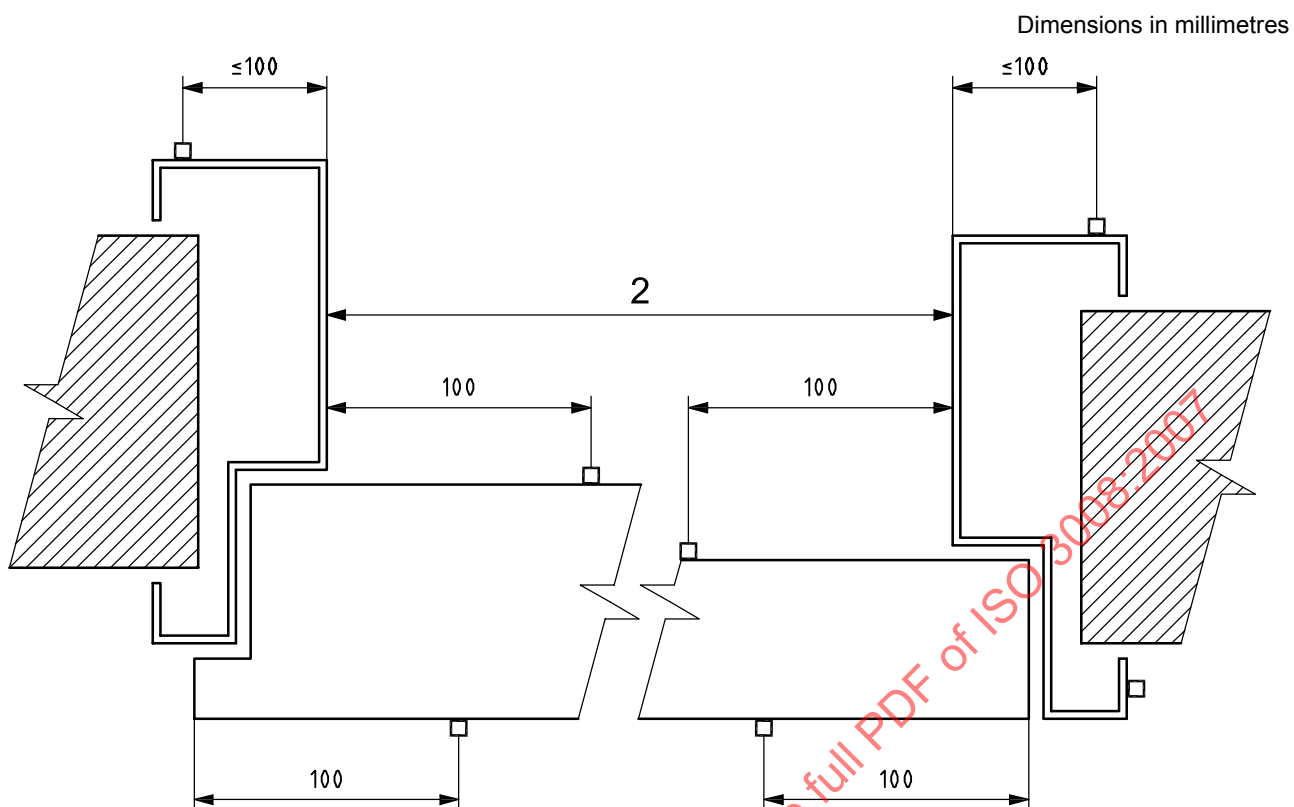
Dimensions in millimetres



Key

- 1 thermocouples for maximum temperature rise
- 2 thermocouples for average temperature rise
- 3 primary door leaf
- 4 secondary door leaf
- 5 door frame

**Figure 15 — Example of locations of unexposed-face thermocouples — General arrangement —
Double-leaf door assembly: primary leaf, 1 200 mm wide; secondary leaf, < 1 200 mm**



□ 1

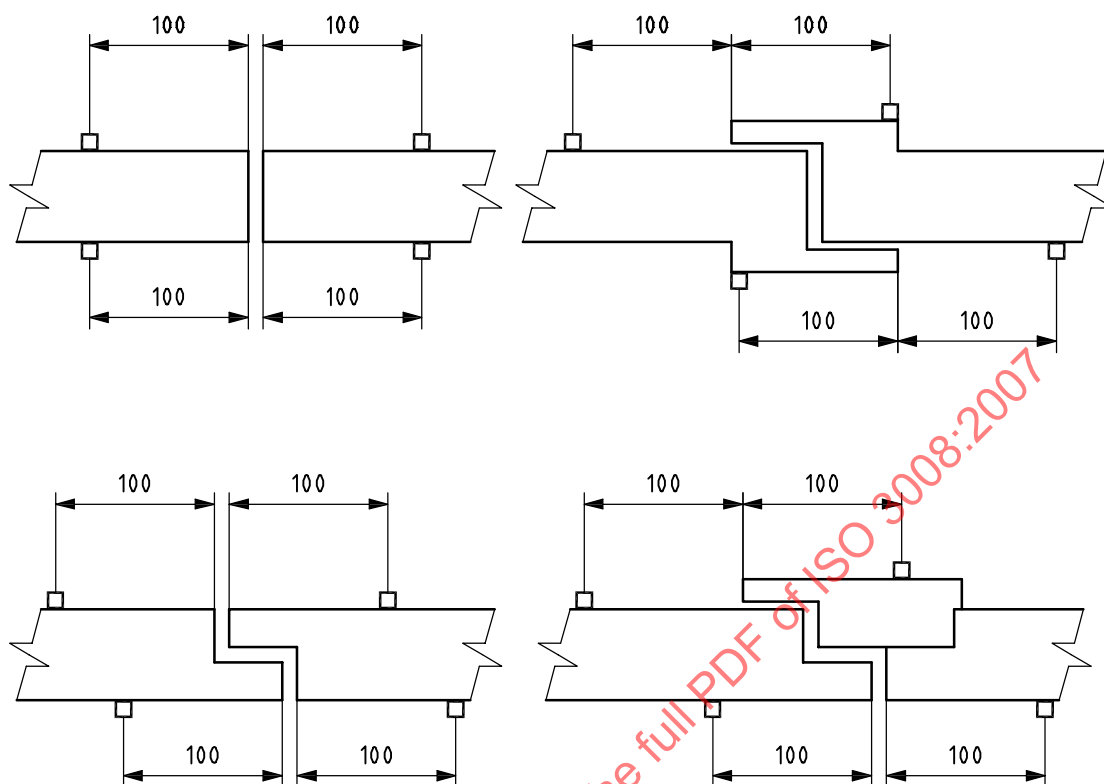
Key

- 1 thermocouples for maximum temperature rise
- 2 clear opening

NOTE Although thermocouples are shown on both sides of the door face in this illustration to show proximity to the frame, they are placed only on the non-fire-exposed face.

