INTERNATIONAL STANDARD

ISO 3008-2

Second edition
2017-05

Fire-resistance tests —

Part 2: Lift landing door assemblies

Essais de résistance au feu —

Partie 2: Assemblage de porte palière d'ascenseur

Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 92, *Fire safety*, SC 2, *Fire containment*, in collaboration with Technical Committee ISO/TC 178, *Lifts, escalators and moving walks*.

This second edition cancels and replaces the first edition (ISO 3008-2:2014), which has been technically revised.

A list of all the parts in the ISO 3008 series can be found on the ISO website.

Introduction

The need for certain lift landing door assemblies to act as a fire barrier against the transfer of a fire via the lift well has been identified. This document specifies a procedure for this purpose. The document follows the general principles of ISO 834-1 and, where appropriate, the principles of ISO 3008.

Lift landing doors are not included in the scope of ISO 3008.

NOTE Annexes E, F and G contain information on extrapolating the leakage rate for higher lift landing door assemblies, interpreting the leakage rate curve and marking information for the door frame assembly.

Fire-resistance tests —

Part 2:
Lift landing door 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 test elements or structures, their testing and disposal of test residues. An assessment of all potential hazards and risks to health shall be made by the laboratory 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 document specifies the method of test for determining the fire-resistance of lift landing door assemblies which can be exposed to a fire from the landing side. The procedure is applicable to all types of lift landing door assemblies used as a means of access to lifts in buildings and which are intended to provide a fire barrier to the spread of fire via the lift well.

The procedure allows for the measurement of integrity and, if required, the measurement of radiation and thermal insulation.

No requirements other than the verification that the specimen is operational are included for the mechanical conditioning before the test.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Fire-resistance tests — Elements of building construction — Part 1: General requirements*

ISO 834-4, *Fire-resistance tests — Elements of building construction — Part 4: Specific requirements for loadbearing vertical separating elements*

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

ISO 3008, *Fire-resistance tests — Door and shutter assemblies*

ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements*

ISO 9705, *Reaction to fire tests — Room corner test for wall and ceiling lining products*

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 3008, ISO 13943 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
associated supporting construction
specific construction in which the *door assembly* (3.4) 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
lift landing door
door designed to be installed in the lift well opening on a landing to provide access to the lift

3.3
door opening
width of the clear opening allowing free passage through the open lift landing door

3.4
door assembly
complete assembly, including any frame or guide, door leaf or leaves, which is provided for access to and from the lift and the landing and includes all panels, hardware, sealing materials and any operating components

3.5
standard supporting construction
form of construction used to close off the furnace and to support the *door assembly* (3.4) 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

3.6
leakage rate
total flow of hot gases passing through openings and gaps of the *door assembly* (3.4), due to overpressure on the landing side

4 Test equipment

4.1 The test equipment and vertical panel furnace referred to in this document shall be as specified in ISO 834-1.

4.2 The canopy shall be as specified in Annex A.

4.3 The equipment for measuring the leakage rate shall be as specified in Annex A.

4.4 The equipment for measuring heat flux shall be as specified in ISO 3008.

5 Test conditions

5.1 The furnace shall be controlled to follow the heating conditions of the standard test as defined in ISO 834-1.

5.2 The furnace shall be controlled to maintain a positive pressure on the exposed side over the entire height of the specimen such that the pressure at the sill level is in the range of 2 Pa ± 2 Pa.

6 Test specimen

6.1 Size of specimen

The specimen shall be full size or the maximum size that can be accommodated in the furnace. The typical size of the front opening of the furnace is 3 m × 3 m. In order to expose a required minimum width of 200 mm of supporting construction for a typical 3 m × 3 m furnace, the opening in the supporting construction is restricted to 2,6 m × 2,8 m (width × height).

6.2 Number of specimens

One specimen is required for the test.

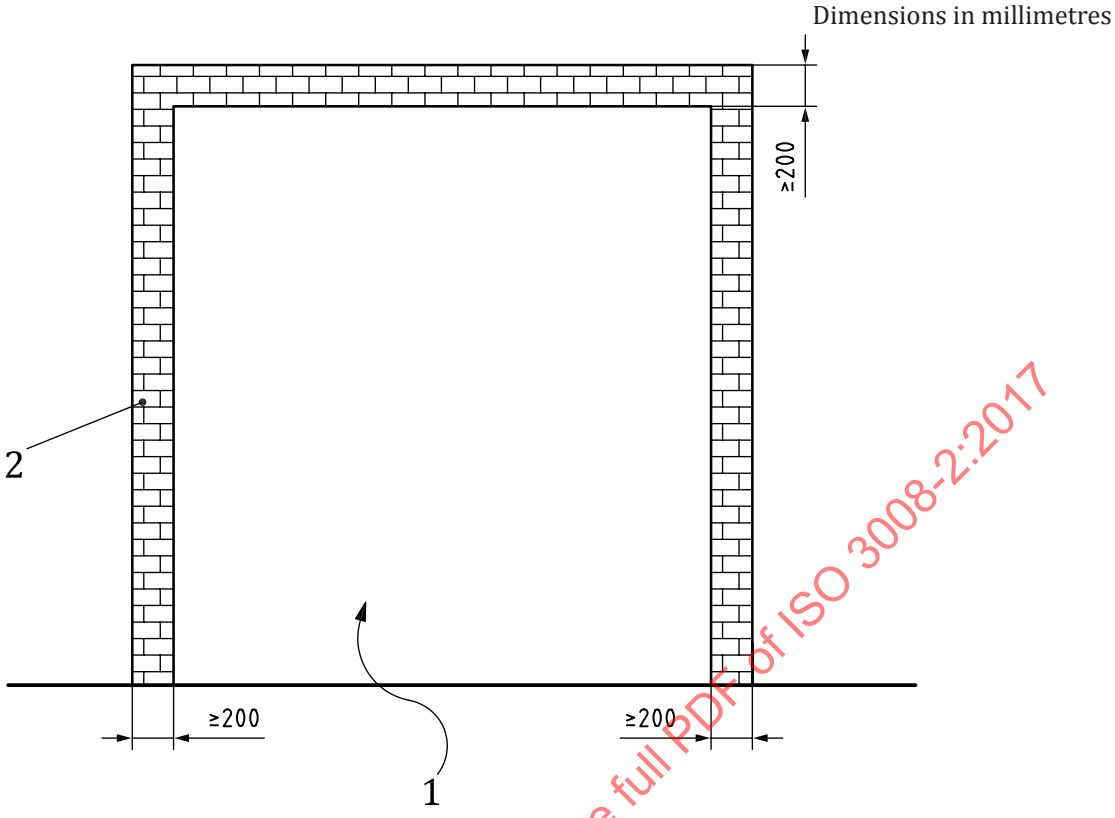
6.3 Supporting construction

6.3.1 A standard supporting construction shall be as described in Annex B.

6.3.2 An associated supporting construction shall be representative of the specific construction into which the test specimen is intended to be installed for use in practice.

