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Fire resistance tests — Fire dampers for air distribution systems —

Part 2: Intumescent dampers

Essais de résistance au feu — Clapets résistant au feu pour des systèmes de distribution d'air —

Partie 2: Clapets intumescents

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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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 92, *Fire Safety*, Subcommittee SC 2, *Fire containment*.

A list of all parts in the ISO 21925 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Fire resistance tests — Fire dampers for air distribution systems —

Part 2: Intumescent dampers

WARNING — For suitable health precautions to be taken, attention is drawn to the possibility that toxic or harmful gases can be released while the test is being conducted.

1 Scope

This document specifies a test method for the determination of the resistance of fire dampers to heat, and for the evaluation of their ability to prevent fire and smoke from spreading from one fire compartment to another through an air distribution system.

This document describes the test requirements related to intumescent fire dampers. It is intended for intumescent fire dampers that are expected to be classified as EI dampers. Without the addition of a mechanical damper, they are unable to achieve the "S" classification, which includes a leakage limit imposed at ambient temperature.

This document is not intended to be used for dampers used only in smoke control systems, for testing fire protection devices which only deal with air transfer applications, or for dampers used in suspended ceilings, as the installation of the damper and duct can have an adverse effect on the performance of the suspended ceiling, requiring other methods of evaluation.

NOTE "Air transfer" is a low-pressure application through a fire separation door (or wall, floor) without any connection to an air duct.

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 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*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
test construction
complete test assembly, consisting of the *separating element* (3.3), damper and duct sections and penetration seals (if any)

3.2
supporting construction
wall, partition or floor into which the damper and duct section are installed for the test

3.3
separating element
wall, partition or floor into which the damper and duct are installed in the building

3.4
connecting duct
duct section between the damper or *separating element* (3.3) and the *measuring station* (3.5)

3.5
measuring station
equipment consisting of pipe system with an orifice plate or venturi and an air flow straightener (if required), installed between the *connecting duct* (3.4) and the *exhaust equipment* (3.6) to determine the volume flow rate of gases passing through the damper under test

3.6
exhaust equipment
equipment consisting of a fan and balancing or dilution dampers to apply and maintain the underpressure in the *connecting duct* (3.4)

3.7
fire damper
mobile closure within a duct which is operated automatically or manually and is designed to prevent the spread of fire

3.8
intumescent
term describing the phenomenon of expansion in excess of normal thermal expansion under the action of heat normally generated by the fire

3.9
intumescent dampers
non-mechanical device installed in a ducted system that intumesces when exposed to hot gases to prevent the spread of fire

3.10
intumescent sheet
intumescent (3.8) material manufactured in rigid or flexible thin sections, typically 1 mm to 4 mm thick, usually cut into strips for incorporation into the *fire damper* (3.7)

3.11
covered intumescent
partly enclosed *intumescent* (3.8) material to provide protection, modify the behaviour, improve the surface finish and/or enhance the aesthetics of the *fire damper* (3.7)

3.12
skinned intumescent material
totally enclosed *intumescent* (3.8) material on all faces and edges to provide protection, modify the behaviour and improve the surface finish and/or the aesthetics of the *fire damper* (3.7)

4 Principles of the test

4.1 General

The damper with its fixing device is built into, or attached directly or remotely via a section of ducting, to a fire-separating building element according to good practice. Temperature and integrity measurements are carried out in various parts of the test construction during the test. The tightness of

the damper system is measured by direct flow measurements whilst maintaining a constant pressure differential across the closed damper of 300 Pa. For special applications, higher underpressures may be employed.

4.2 Additional tests

Additional tests are included to provide an assessment on the operational reliability of the intumescent dampers. See Annex C for information on reaction to fire tests. The conditions specified in Annex A apply.

Annex D provides general information on the use and application of intumescent dampers.

5 Apparatus

5.1 General

The test apparatus specified in 5.2 to 5.11, including the instrumentation, shall be in accordance with ISO 834-1 except where specifically stated otherwise. Intumescent dampers give off some moisture. A suitable condensing device shall therefore be installed before the flow-measuring device. This will be deemed to be effective if the gas temperature within the flow-measuring device does not exceed 40 °C at any time during the test. An example of a suitable condensing device is a water tank fed with water at ambient temperature with approximately 9 m of measuring duct immersed in the tank prior to reaching the measuring device.

An example of a test arrangement is shown in Figure 1.

5.2 Furnace, capable of achieving the heating and pressure conditions specified in ISO 834-1.

5.3 Damper under test, attached to the connecting duct in accordance with the manufacturer's instructions.

5.4 Connecting duct, of all welded construction fabricated from (1,5 ± 0,1) mm thick steel with a width and height appropriate to the size of the damper under test. The duct shall have a length of twice the diagonal dimension of the damper, up to a maximum of 2 m. The connecting duct shall be provided with a gas-tight observation port.