Figure 16 — Example of locations of unexposed-face thermocouples at periphery of hinged and pivoted doors (detail)

Dimensions in millimetres



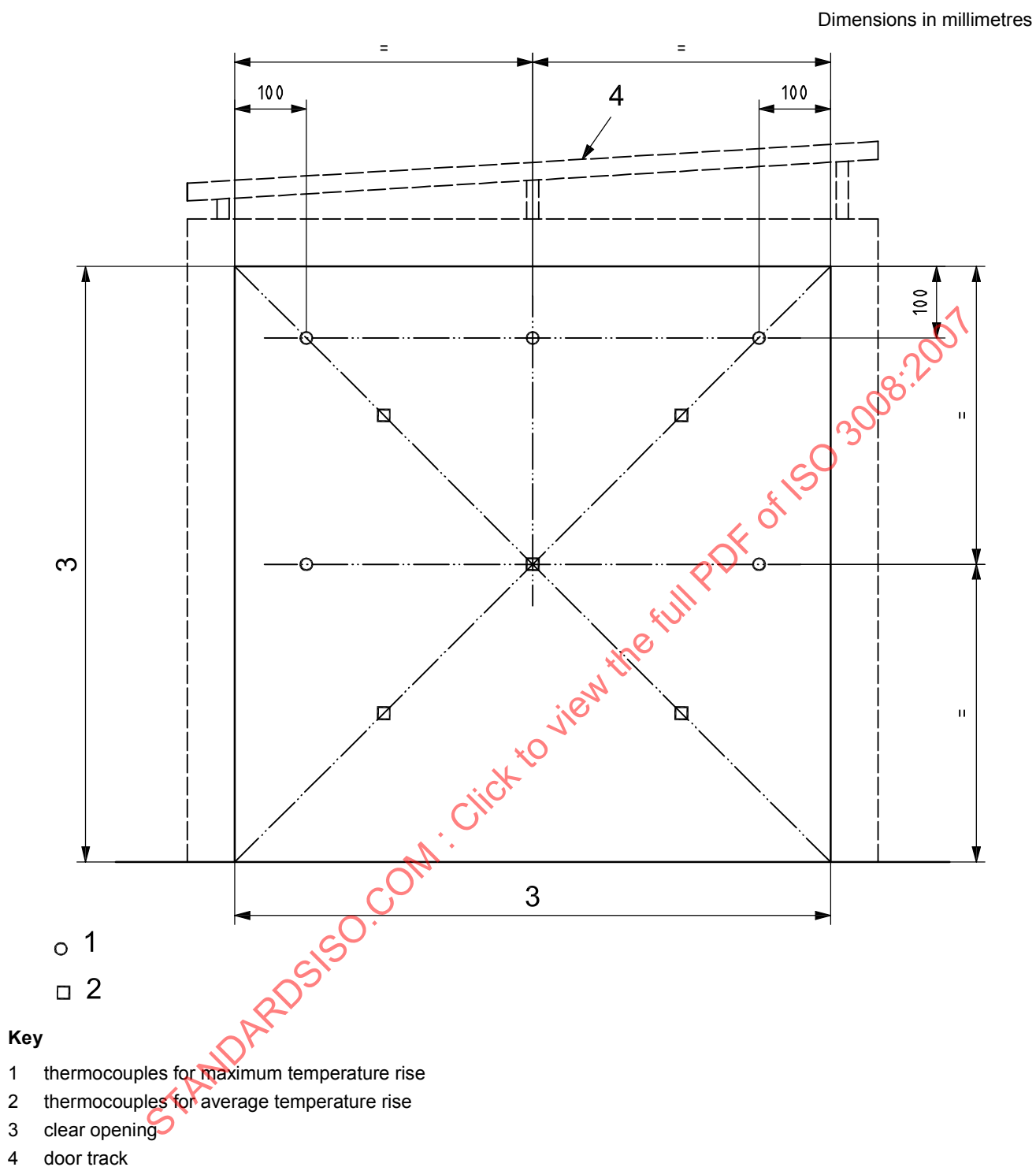
□ 1

Key

1 thermocouples for maximum temperature rise

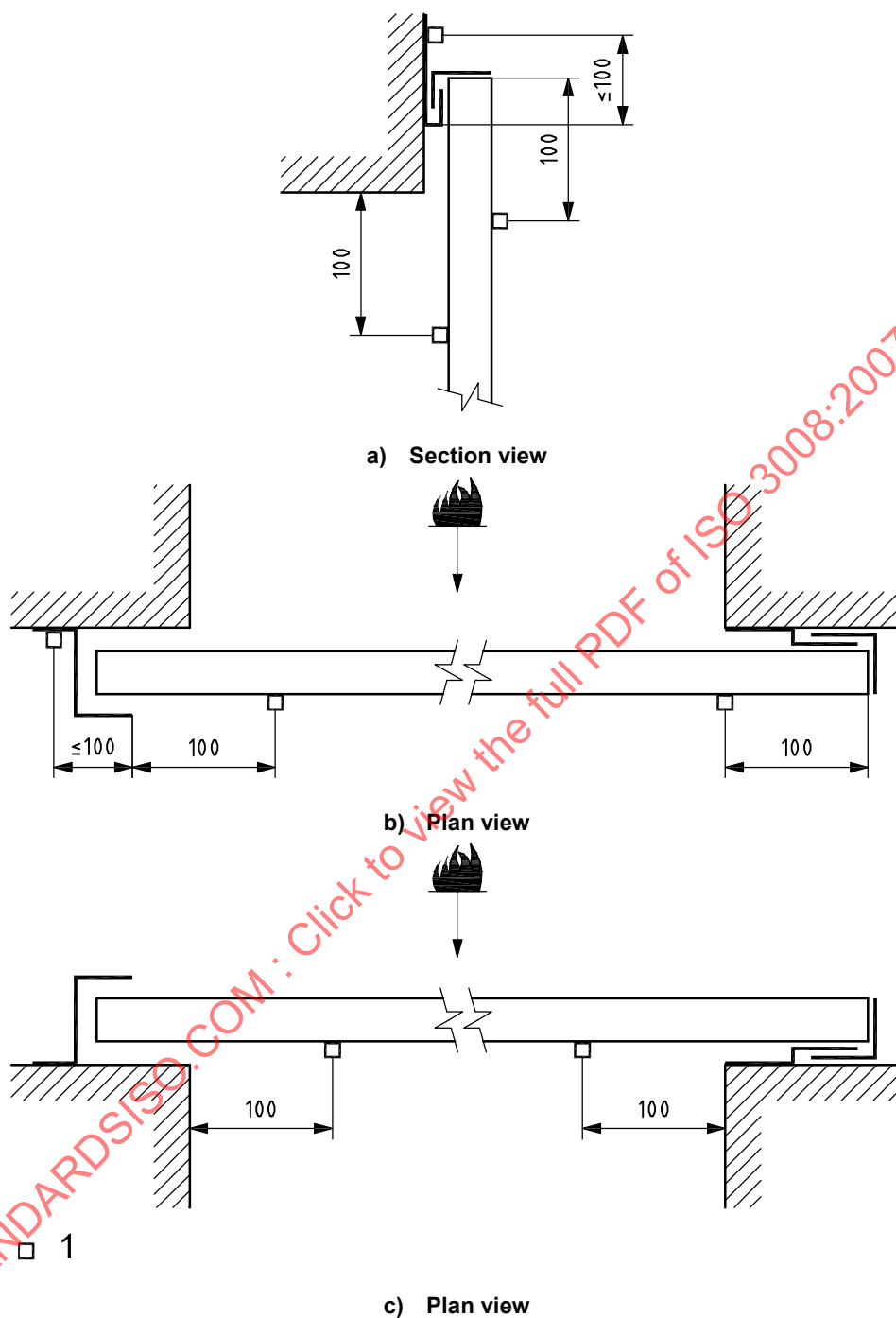
NOTE Although thermocouples are shown on both sides of the door face in this illustration to show proximity to the meeting edge, they are placed only on the non-fire-exposed face.