6.4 Installation of specimen

6.4.1 The specimen shall be mounted in a supporting construction having a fire-resistance rating of equal or greater than the hourly rating of the assembly to be tested. The supporting construction shall be built first within the test frame leaving an aperture of the specified size. The width of the supporting construction on the two vertical sides and the top shall be not less than 200 mm. See Figure 1.



Key

1 test specimen

2 supporting construction

NOTE All dimensions are minimum.

Figure 1 — Specimen with supporting construction

6.4.2 The specimen shall be mounted in a supporting construction such that the lift landing side of the door faces the furnace.

6.4.3 The design of the connection between the door and the supporting construction, including any materials used to make the junction, shall be as used in practice with the type of the supporting construction.

6.4.5 The clearances shall correspond to the maximum that is permissible when the lift landing doors are put into service.

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 in agreement with the sponsor:

a) either the laboratory shall oversee the manufacture of the lift landing door assembly subjected to the test;

b) 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 in addition to the assembly 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 Conditioning

The test specimen as well as the supporting construction and any sealing materials used, shall be conditioned in accordance with the requirements of ISO 3008.

8 Clearances

The clearance between the moving components and the fixed parts of the door assembly shall be measured prior to the test as described in 11.1.

9 Functionality test

Prior to the test, the door shall be checked for functionality once by opening and closing to the maximum width possible by the supporting construction, with a minimum opening of width 150 mm.

10 Application of instrumentation

10.1 Temperature measurements

10.1.1 Furnace-temperature measurement 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. There shall be at least one plate thermometer for every 1,5 m^2 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.

10.1.2 Gas temperature measurement

One or more thermocouples shall be provided within a distance of 100 mm to the gas flow measuring system to measure the temperature of the exhaust gases drawn from the canopy. See ISO 5167-1.

10.1.3 Unexposed-face temperature measurement

10.1.3.1 General

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

10.1.3.1.2 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.

10.1.3.1.3 The average insulation performance of the door leaves and of each area of the door frame shall be determined.

10.1.3.2 Door leaf (leaves)

10.1.3.2.1 The maximum number of thermocouples placed on the leaves of the door assembly shall be twelve evenly distributed over all door leaves.

10.1.3.2.2 Position five thermocouples per door leaf, one as close as possible to the centre of the door leaf (leaves) and one as close as possible to the centre of each quarter section. These shall not be located closer than 100 mm to any joint, stiffener or through component, nor closer than 100 mm to the edge of the leaf (leaves).

10.1.3.2.3 When the door leaf (leaves) are of small size (i.e. less than 400 mm wide) such that the conventional five thermocouples cannot be fixed and/or the 100 mm minimum distance cannot be respected or the number of thermocouples is exceeding the maximum, then at least two thermocouples shall be evenly distributed on the centre and diagonals of the clear entrance surface of the door

10.1.3.2.4 When the total area of a single part of the door assembly is equal or smaller than 0,2 m^2, it shall be disregarded for the purpose of ascertaining the average unexposed face temperature.

10.1.3.3 Door frame

10.1.3.3.1 The door frame of lift landing doors can include the following parts: the horizontal top member which may include the door mechanism (on sliding and folding doors), two vertical members and an over (transom) panel. No thermocouples shall be placed on the horizontal top member including the door mechanism.

10.1.3.3.2 The side panels and over panels of more than 300 mm width or height shall be provided with one thermocouple for each square metre or part thereof, subject to a minimum of two thermocouples. These thermocouples shall not be located closer than 100 mm to any joint, stiffener or through component, nor closer than 100 mm to the edge of the side/over panel.

10.1.3.3.3 When the height of the over panels or width of the side panels are less than or equal to 300 mm, no thermocouples are required for determining the average temperature rise.

10.1.4 Position of the thermocouples to determine the maximum temperature

10.1.4.1 Door leaf (leaves)

The maximum temperature shall be determined from the thermocouples fixed to determine the average temperature rise.

10.1.4.2 Door frame

10.1.4.2.1 The maximum temperature shall be determined from the thermocouples fixed to determine the average temperature rise.

10.1.4.2.2 For vertical members with a width equal to or less than 300 mm and greater than 100 mm and for horizontal members with a height equal to or less than 300 mm and greater than 100 mm, only one thermocouple shall be fixed to the width or height of the respective member.

10.1.4.2.3 For vertical or horizontal members with width or height equal to or less than 100 mm, no temperature measurements are required.

10.2 Pressure measurements

10.2.1 Furnace pressure measurement

The furnace pressure shall be measured as required in ISO 3008.

10.2.2 Gas flow pressure measurement

Provision shall be made at the gas flow measuring system to record the pressure differential of the measuring device and the absolute pressure in relation to ambient conditions. The range of the instrument shall be compatible with the flow rate generated by the suction fan. See ISO 5167-1.

10.3 Gas flow measurement

The gas flow measuring system shall be in compliance with ISO 5167-1. See Figures A.1 and A.2 for specific requirements. The accuracy of the determination of the leakage rate shall be within 10%.

10.4 CO_2 concentration

10.4.1 Furnace

The instrument shall have a range of 0 % to 20 % CO_2 concentration and the calibration shall be established prior to the test by using a sample of known concentration. The accuracy of measurement for CO_2, i.e. the instruments and the measurement system, shall be within ±0,2 % CO_2.

10.4.2 Gas flow

The instrument shall have a range of 0 % to 2,5 % and the accuracy of measurement shall be within 0,05 % CO_2. The instrument shall be checked prior to the test by using a sample of known concentration of CO_2 in the range of 1 % to 2,5 %.

10.5 Heat-flux measurement

When required, the heat flux from the unexposed face of the lift landing door shall be measured as described in ISO 3008.

10.6 Deflection

The deflection of the lift landing door assembly shall be measured as described in ISO 3008.