5.5 Measuring station, consisting of an orifice plate, venturi, or other suitable device, an air flow straightener (if required) and straight lengths of pipe sized in accordance with ISO 5167-1 installed between the connecting duct and the exhaust fan to determine the volume flow rate of gases passing through the damper under test. When testing dampers installed in floors, it is still possible to use the measuring station horizontally. A suitable mounting detail is shown in Figure 2.

5.6 Exhaust fan system, capable of controlling flow rates and maintaining a pressure difference between the connecting duct and the furnace, as required, when the damper is closed.

Regardless of what test pressure is chosen, the fan should be capable of achieving a 200 Pa pressure difference higher than the test pressure difference chosen for the test.

Regulation of the 300 Pa (or higher pressure differential) may be by means of a dilution damper installed just before the fan inlet. The pressure shall be controlled to within ±5 % of the required pressure. A balancing damper shall be fitted at the outlet of the fan to adjust the pressure range of the systems to suit the damper under test. A variable speed fan may be used instead of the dilution damper.

5.7 Instrumentation for measuring and recording the furnace temperature, in accordance with ISO 834-1. Locations of the furnace thermocouples for a number of different test arrangements are shown in Figures 3, 4, 5, 6, 7 and 8.

The gas temperature adjacent to the flow measuring device shall be measured by a 0,25 mm bare wire thermocouple enclosed in a 6 mm diameter porcelain twin wall tube with its measuring junction located at the centreline of the measuring duct and at a distance equal to twice the diameter of the measuring duct downstream from the flow measuring device. A similar thermocouple shall be located at the exit from the connecting duct plenum (see Figures 1 and 2). Alternative thermocouples may be used provided it can be shown that they have equivalent response time.

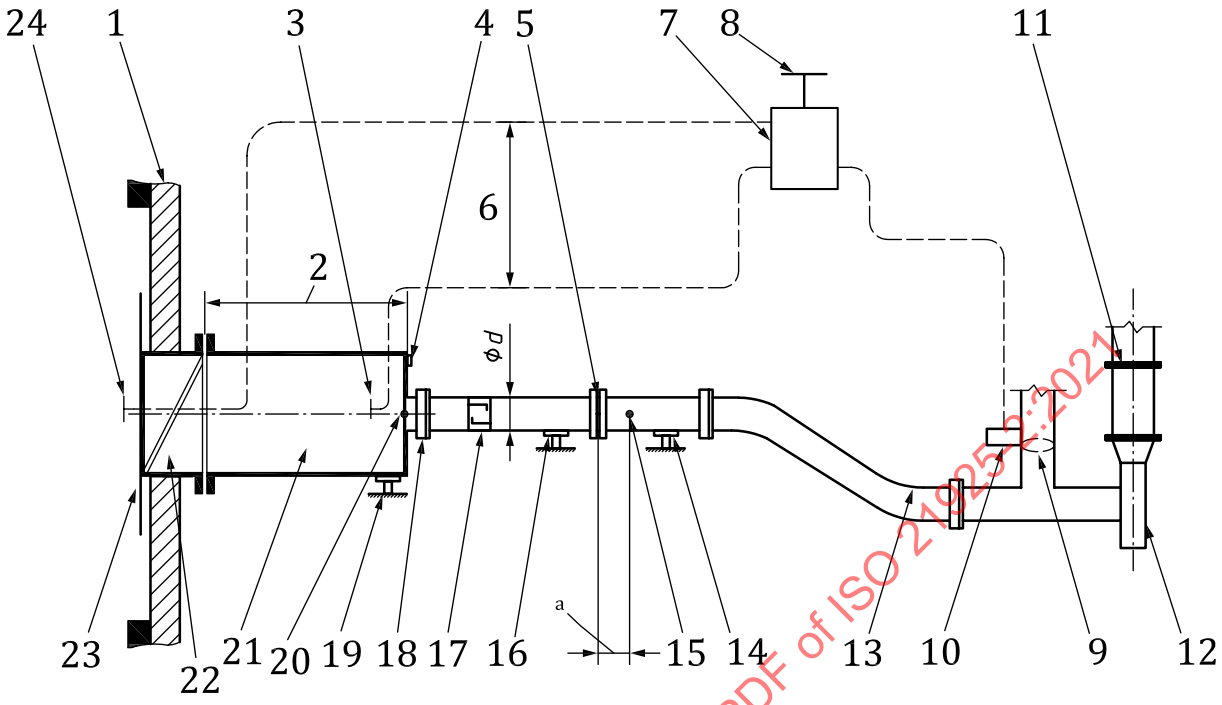
5.8 Instrumentation for measuring and recording surface temperature, in accordance with ISO 834-1. This shall be located in the positions shown in Figures 3, 4, 5, 6, 7 or 8, depending on the method of mounting the damper selected.