**Figure 17 — Example of location of unexposed-face thermocouples on meeting edges —
Hinged or pivoted double-leaf doors**



**Figure 18 — Example of locations of unexposed-face thermocouples —
Single-leaf sliding door**

Dimensions in millimetres

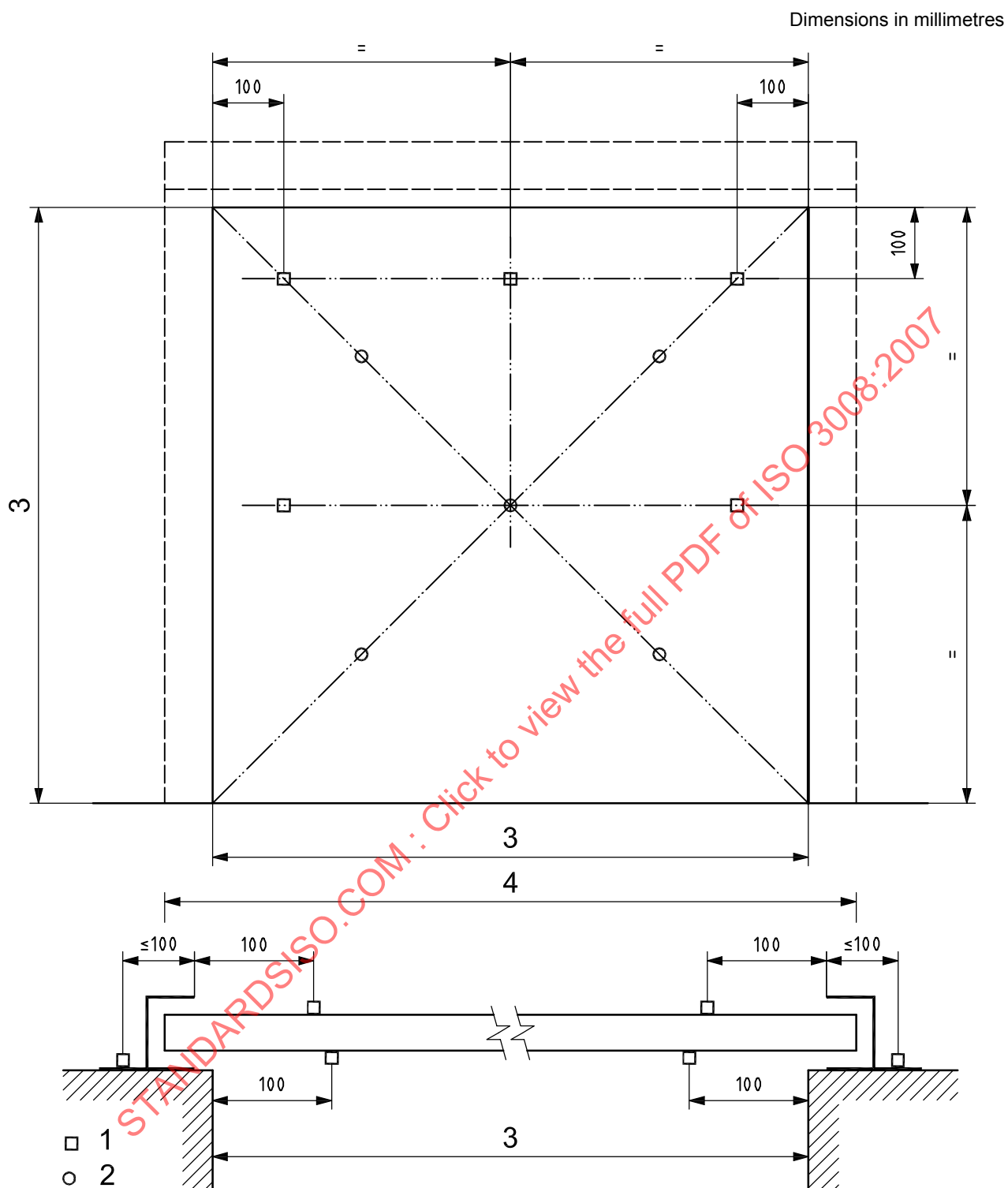


Key

1 thermocouples for maximum temperature rise

NOTE Although thermocouples are shown on both sides of the door face in this illustration to show proximity to the frame, they are placed only on the non-fire-exposed face.

**Figure 19 — Example of locations of unexposed-face thermocouples —
Single-leaf sliding door**



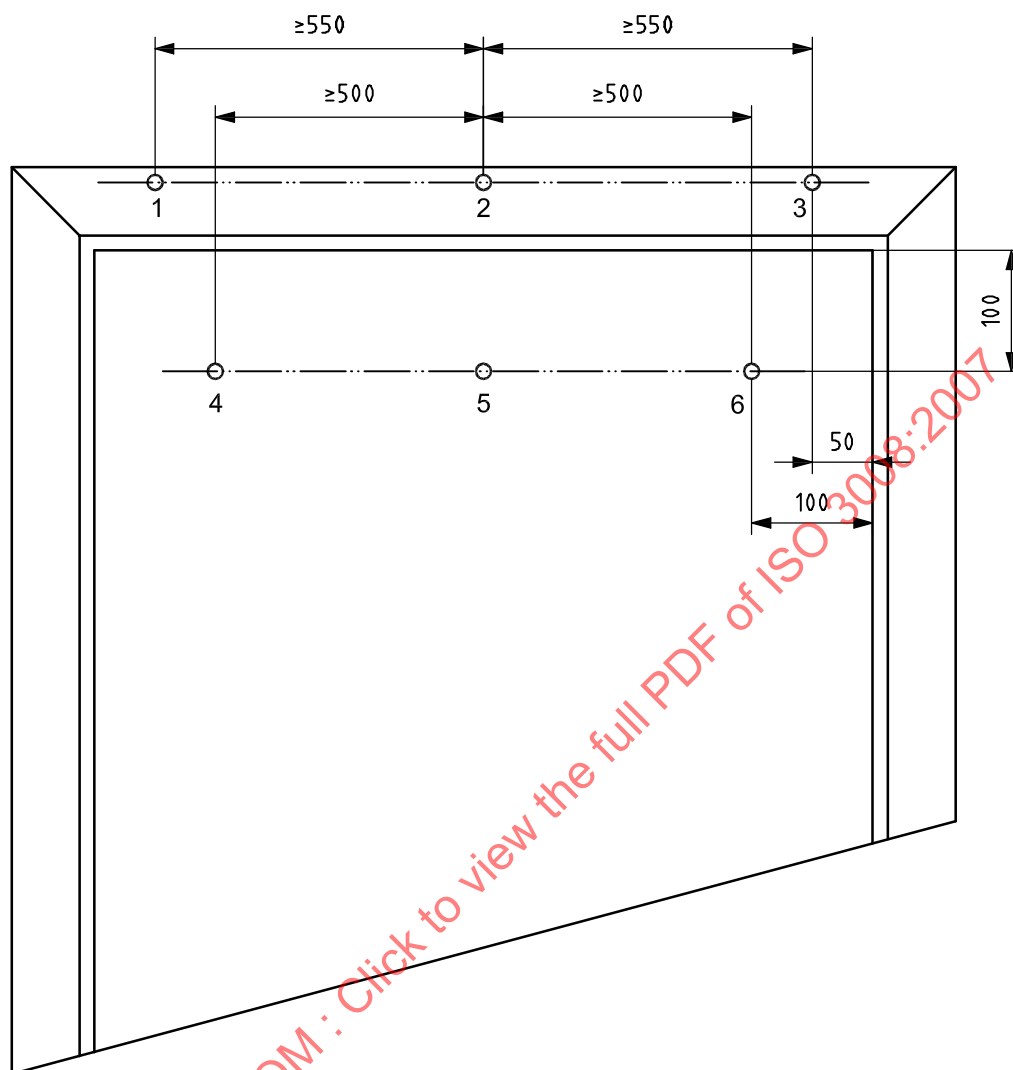
Key

- 1 thermocouples for maximum temperature rise
- 2 thermocouples for average temperature rise
- 3 clear opening
- 4 shutter curtain

NOTE Although thermocouples are shown on both sides of the door face in this illustration to show proximity to the frame, they are placed only on the non-fire-exposed face.