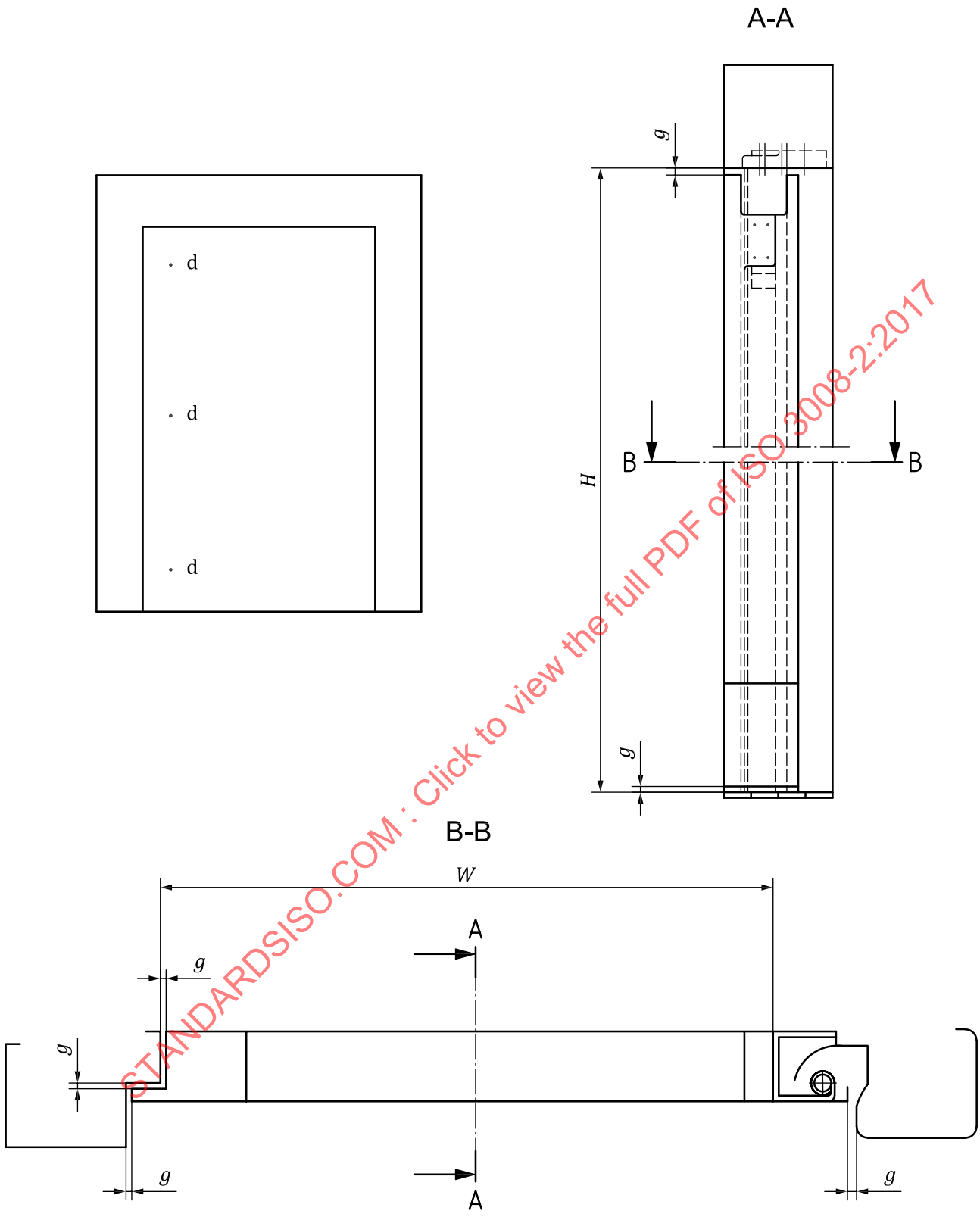
11 Test procedure

11.1 Gap measurements

The clearance between moving components and fixed components of the door assembly (e.g. between door leaf/leaves and the frame) shall be measured prior to test. Sufficient measurements shall be made to adequately quantify the gaps. There shall be a minimum of three measurements made along each side, top and bottom of each leaf of the door. Measurements to determine the gaps shall be made at distances not greater than 750 mm apart and shall be given to an uncertainty not exceeding ±0,5 mm.

Figures 2, 3, 4 and 5 provide guidance for gap measurement locations. These figures do not indicate any features or constructional requirements for lift landing doors.

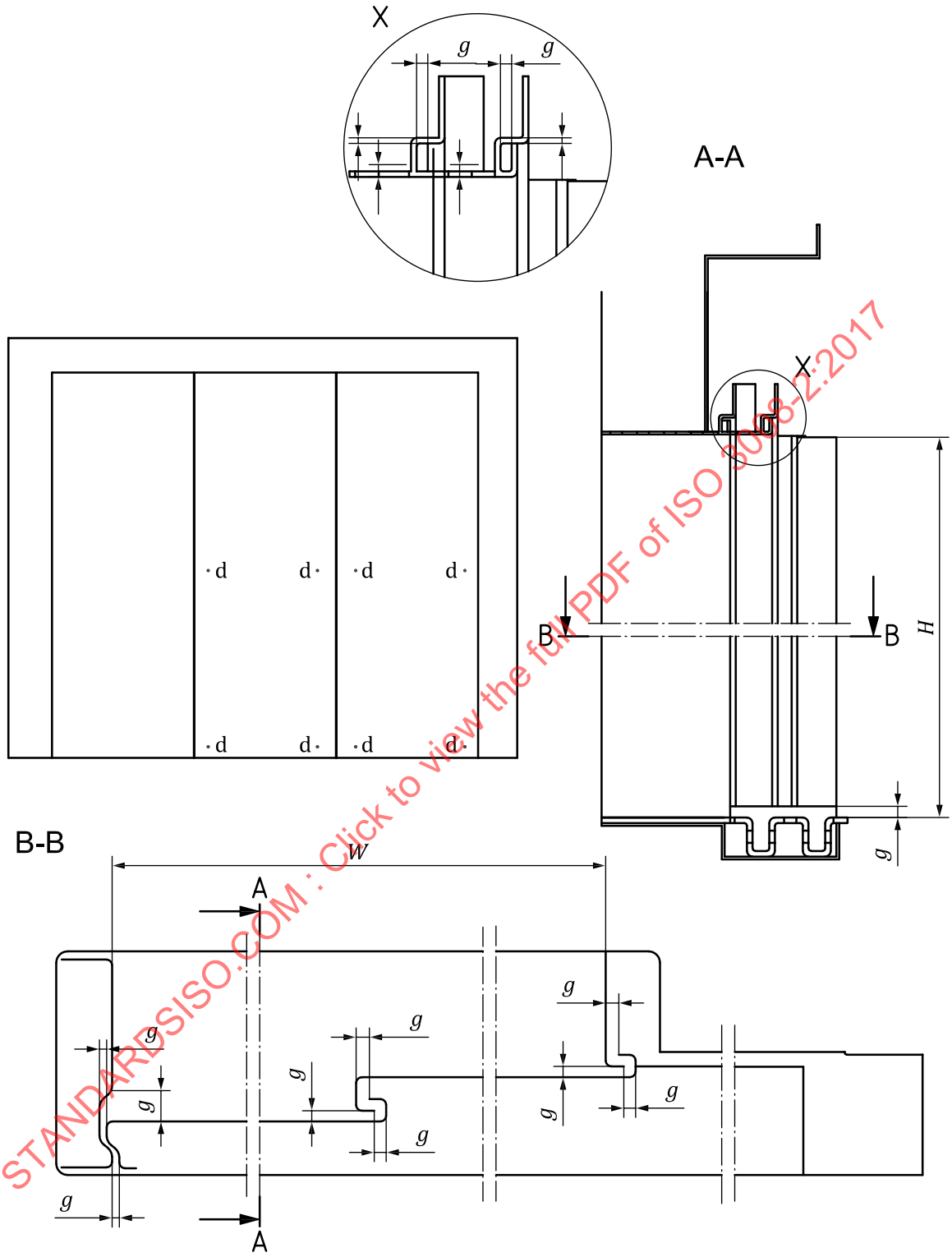
The depth of penetration of any door safety guide, where provided, shall be measured and recorded.