5.9 Instrumentation for measuring pressure differential between the furnace and the connecting duct. A pressure tapping shall be located on the centreline of one vertical side wall of the connecting duct. Instrumentation shall have a 300 Pa measurement capacity higher than the test pressure chosen for the test. Instrumentation shall also be provided for measuring the pressure difference between inside and outside (ambient) of the furnace.

5.10 Timing device, capable of running throughout the test period.

5.11 Gap gauges and cotton pad, according to ISO 834-1, to judge the integrity of the joints between the damper and its connecting duct and the damper assembly and the supporting construction of the test arrangement.

Dimensions in millimetres



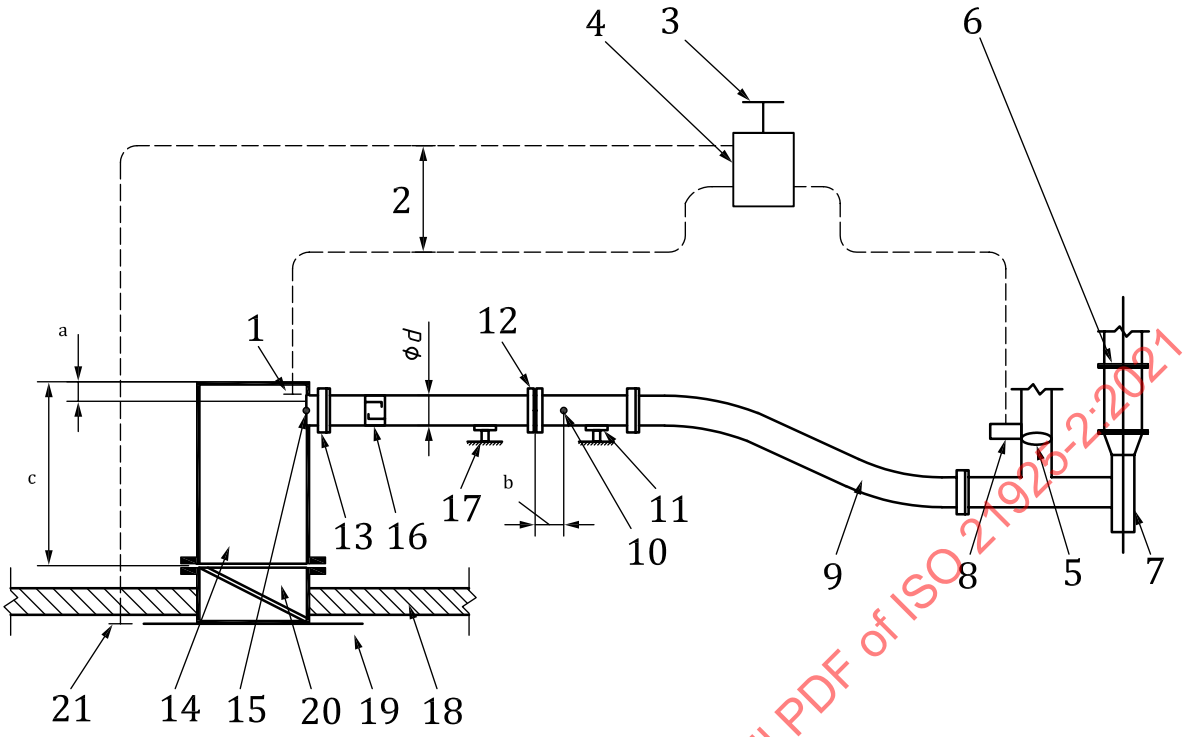
Key

1 supporting construction (wall)
2 2 × diagonal dimension of the damper (to a maximum of 2 m)
3 pressure sensor (on centreline)
4 observation port
5 orifice plate or venturi
6 pressure differential (300 Pa)
7 pressure differential control box
8 pressure sensor in laboratory
9 pressure control dilution damper
10 pneumatic actuator or manual control
11 balancing damper
12 fan
13 flexible connecting duct
14 support
15 thermocouple
16 support
17 flow straightener
18 flange
19 support
20 thermocouple at exit from plenum
21 connecting duct
22 test damper
23 furnace chamber
24 pressure sensor (on centreline of damper)

[a] Distance from thermocouple to orifice plate = 2 × diameter of the measuring duct.