Figure 20 — Example of locations of unexposed-face thermocouples, general arrangement — Roller shutter

Dimensions in millimetres

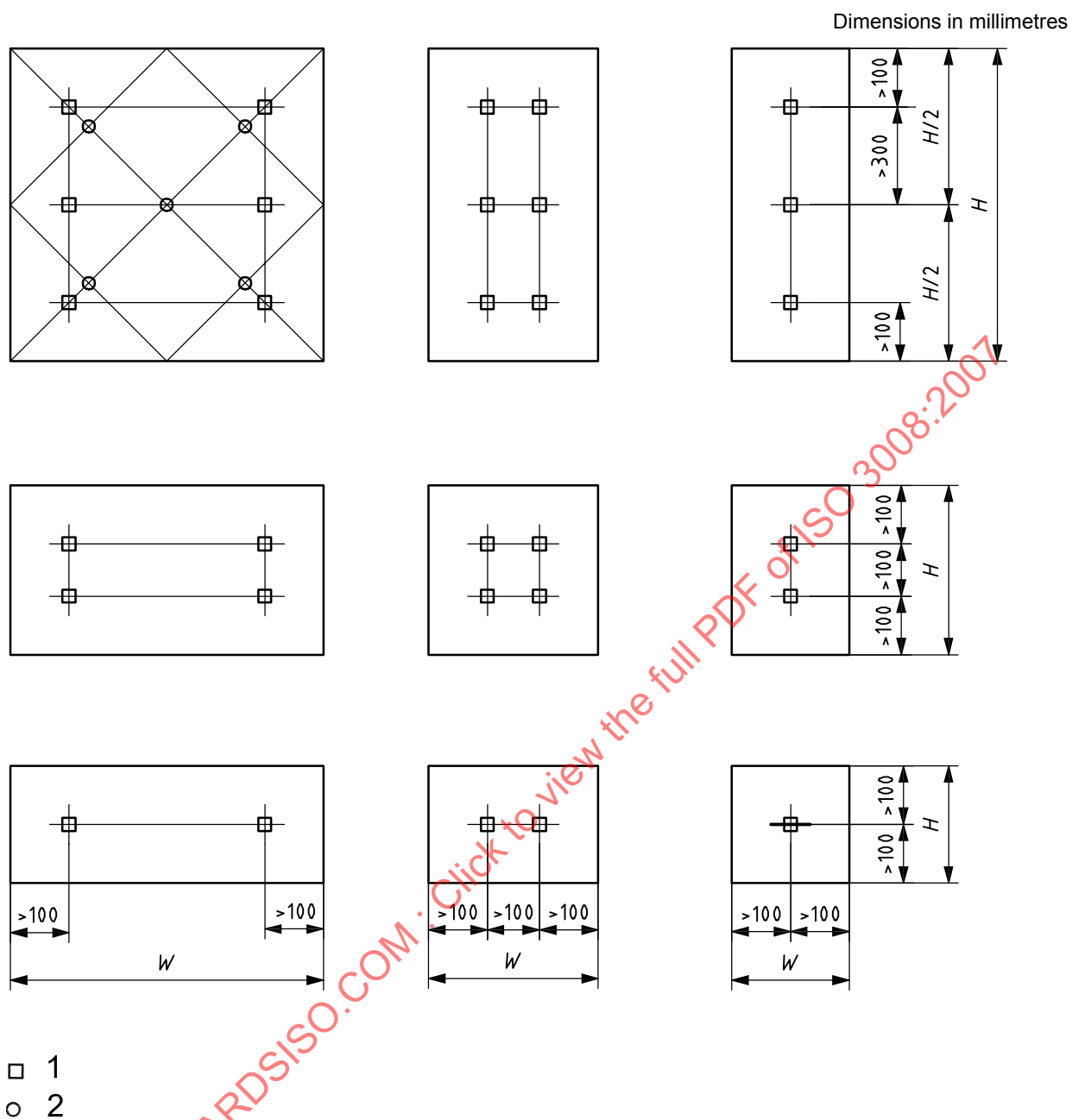


Key

1 to 6 thermocouples for maximum temperature rise

Thermocouples 1, 3, 4 and 6 are always required. Thermocouples 2 and 5 are not required if the leaf width is less than 1 200 mm.

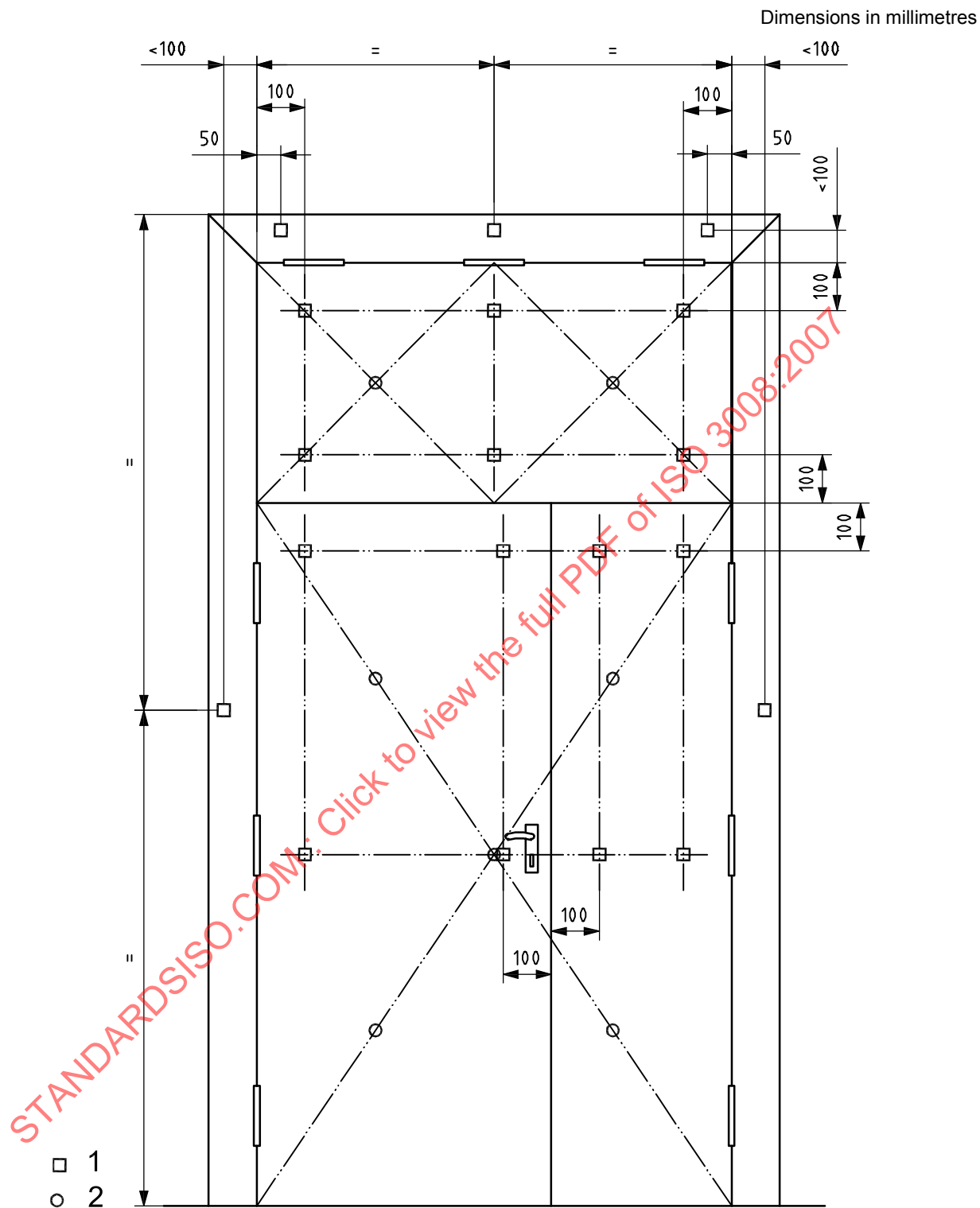
Figure 21 — Reduction in number of unexposed-face thermocouples with decreasing leaf width