Key

g	gap measurement location	*H*	clear height
d	deformation measurement location	*W*	clear width

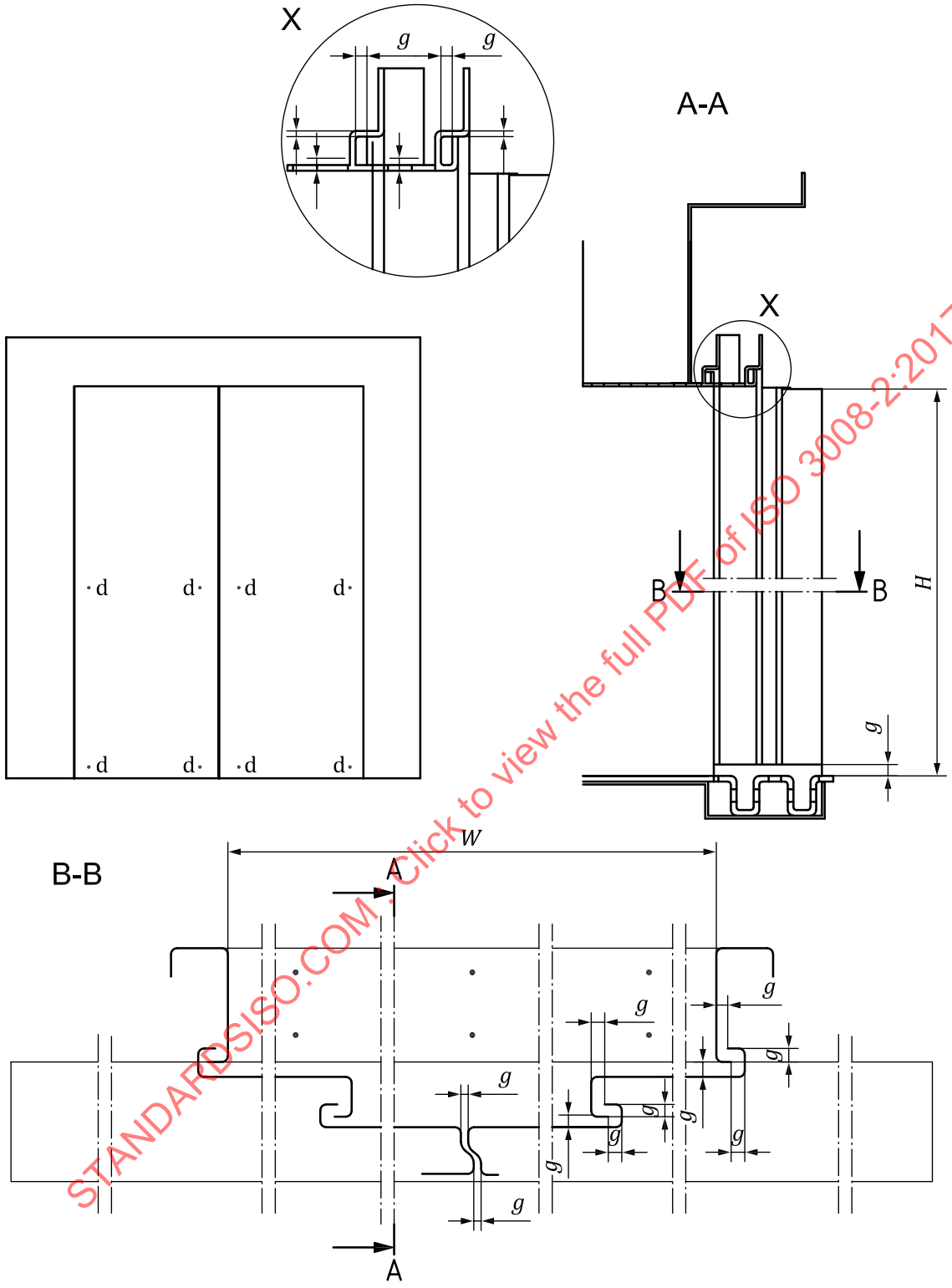
Figure 2 — Clearance gaps and deformation measurements — Single panel swing door



Key

g	gap measurement location	*H*	clear height
d	deformation measurement location	*W*	clear width