Figure 1 — Example of general test arrangement

Dimensions in millimetres



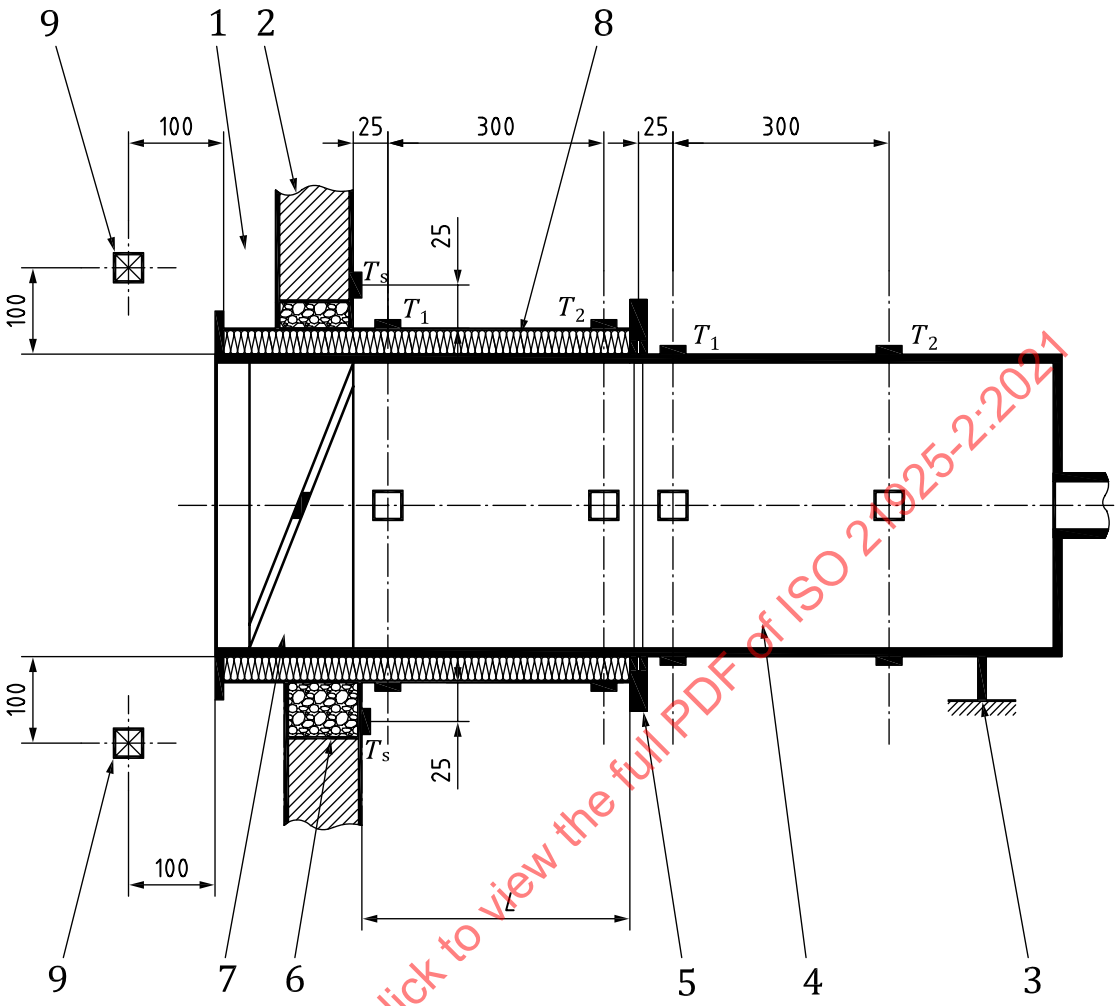
Key

1 pressure sensor
2 pressure differential (300 Pa)
3 pressure sensor in laboratory
4 pressure differential control box
5 pressure control dilution damper
6 balancing damper
7 fan
8 pneumatic actuator or manual control
9 flexible connecting duct
10 thermocouple
11 support
12 orifice plate or venturi
13 flange
14 connecting duct
15 thermocouple at exit from plenum
16 flow straightener
17 support
18 supporting construction {floor)
19 furnace chamber
20 test damper
21 pressure sensor

a Dimension equal to the diameter of the measuring station.
b Distance from thermocouple to orifice plate = 2 x diameter of the measuring duct.
c 2 × diagonal dimension of the damper (to a maximum of 2 m).