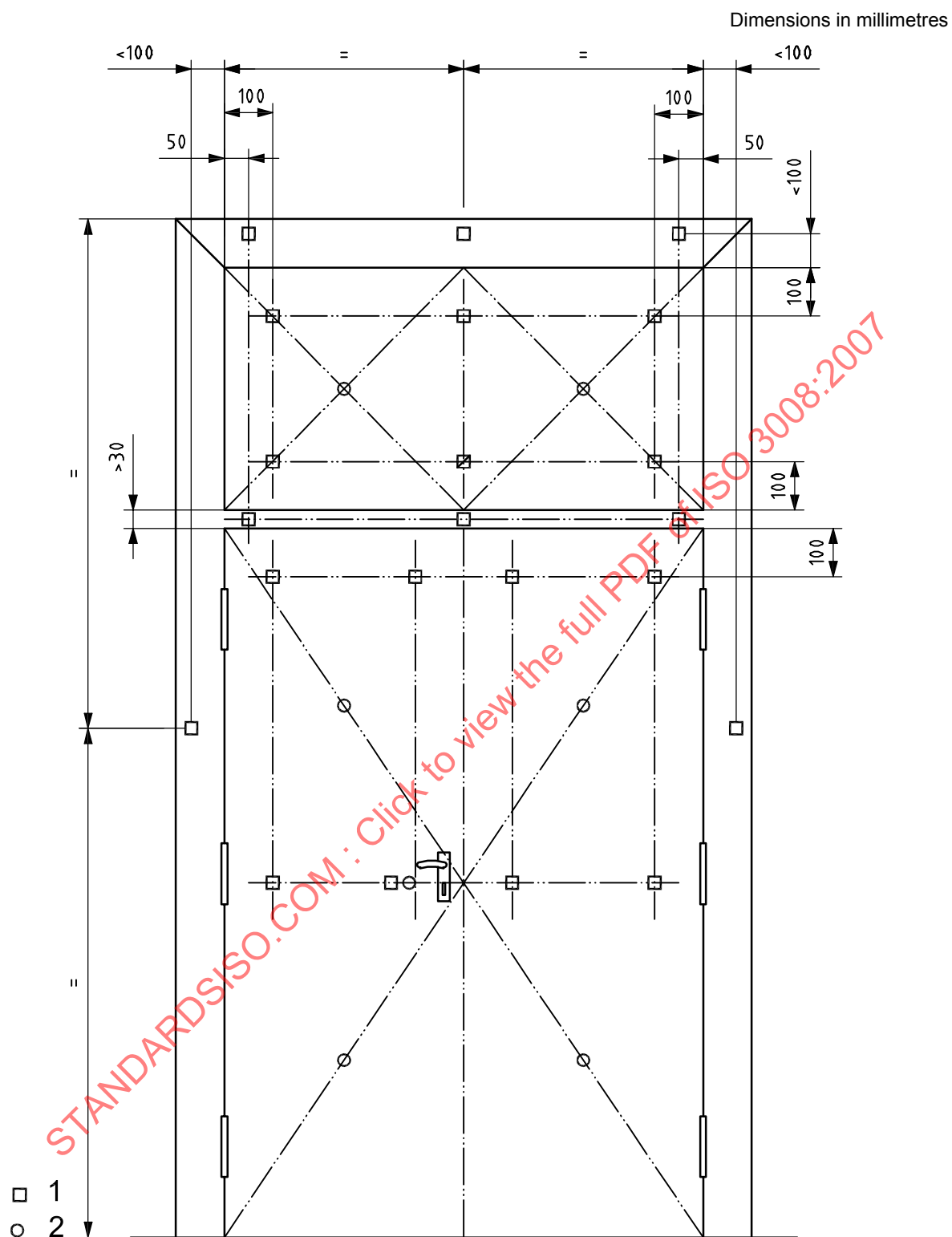
Key

- 1 thermocouples for maximum temperature rise
- 2 thermocouples for average temperature rise
- W width of panel
- H height of panel

Figure 22 — Examples of locations of thermocouples in discrete areas, e.g. side panels, over panels and transom panels, assuming that there is only one of each type in the specimen



**Figure 23 — Example of locations of thermocouples on unexposed face —
Example of double-leaf door with hinged flush over panel (largest leaf width < 1 200 mm)**

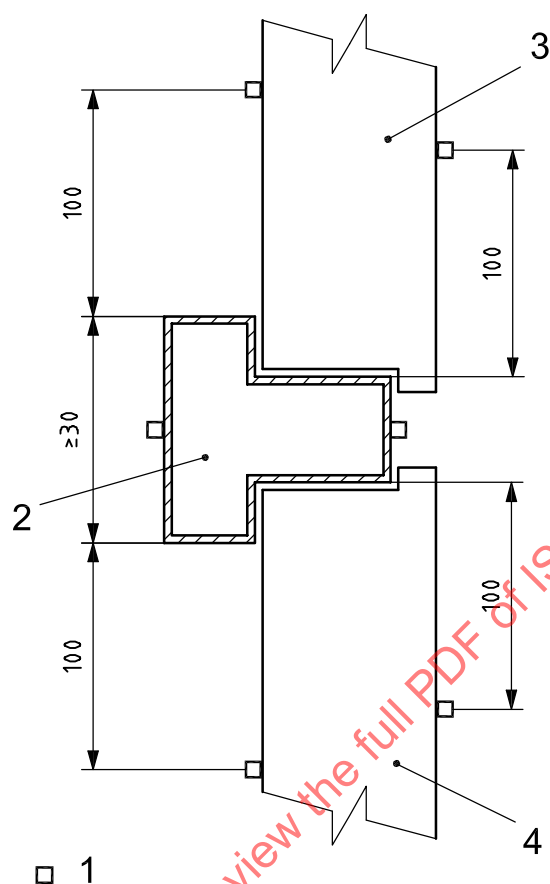


Key

- thermocouples for maximum temperature rise
- thermocouples for average temperature rise

**Figure 24 — Example of locations of thermocouples on unexposed face —
Example for double-leaf door with transom panel (largest leaf width < 1 200 mm)**