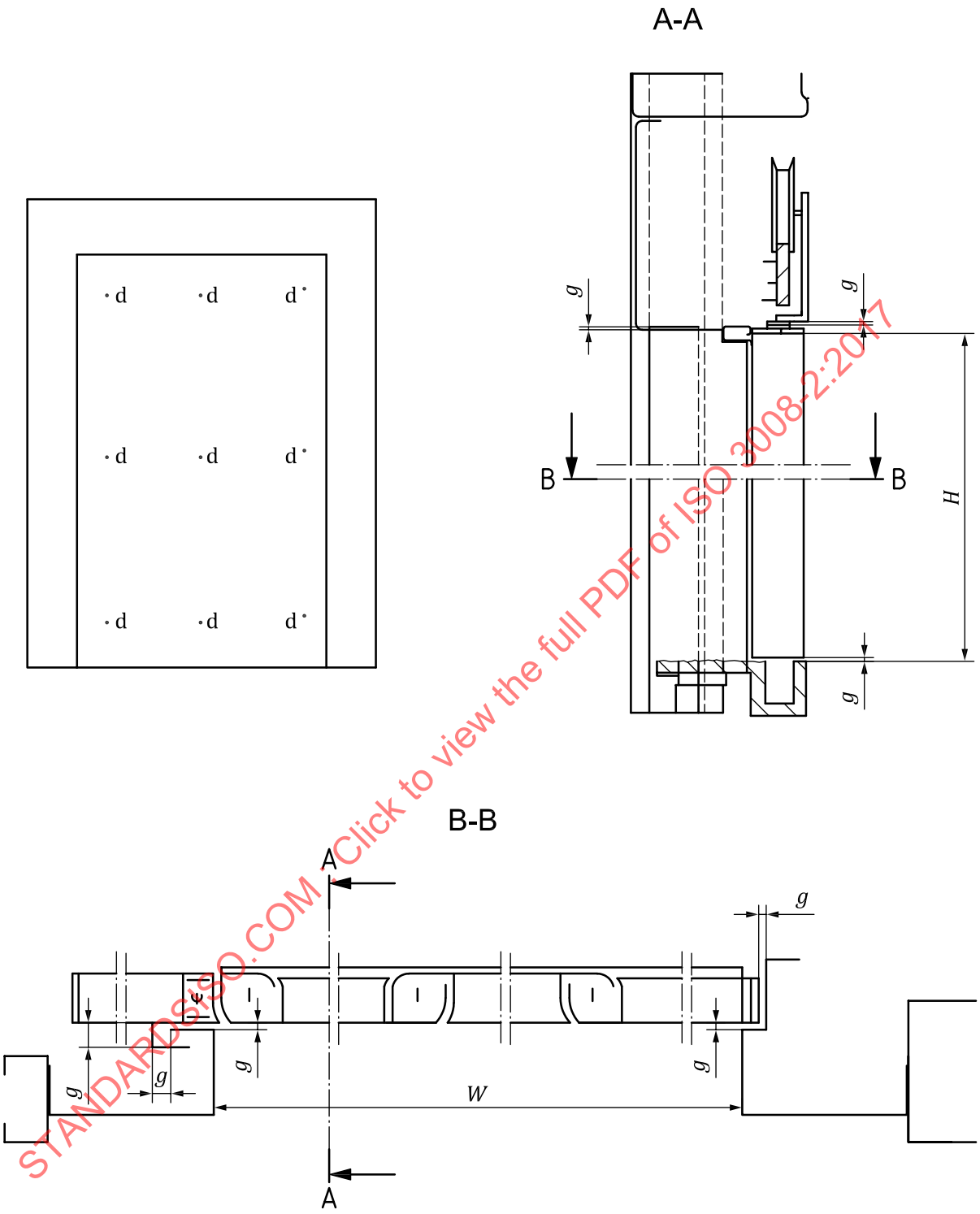
Figure 3 — Clearance gaps and deformation measurements — Double leaf telescopic door



Key

g	gap measurement location	*H*	clear height
d	deformation measurement location	*W*	clear width

Figure 4 — Clearance gaps and deformation measurements — Central opening door



Key

g	gap measurement location	*H*	clear height
d	deformation measurement location	*W*	clear width

Figure 5 — Clearance gaps and deformation measurements — Multi-sliding door

11.2 Functionality test

The door shall be checked for functionality by opening and closing to the maximum possible width, with a minimum opening of width 150 mm.

11.3 Flow measurement verification

The reliability and the adequacy of the leakage rate measurement system shall be established prior to the start of the furnace test according to Annex C using the calibration burner to generate CO_2 as shown in Figure C.1.

Provision should be made during the verification test to protect the lift landing doors against heating.

11.4 Fire test

The fire test shall be conducted in compliance with ISO 3008 with the following modifications.

11.4.1 The pressure in the furnace shall be such that a positive pressure is maintained over the whole height of the specimen with the pressure at the sill level at a range of 2 Pa ± 2 Pa.

11.4.2 The air flow from the canopy and the CO_2 shall be recorded at least once every 10 s.

12 Performance criteria

12.1 Integrity (E)

Integrity requirements shall be satisfied as long as none of the following occur:

— Sustained flaming on the unexposed face in excess of 10 s duration. This criterion shall be applied during the entire test period.

— After the first 14 min of the fire test, the leakage rate per metre width of the door opening exceeding 3 $m^3/(min - m)$.

12.2 Insulation (I)

When insulation requirements apply the insulation criterion l is no longer satisfied when:

— the average temperature rise exceeds 140 °C;

— the maximum temperature rise on the door leaf, over panel and side panel with a width ≥300 mm exceeds 180 °C;

— the maximum temperature rise on vertical members and/or over panels have a width (vertical members) or height (over panels) of between 100 mm and 300 mm exceeds 360 °C.

12.3 Radiation (W)

When radiation requirements apply, the radiation criterion is satisfied until the measured radiation exceeds the value of 15 kW/m^2.

13 Termination of test

The test can be terminated for any of the following reasons:

a) safety of personnel or pending damage to equipment;

b) attainment of selected criteria;

c) request of the sponsor.

The test may be continued after b) with the agreement of the sponsor to obtain additional data.

14 Test report

In addition to the items required by ISO 834-1, the following shall also be included in the report:

a) a reference that the test was carried out in accordance with this document, i.e. ISO 3008-2;

b) details of how the construction of the test specimen was verified;

c) the leakage rate though the door during the fire test;

d) the time and duration of occurrences of flaming along with its location;

e) the temperature measurements on the unexposed face of the door as a function of time when measured;

f) the radiation emission, when measured, as a function of time;

g) the deflection of the door as a function of time;

h) the pressure in the furnace at the sill level of the door as a function of time.