Figure 2 — Example of an alternative arrangement when testing dampers in floors

Dimensions in millimetres

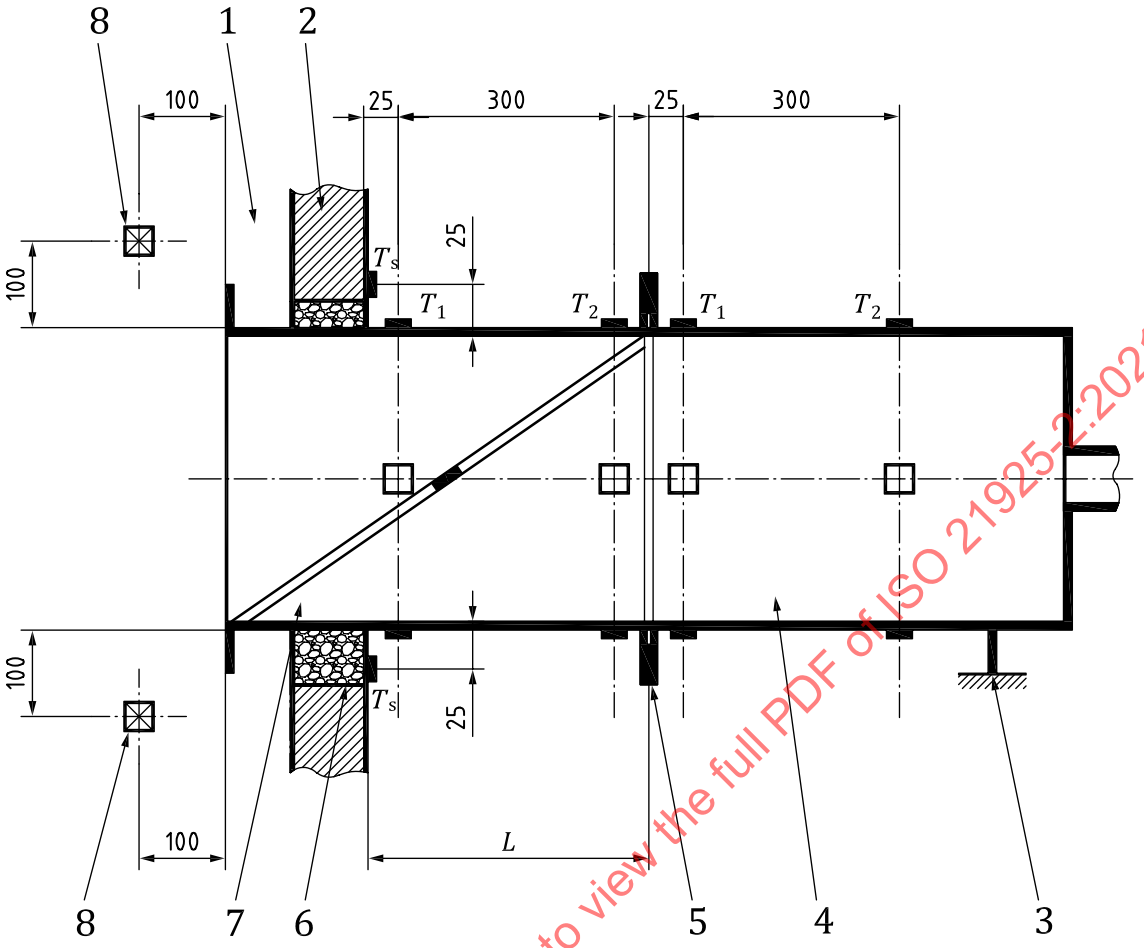


Key

1	furnace
2	supporting construction
3	support
4	connecting duct
5	connecting angle
6	infill material, provided it is necessary
7	test damper
8	insulated ductwork
9	furnace thermocouples, 4 places
L	dimension to be specified by damper manufacturer
T_s	supporting construction unexposed surface thermocouples (minimum of one each side)
T_1, T_2	unexposed surface thermocouples (minimum of one each side)

Figure 3 — Position of surface thermocouples when damper is installed in an insulated duct