Dimensions in millimetres

**Key**

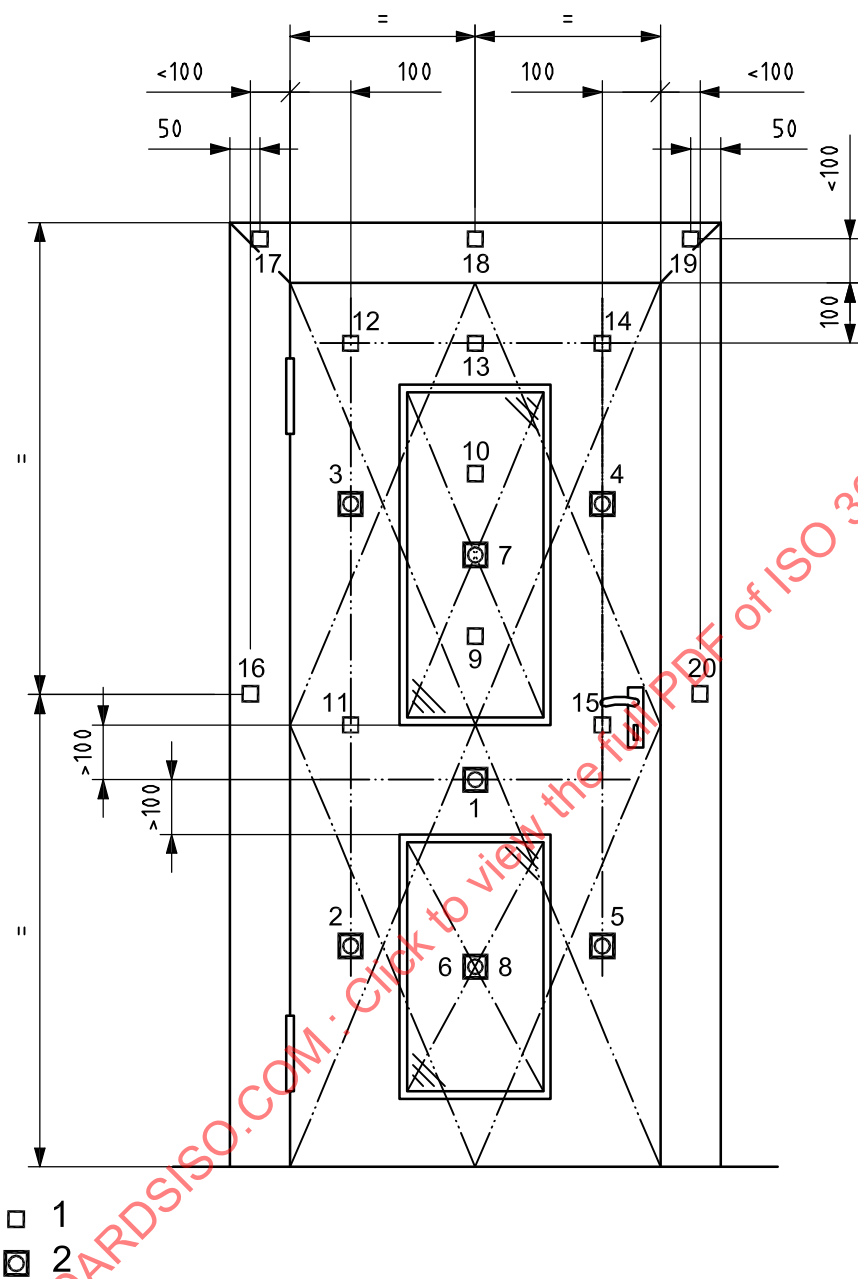
- 1 thermocouples for maximum temperature rise
- 2 transom frame width for application of thermocouples
- 3 transom panel
- 4 door leaf

NOTE 1 Although thermocouples are shown on both sides of the door face in this illustration to show proximity to the frame, they are placed only on the non-fire-exposed face.

NOTE 2 See 9.3 for additional guidance on single doors.

**Figure 25 — Example of locations of thermocouples on an unexposed face —
Example for double-leaf door with transom panel (largest leaf width < 1 200 mm)**

Dimensions in millimetres

**Key**

- 1 thermocouples 9 to 20 for maximum temperature rise
- 2 thermocouples 1 to 8 for both average and maximum temperature rise

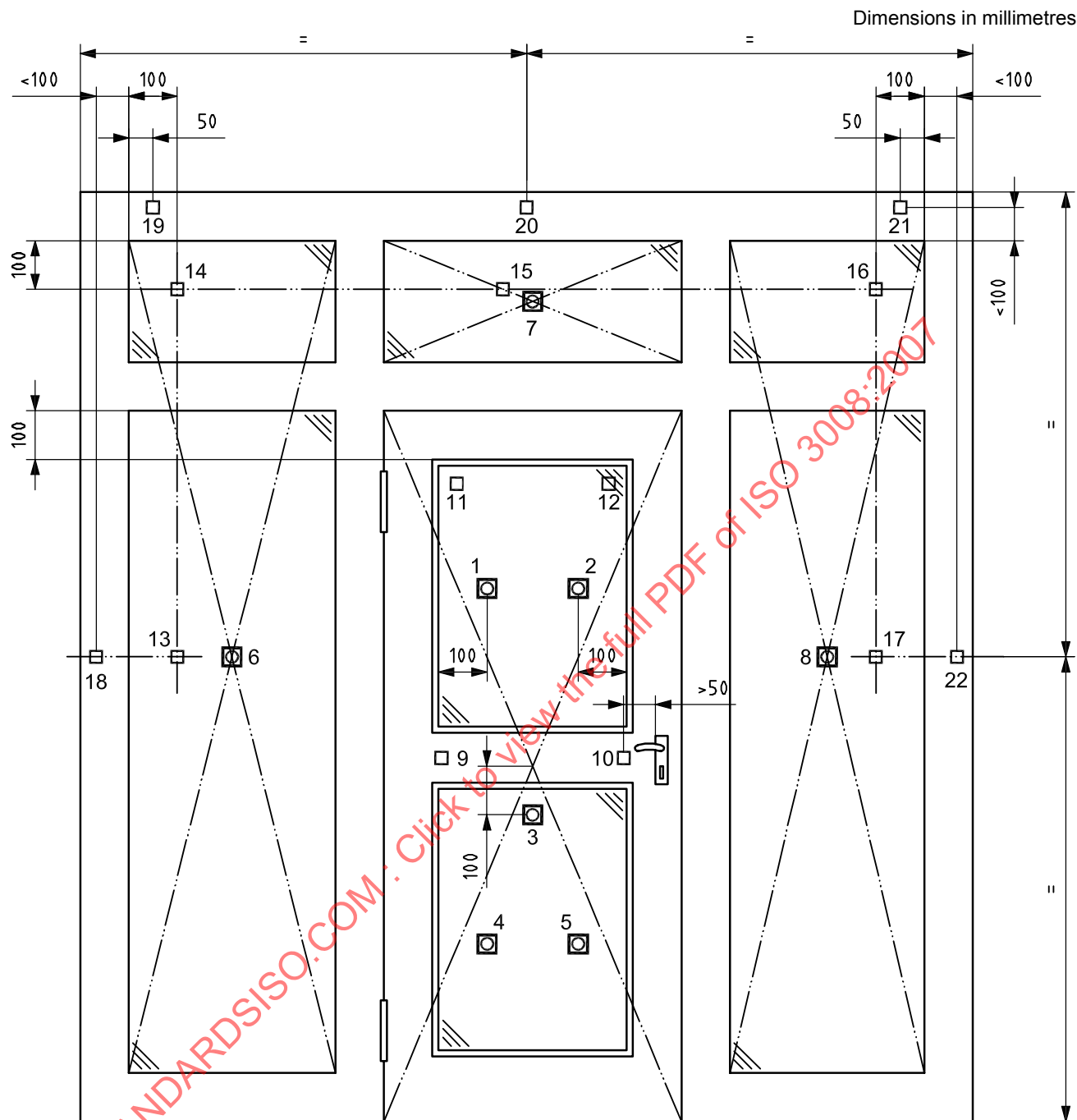
NOTE 1 Average temperature of glazed area is the average of thermocouples 6 and 7.

NOTE 2 Maximum temperature of glazed area is the maximum of thermocouples 6 to 10.