15 Field of direct application of test results

Test results in terms of integrity and insulation are considered to be applicable to doors of sizes different from those of the test specimens, all other constructional details being the same, within the following limitations:

a) without correction to be applied on the measured leakage rate;

   1) a similar lift landing door assembly of lower height than the tested specimen;

   2) a similar lift landing door assembly with a door opening or an opening width in the wall equal to the one tested within a range of ±30 %.

b) after correcting the measured leakage rate as a function of the increase in height, as specified in Annex D;

   1) a similar door with increased height of up to 15 %.

The allowance given in a) and b) can be applied together.

If tested in a standard supporting construction, the results are valid for all constructions with a density equal to or greater than 600 kg/m^3 and thickness equal to or greater than 100 mm.

The results of doors tested with an associated supporting construction are restricted to that specific associated supporting construction.

16 Classification procedure and declaration of performance

16.1 Classification periods

For the purpose of classification, the results in minutes, as specified in Clause 12, shall be rounded down to the nearest classification period: 15 min, 20 min, 30 min, 45 min, 60 min, 90 min or 120 min.

16.2 Declaration of performance

16.2.1 The classes shall be expressed as follows:

E tt: tt being the classification period during which the criterion integrity is satisfied;

EI tt: tt being the classification period during which the criteria for integrity and insulation are satisfied;

EW tt: tt being the classification period during which the criteria for integrity and radiation are satisfied.

16.2.2 When criteria are combined, the time declared shall be that of the criterion having the shortest time. So a lift landing door assembly with E = 47 min, W = 25 min and I = 18 min, shall be classified as E 45 and/or EW 20 and/or EI 15.

16.3 Classification periods

Only classification periods specified in Table 1 shall be used.

Table 1 — Classes

Performance	Classification periods						
E	15	20	30	45	60	90	120
EI	15	20	30	45	60	90	120
EW	NA	20	30	NA	60	NA	NA
NOTE NA identifies classification periods that are not available.							

Annex A
(normative)

Description of the canopy and measuring system

A.1 Canopy

A.1.1 The canopy shall take the form of a sheet metal box, open at the bottom and fixed on the unexposed side of the furnace to provide a collector for the escape gases emitted from the door under test. Glass fibre curtains shall be located at the front and the side to minimize mixing of the gases with the surrounding air.

NOTE A 3 000 mm wide canopy is found to be adequate for door sizes up to 2 600 mm wide.

A.1.2 Adjustable glass fibre fabric screens shall be attached to the front and two sides of the canopy. The depth of the screens shall be adjusted such that the front screen drops 1 500 mm below the front lower edge of the canopy and the side screens shall be down to the sill level of the door under test. Small weights shall be located at the lower edge of the screen to prevent its flapping during a test.

A.1.3 The canopy shall be positioned so that the underside of the baffle is 300 mm above the top edge of the door including any fixing. The door shall be located in its frame to be central in relation to the canopy width.

A.2 Measuring system

A.2.1 A fan shall be provided to extract the gases collecting near the top of the canopy. A monitoring system utilizing an orifice plate or other equivalent system shall provide a means for measuring the flow rate of gases, their temperature and the CO_2 concentration. The leakage rate from the door shall be calculated by comparison with the CO_2 concentration of the furnace atmosphere.

NOTE For normal two leaf door, a fan of 2 500 m^3/h capacity is found to be adequate.

A.2.2 The general arrangement of the system shall conform to Figure A.1 and canopy details shall conform to Figure A.2. The canopy shall be fabricated from sheet metal, 1,0 mm to 1,5 mm in thickness, with suitable facilities for attaching it to the face of the furnace or the supporting construction such that the junction is gas tight. Inside the canopy, at a distance of 150 mm below the top, a (15 ± 5) mm thick calcium silicate sheet shall be attached to act as a baffle. There shall be a clearance of 50 mm on three sides between the baffle and the canopy shell for the flow of the gases. At the top of the canopy, in a central position, an outlet for a metal duct, at least 200 mm in diameter, shall be provided to connect to a suitable exhaust fan.

A.2.3 The extract ducting shall be provided with a device for measuring mass gas flow, of a design complying with the specifications in ISO 5167-1, to measure the velocity of gases passing through the duct. Instrumentation shall be provided to make the following measurements:

— In the furnace:

  — CO_2 concentration up to 10% concentration.

— At the gas flow measuring point:

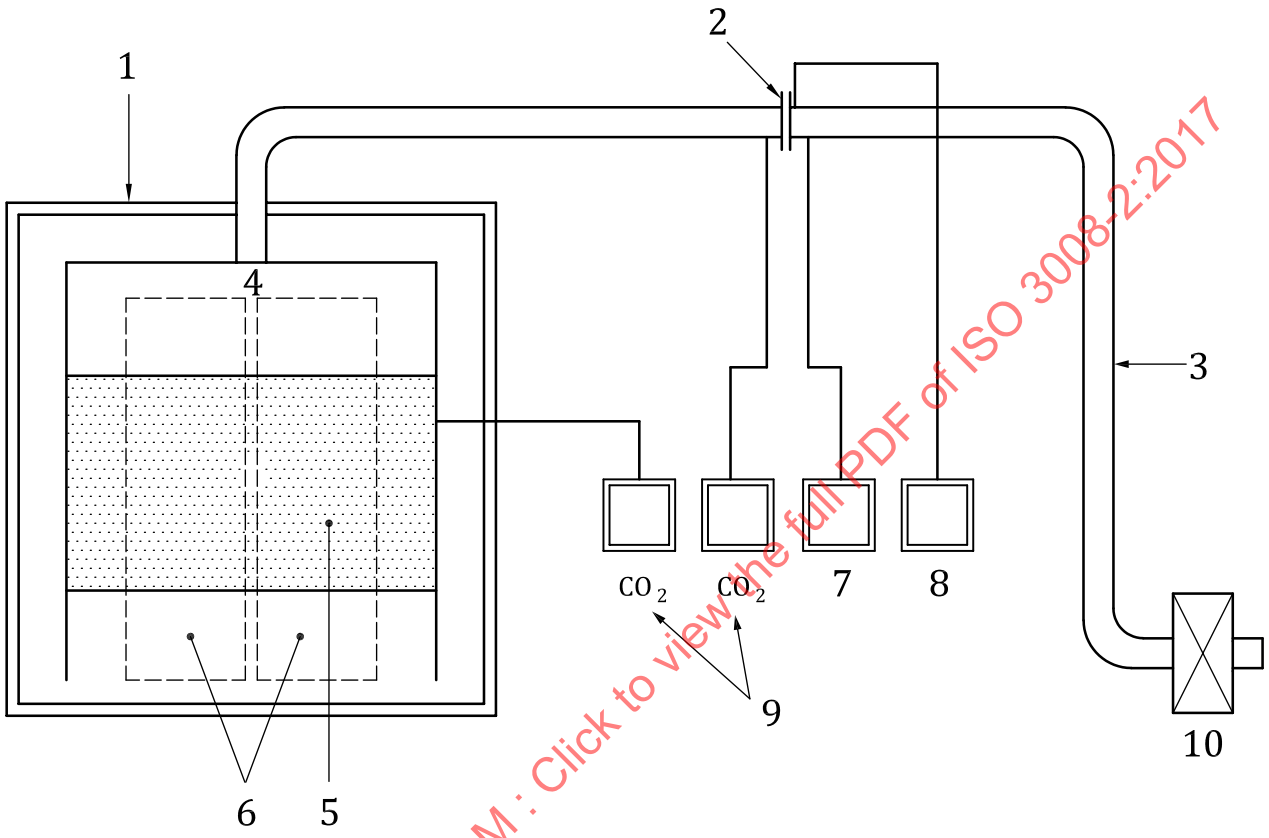
  — CO_2 concentration up to 1% concentration;