Dimensions in millimetres

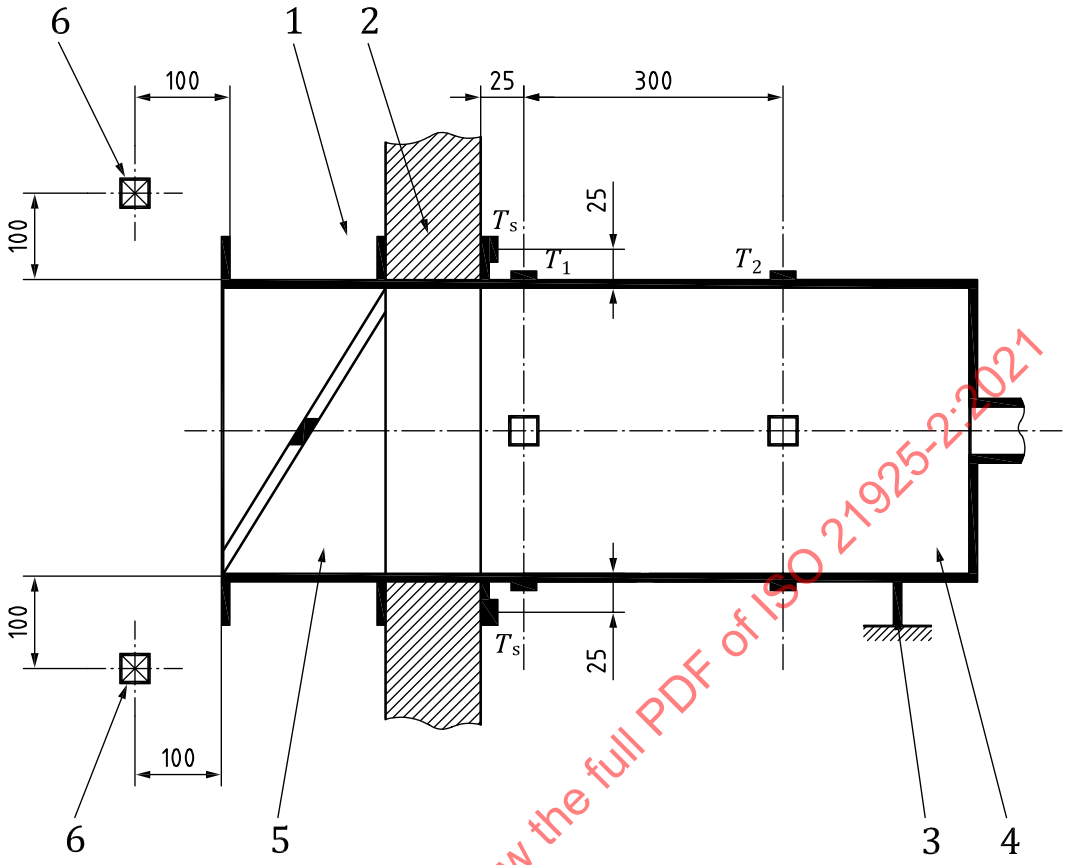


Key

1	furnace
2	supporting construction
3	support
4	connecting duct
5	connecting angle
6	infill material, provided it is necessary
7	test damper
8	furnace thermocouples, 4 places
L	dimension to be specified by damper manufacturer
T_s	supporting construction unexposed surface thermocouples (minimum of one each side)
T_1, T_2	unexposed surface thermocouples (minimum of one each side)

Figure 4 — Position of surface thermocouples when damper is installed in a non-insulated duct