NOTE 3 Average temperature of door leaf is the average of thermocouples 1 to 5.

NOTE 4 Maximum temperature of door leaf is the maximum of thermocouples 1 to 5 and 11 to 20.

Figure 26 — Example of locations of unexposed-surface thermocouples on hinged door incorporating glazing (width of door leaf > 1 200 mm)



- 1
 ◻ 2

Key

- 1 thermocouples 9 to 22 for maximum temperature rise
 2 thermocouples 1 to 8 for both average and maximum temperature rise

NOTE 1 Average temperature of door leaf is the average of thermocouples 1 to 5.

NOTE 2 Maximum temperature of door leaf is the maximum of thermocouples 1 to 5 and 9 to 12.

NOTE 3 Average temperature of side/over panels is the average of thermocouples 6 to 8.

NOTE 4 Maximum temperature of side/over panels is the maximum of thermocouples 6 to 8 and 13 to 22.

Figure 27 — Example of locations of unexposed-surface thermocouples on door assemblies with multiple side/over panels

9.1.2.3 The temperature of the supporting construction in which the door or shutter assembly is mounted is not required to be measured and, therefore, no thermocouples are required.

9.1.2.4 No thermocouple shall be placed within 50 mm of any hardware.

9.1.2.5 Position five thermocouples (for single- or double-leaf doors), one at the centre of each of the specimen leaves (single or multiple) and one at the centre of each quarter section. These shall not be located closer than 50 mm to any joint, stiffener or through component, nor closer than 100 mm to the edge of the leaf.

9.1.2.6 For door or shutter assemblies which incorporate discrete areas of different thermal insulation $\geq 0,1 \text{ m}^2$ (e.g. flush over panels, transom panels, side panels or glazed panels within a door leaf), extra thermocouples shall be evenly distributed over the sum of the surface of those areas to determine the average temperature at a density of one thermocouple per square metre or part thereof, subject to a minimum of two. The average insulation performance of the sum of each area shall be determined.

9.1.2.7 When the total area of a single portion of the door or shutter assembly represents less than $0,1 \text{ m}^2$, it shall be disregarded for the purpose of ascertaining the average unexposed-face temperature.

9.2 Maximum temperature

9.2.1 The maximum temperature shall be determined from the five thermocouples fixed to determine the average temperature rise (as given in 9.1.2.5), the roving thermocouple and from additional thermocouples fixed as indicated in 9.2.2 and 9.2.3.

9.2.2 If the door or shutter assembly incorporates discrete areas of different thermal insulation $\geq 0,1 \text{ m}^2$ (e.g. flush over panels, transom panels, side panels, or glazed panels within a door or shutter area) that are evaluated separately with respect to average temperature rise, then the evaluation of maximum unexposed-face temperature of those areas shall also be undertaken separately. This can require extra unexposed-surface thermocouples to be applied as given in 9.1.2.6 and 9.1.2.7.

9.2.3 For the temperature of door leaf or shutter, thermocouples shall be fixed to the face of each leaf or shutter as follows:

- a) at mid-height, 100 mm in from the vertical edges as specified below;
- b) at mid-width, 100 mm down from the horizontal edge as specified below;
- c) 100 mm in from the vertical edges, 100 mm down from the horizontal edge as follows:
 - 1) the inside edges of the clear opening for
 - hinged or pivoted doors opening toward the furnace,
 - shutters or sliding doors installed on the exposed side of the supporting construction, or,
 - 2) the visible part of the edge of the door leaf for
 - hinged or pivoted doors opening away from the furnace,
 - shutters or sliding doors installed on the unexposed side of the supporting construction.

If, due to the narrow width of the leaf (leaves) or shutter(s), the thermocouples specified in b) and c) are closer than 500 mm to each other, then those specified in b) are omitted.

If the leaf is $< 200 \text{ mm}$ wide (e.g. as in a multi-leaf folding shutter), then the leaves are treated as if they were one leaf with respect to application of unexposed-face thermocouples for evaluating maximum temperature rise.

Examples of the reduction in the requirement for unexposed-face thermocouples with decreasing leaf width are given in Figure 21.

Additional thermocouples shall be fixed to other areas of the leaf or shutter, e.g. over any through connection or position where the temperature can be expected to be higher than the mean for the surface, subject to the limitations given in 9.2.4, 9.2.5 and 9.2.6. See Figures 14 to 20 and 22 to 27.

9.2.4 For the temperature of other areas, thermocouples for determination of the maximum temperature rise of side, transom and flush over panels and discrete panels of different thermal insulation within the door leaf shall be applied as for door leaves. However, if there is more than one other area of the same type, then they shall be treated as one large area (as those for the average temperature rise are). In such cases, thermocouples shall avoid any framework adjacent to the frame leaf; see Figures 26 and 27.

9.2.5 In addition, thermocouples shall be placed on flush over panels and transom panels above door leaves (but not discrete panels within the leaf) as follows:

- a) at mid-width, 100 mm in from the horizontal edge; and
- b) 100 mm in from the vertical edges, 100 mm in from the horizontal edges.

See Figures 23 and 24 for examples of the above. See Figure 22 for exclusion of the thermocouples on panels on the basis of size and distance between thermocouples.

9.2.6 The rules for reducing the number of thermocouples on door leaves of decreasing width shall also apply in transom panels, side panels and flush over panels.

9.3 Temperature of door frame

Thermocouples shall be fixed at each of the following positions:

- a) one at mid-height on each vertical member;
- b) one on the horizontal top member of the frame (and any transom > 30 mm wide, if fitted) at mid-width (100 mm away from the door joint of a multi-leaf door on the primary leaf side);
- c) one on the horizontal top member of the frame (and any transom > 30 mm wide, if fitted) 50 mm in from each corner of the leaf opening.

At each of the positions, thermocouples shall be fixed as close as possible, i.e. with the centre of the disc 15 mm from the junction between the frame and the supporting construction. Irrespective of this, the distance of these thermocouples from the inside edge of the frame shall not be greater than 100 mm. See Figure 16.

For single-leaf doors, if due to the narrow width of the opening, the thermocouples specified in b) and c) are closer than 550 mm to each other, then that specified in b) is omitted; see Figure 21.

9.4 Pressure measurements

9.4.1 The pressure in the furnace shall be measured by means of one of the designs of sensors shown in ISO 834-1:1999, Figure 4.

9.4.2 The pressure measuring equipment shall be capable of operating within a range of – 20 Pa to + 30 Pa with a tolerance of ± 2 Pa.

9.4.3 The pressure recording equipment shall be capable of recording data at 1-min intervals with a tolerance of ± 1 s.

9.4.4 The pressure sensors shall be located where they are not subjected to the direct impingement of convection currents from flames or in the path of exhaust gases. The pressure sensors shall be horizontal

both in the furnace and as they exit through the furnace wall, such that the pressure is relative to the same positional height from inside to the outside of the furnace. When T-shaped pressure sensors are used, the "T" branches shall be horizontally oriented. Any vertical section of tube to the measuring instrument shall be maintained at room temperature.

9.4.5 A minimum of three pressure sensors shall be used. One pressure sensor shall be located within 100 mm from the floor, one pressure sensor shall be located within 100 mm of two thirds the height of the door or shutter and one pressure sensor shall be located within 100 mm from the top of the door or shutter.

9.5 Heat-flux measurement

9.5.1 General

In 9.5 a method of measuring heat flux is described. The hazard presented by radiation is evaluated in the test by measuring total heat flux. However, as the convection heat transfer is negligible, the measurement is reported as heat flux in this International Standard. It considers the measurement of heat flux in a plane parallel to, and at a distance of 1,0 m from, the unexposed face of the test specimen. It includes the concept of both an average value, measured opposite the centre of the specimen, and the maximum value, which is equal to or greater than the average value if the specimen is not a uniform radiator.