— the gas temperature;

— the gas pressure;

— the pressure difference over the flow measuring device.

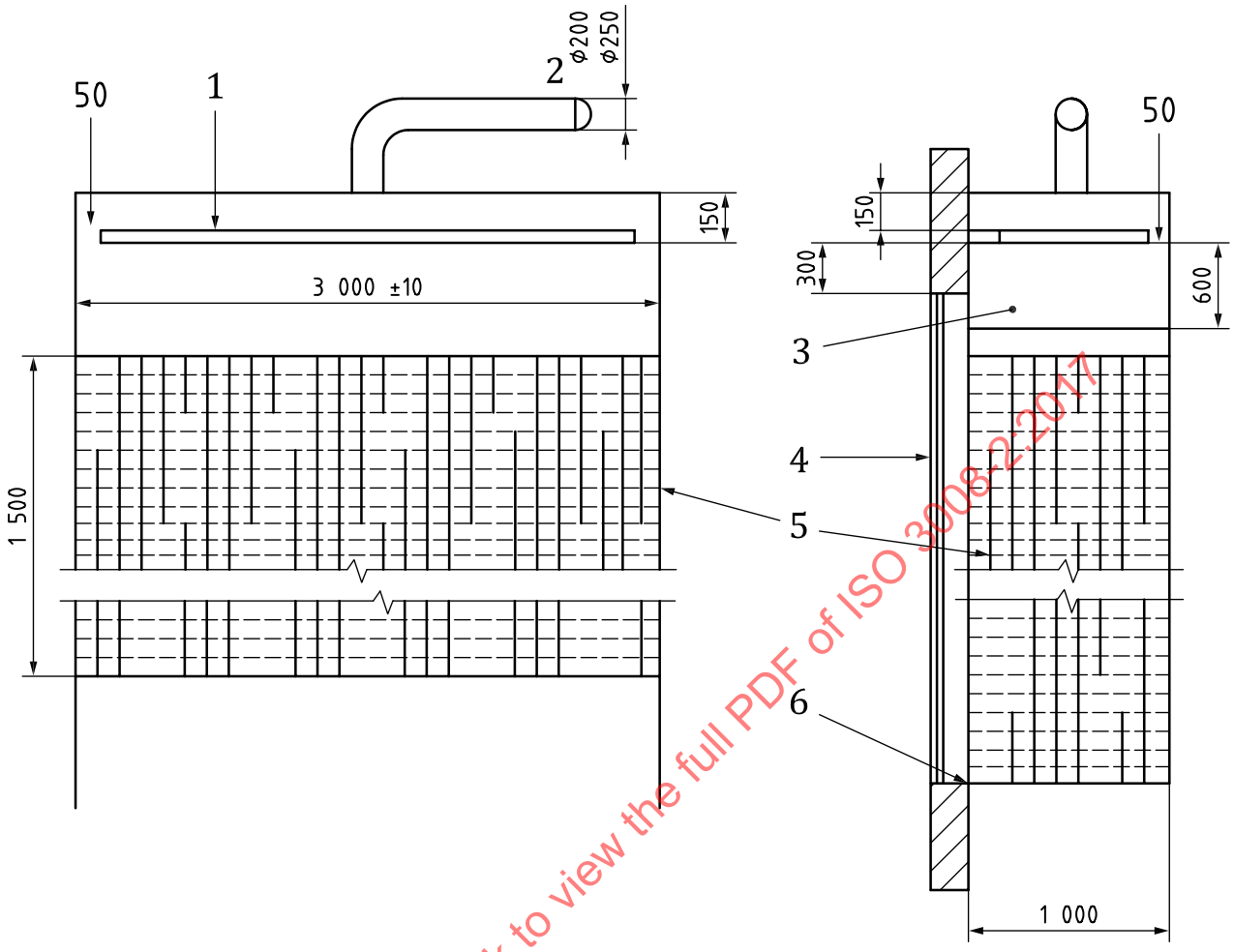
A.2.4 The total length of the duct shall not be excessive and it shall have a long straight portion each side of the gas flow measuring device as specified in ISO 5167-1.



Key

1	furnace	6	test door
2	orifice plate	7	pressure
3	exhaust pipe	8	temperature
4	canopy	9	instrumentation
5	curtain	10	fan

Figure A.1 — General arrangement



Key

1	baffle	4	door
2	exhaust pipe	5	curtain
3	canopy	6	sill level

Figure A.2 — Canopy details

Annex B
(normative)

Standard supporting construction

The supporting construction shall be representative of the intended field of application.

For applications representing blockwork, masonry or homogenous concrete, the supporting construction shall be a wall with an overall density of (1 200 ± 400) kg/m^3 and a thickness of (200 ± 50) mm.

For applications representing installation into a gypsum board construction, the supporting construction shall be a fire-resistant gypsum wall or partition having a fire-resistance rating equal to or greater than the desired rating for the door assembly being tested when the supporting construction is tested per ISO 834-4 or ISO 834-8. Depth of the partition framing to be specified by the test sponsor.