Dimensions in millimetres

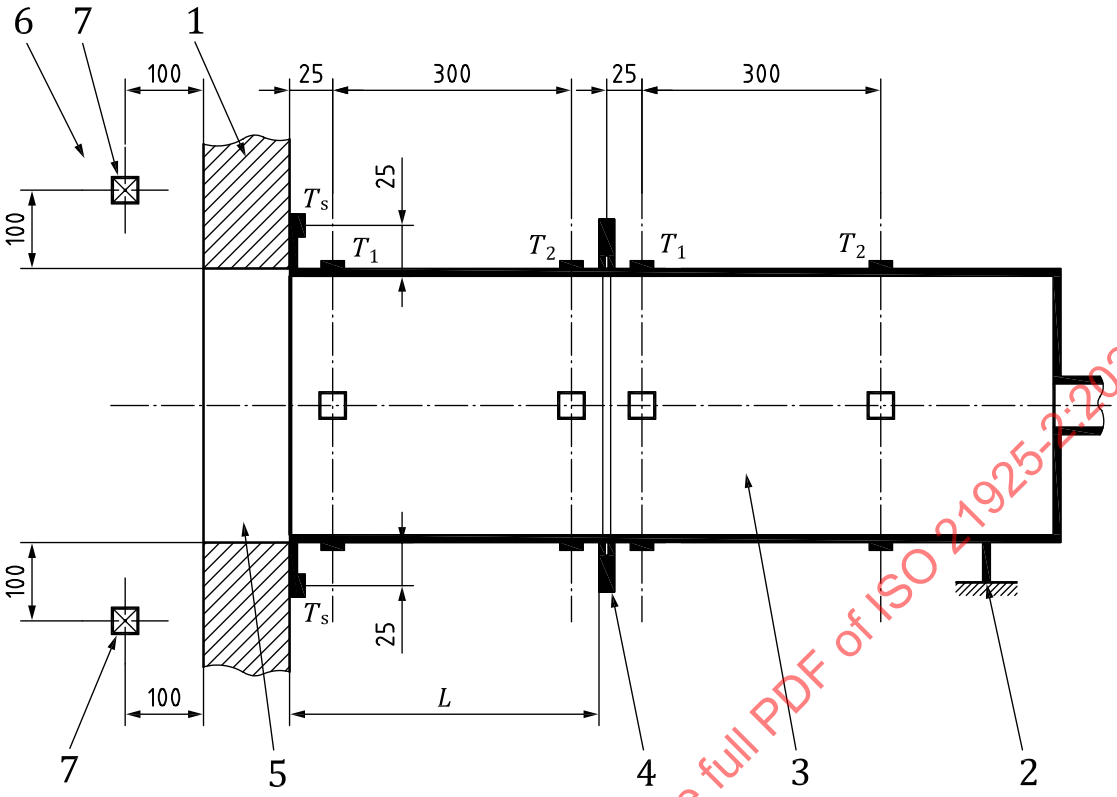


Key

1	furnace
2	supporting construction
3	support
4	connecting duct
5	test damper
6	furnace thermocouples, 4 places
T_s	supporting construction unexposed surface thermocouples (minimum of one each side)
T_1, T_2	unexposed surface thermocouples (minimum of one each side)

Figure 5 — Damper mounted onto face of supporting construction within the furnace

Dimensions in millimetres

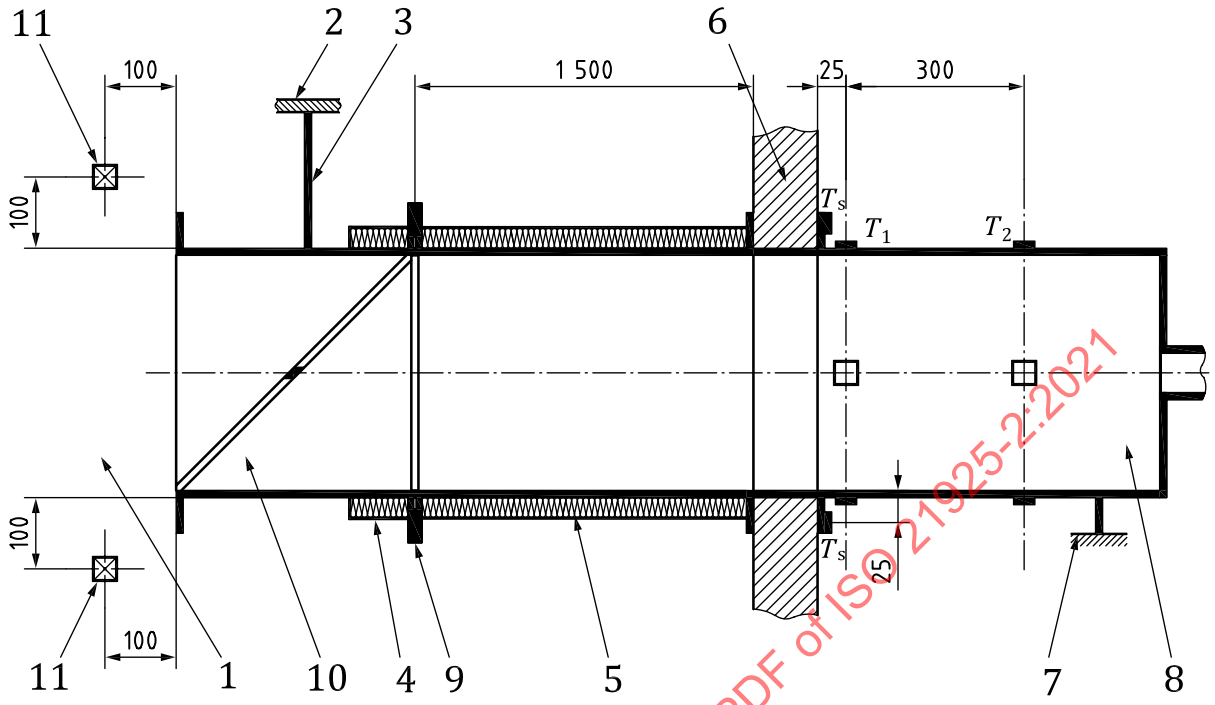


Key

1	supporting construction
2	support
3	connecting duct
4	test damper
5	connecting angle
6	furnace
7	furnace thermocouples, 4 places
L	dimension to be specified by damper manufacturer
T_s	supporting construction unexposed surface thermocouples (minimum of one each side)
T_1, T_2	unexposed surface thermocouples (minimum of one each side)

Figure 6 — Damper mounted onto face of supporting construction outside the furnace