Guidance is provided on the determination of the maximum value.

There is no requirement to measure the heat flux from a surface with a temperature below 300 °C because the radiation emitted from such a surface is low (typically 6 kW/m², even with an emissivity of 1,0).

9.5.2 Apparatus

Measurements of heat flux from the unexposed surface of specimens shall be made by an instrument complying with the following specifications:

- target: The target of the instrument shall not be shielded by a window or subject to a gas purge, i.e. it shall be subject to convection as well as radiation;
- suggested range: 0 kW/m² to 50 kW/m²;
- accuracy: ± 5 % of maximum in range;
- time constant (time to reach 64 % of target value): < 10 s;
- view angle: $180^\circ \pm 5^\circ$.

9.5.3 Procedure

9.5.3.1 General positioning

Each heat flux meter shall be positioned 1,0 m from the unexposed surface of the test specimen.

At the start of the test the target of each heat flux meter shall be parallel ($\pm 5^\circ$) to the plane of the unexposed surface of the test specimen. The target shall be pointing towards the unexposed surface of the test specimen.

There shall be no significant radiating surfaces other than the specimen within the field of view. The heat flux meter shall not be shielded or masked so that the field of view is restricted.

9.5.3.2 Specific locations

Measurements shall be taken at the following locations:

- a) opposite the geometric centre of the specimen; this is referred to as the average heat flux level;
- b) at the point at which the maximum heat flux can be expected. Often this follows logically or can be calculated from the geometry of the specimen. If the specimen is symmetrical about its centre and a uniform radiator this will coincide with the position described in 9.5.3.2 a).

If the specimen has areas of differing insulation and/or transmission, then it can be difficult to predict the point of maximum intensity with any degree of certainty. In these cases the following procedure shall be used.

- 1) Identify all areas where it is anticipated that the temperature will exceed 300 °C and that also have an area in excess of 0,1 m². Measure the heat flux opposite the notional centre of each area.
- 2) Two or more identical adjacent parts of the specimen having the same height or width, separated by less than 0,1 m, may be treated jointly together as a single radiation surface.
- 3) If the area, or sub-area, of the specimen that is expected to remain below 300 °C is less than 10 % of the total area or sub-area under consideration, then that area, or sub-area, may be treated as a single radiating surface. This allows for breaks, such as glazing bars.

9.5.4 Measurement

Measurements taken at each location described in 9.5.3.2 shall be recorded throughout the test at intervals not exceeding 1 min.

NOTE Annex B provides an alternative method of estimating the energy radiated from the specimen surface to the surrounding area based on the Stefan-Boltzmann radiation law.

9.6 Deflection

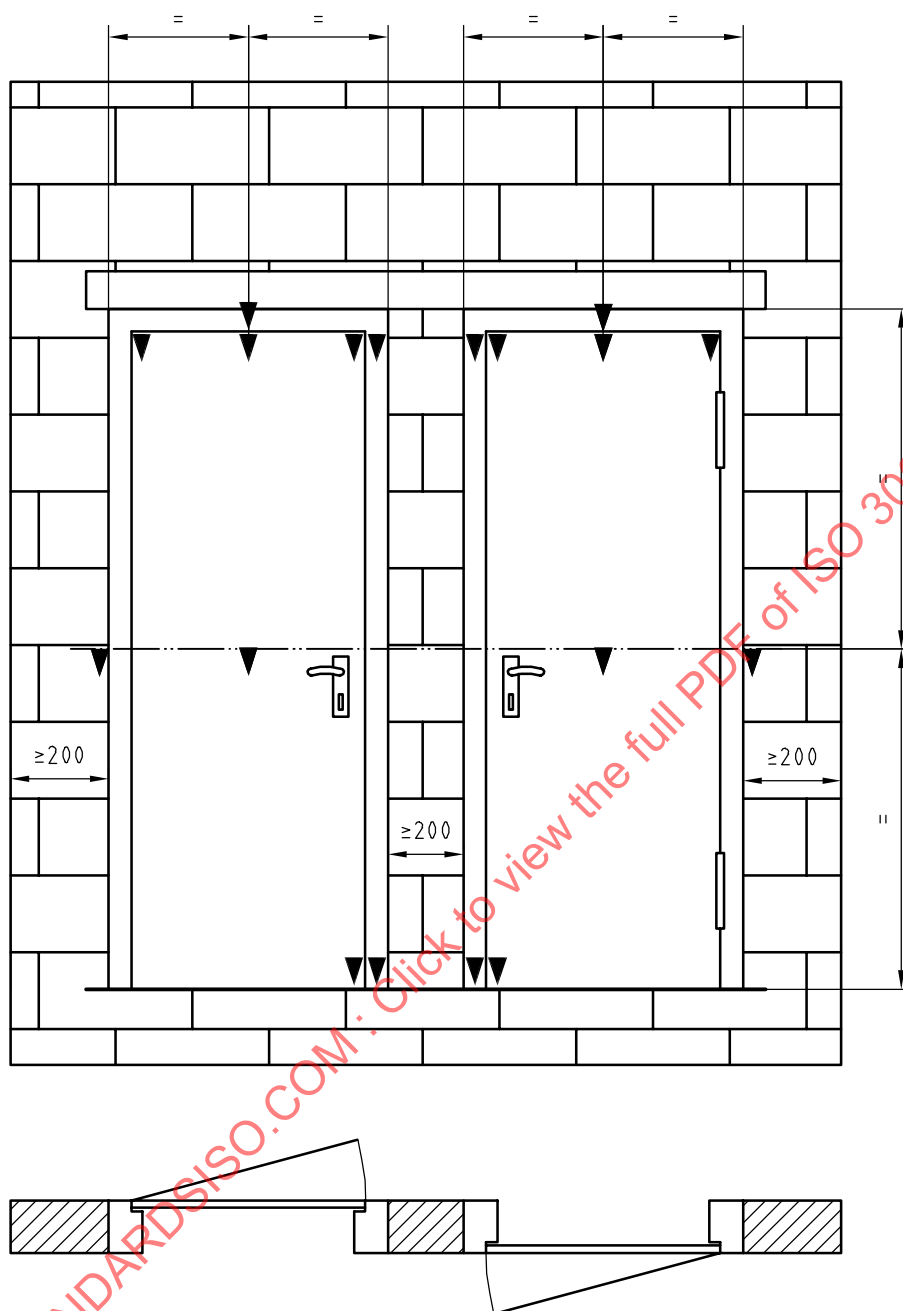
9.6.1 Deflection shall be measured with appropriate instrumentation to provide a history of all significant movements (i.e. greater than 3 mm) of the test construction during the test. Components where significant movement is likely to occur are

- a) door leaf or shutter relative to the frame,
- b) frame relative to the supporting construction, and
- c) supporting construction.

9.6.2 The principle of the measurement shall be by measurement against a fixed datum. The interval between measurements shall be chosen to present a history of deflection during the test. A suitable method for determining deflection of the test construction including proposals for selection of suitable intervals between measurements is given in ISO 3009.

Measurement of deflection is a mandatory requirement although there are no performance criteria associated with it. Information relating to the relative deflection between components of the test specimen, between the test specimen and the supporting construction and of the supporting construction itself can be important in determining the extended field of application of the test result. Figures 28 to 31 show suggested positions for measuring deflection.

Dimensions in millimetres

**Key**

- 1 suggested positions for measuring deformation

Figure 28 — Suggested positions for deformation measurements — Single-leaf door assemblies