Annex C
(normative)

Verification procedure for leakage rate measurement

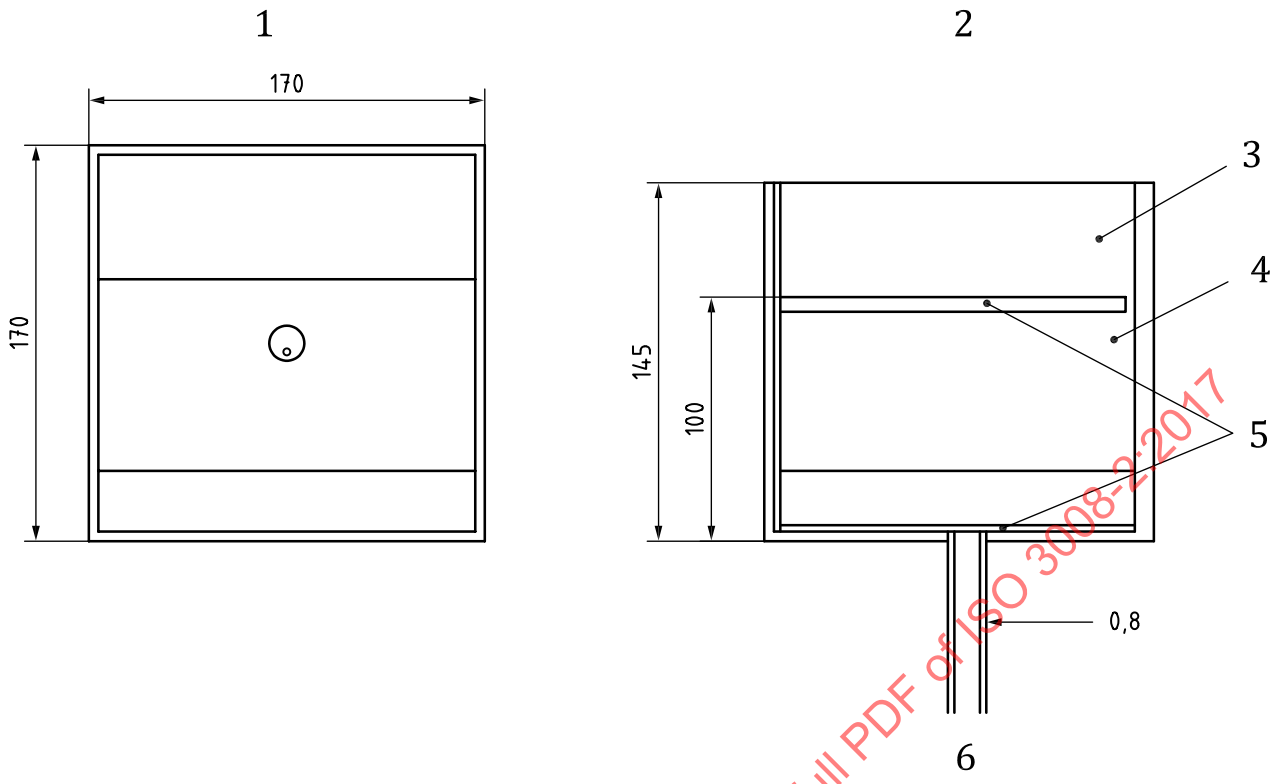
Before the fire test on a lift landing door, the operation and the accuracy of the measuring system shall be verified by a 10 min preheat period followed by a 5 min measurement period.

A burner, an example of which is shown in Figure C.1, shall be placed below the canopy near mid-height of the lift landing door. The burner shall conform to ISO 9705 with a heat output of up to 300 kW.

The burner shall be supplied with propane gas at the normalized rate of 1,36 l/s to produce CO_2 at the rate of 0,25 m^3/min (i.e. 15 m^3/h = 0,004 16 m^3/s). Using the relationship in Formula (D.2), the flow rate and CO_2 concentration shall be established. The flow rate of CO_2 production shall be controlled with a mass flow controller or by measuring weight loss.

Action shall be taken to reduce any difference between the theoretical and measured flow rate and CO_2 concentration of more than 10 % (i.e. $q_{CO_2\ measured}$ < 13,5 m^3/h or >16,5 m^3/h). When the difference is lower than 10 % (i.e. 13,5 m^3/h ≤ $q_{CO_2\ measured}$ ≤ 16,5 m^3/h), the leakage rate of the test shall be corrected for this difference.

The test specimen shall be protected from the burner during this verification procedure.



Key

1	plan view	4	gravel
2	sectional evaluation	5	brass wire gauze
3	sand	6	gas supply

Figure C.1 — Example of a standard calibration burner

Annex D
(normative)

Calculation of leakage rate

D.1 Initial calculation of leakage rate

D.1.1 During the course of a test the following measurements shall be made to establish the leakage rate through the specimen door:

— CO_2 concentration in the furnace, C_{furn} (%);

— CO_2 concentration in the duct at the orifice plate, C_{orif} (%);

— pressure at top of door in the furnace, p_{furn} (Pa);

— pressure differential across the orifice plate, Δp (Pa);

— under pressure at orifice plate, p_{orif} (Pa);

— ambient pressure in the laboratory, p_{amb} (Pa);

— temperature of gases at the orifice, T_{orif} (°C);

— sectional area of the exhaust duct A (m^2).

D.1.2 The gas flow at the orifice shall be established from the orifice plate characteristics on the basis of the information supplied by the orifice plate manufacturer. This provides a constant, k, for the orifice plate assembly from which the flow rate q_{vo} is established as follows:

$$q_{vo} = k \cdot A \sqrt{\frac{2 \cdot \Delta P}{\rho_0} \cdot \frac{T_0 + 273{,}15}{T_{orif} + 273{,}15} \cdot \frac{P_{amb} - P_{orif}}{P_0}} \ m^3 / s \qquad (D.1)$$

where

T_0, p_0 and ρ_0 are reference temperature, pressure and density conditions.

If reference conditions of 20 °C, 1,204 5 kg/m^3 and 101 325 Pa are chosen, Formula (D.1) becomes Formula (D.2):

$$q_{vo} = k \cdot A \sqrt{\frac{2 \cdot \Delta P}{1{,}204\ 5} \cdot \frac{293{,}15}{T_{orif} + 273{,}15} \cdot \frac{P_{amb} - P_{orif}}{101\ 325}} \ m^3 / s \qquad (D.2)$$