Dimensions in millimetres

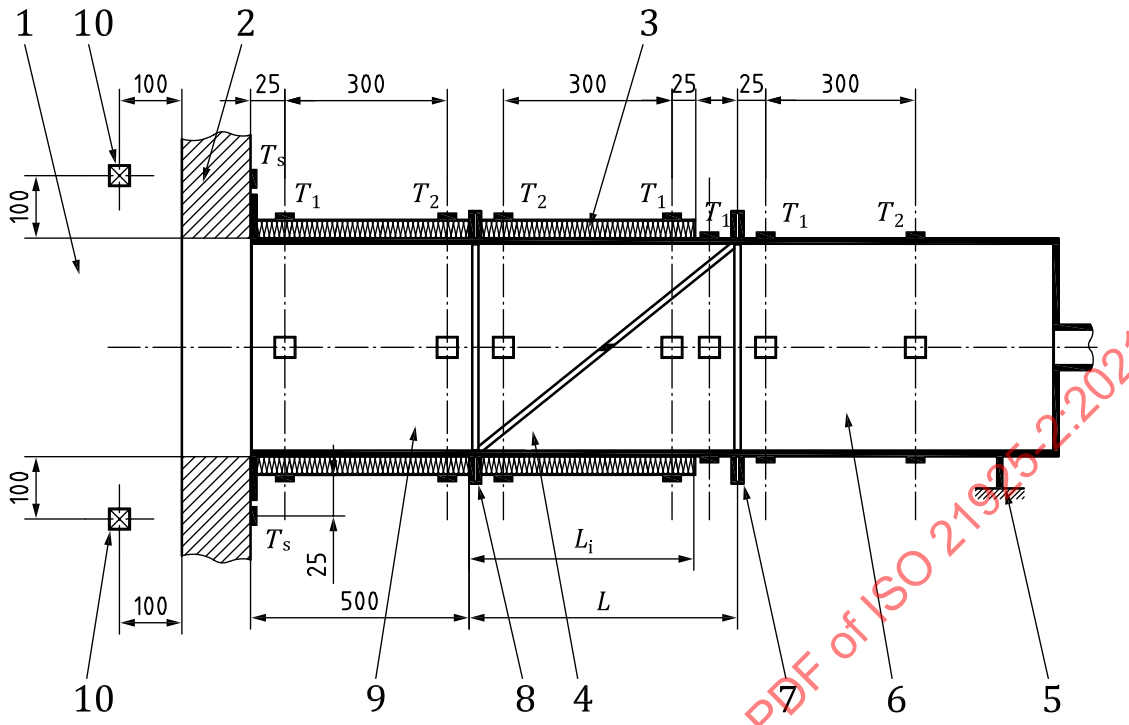


Key

1	furnace
2	floor, for example
3	suitable attachment as in practice
4	insulation, provided it is necessary
5	insulated duct
6	supporting construction
7	support
8	connecting duct
9	connecting angle
10	test damper
11	furnace thermocouples, 4 places
T_s	supporting construction unexposed surface thermocouples (minimum of one each side)
T_1, T_2	unexposed surface thermocouples (minimum of one each side)

Figure 7 — Damper mounted remote from the supporting construction and within the furnace chamber

Dimensions in millimetres



Key

1	furnace
2	supporting construction
3	damper insulation, provided it is necessary
4	test damper
5	support
6	connecting duct
7	connecting angle
8	connecting angle
9	insulated duct
10	furnace thermocouples, 4 places
L	dimension to be specified by damper manufacturer
L_i	dimension of insulation where insulation is necessary
T_s	supporting construction unexposed surface thermocouples (minimum of one each side)
T_1, T_2	unexposed surface thermocouples (minimum of one each side)

Figure 8 — Damper mounted remotely from the supporting construction and outside the furnace chamber

6 Test construction

6.1 General

6.1.1 Introduction

The test construction shall be representative of the construction for which information is required. Only a maximum of two dampers may be tested at one time.

6.1.2 Side to be tested

Where dampers are asymmetrical, they shall be tested from both sides, as it is probably not possible to determine which side will give the worse result. Symmetrical dampers need only be tested from one side.

If testing is carried out from one side only (i.e. one specimen) the reason for this shall be clearly stated in the report.

6.1.3 Dampers installed in both walls and floors

Dampers which are to be employed in both walls and floors shall be tested in both orientations, unless it can be demonstrated that one is more onerous.

6.1.4 Dampers installed within a structural opening

Dampers to be positioned within a structural opening shall be tested as shown in Figure 1 when installed in a wall and as shown in Figure 2 when installed in a floor.

6.1.5 Dampers mounted onto face of wall or floor

Uninsulated dampers mounted on a wall or floor and attached to the face of a structure shall be tested with the damper positioned within the furnace as shown in Figure 5. Insulated dampers shall be tested from both sides so that the insulation properties of the damper body, and where appropriate the duct, can be evaluated. An example of a damper mounted to the wall/floor outside the furnace is shown in Figure 6.

6.1.6 Dampers remote from wall or floor

6.1.6.1 Within the furnace

Dampers remote from the wall or floor and separate from the structure shall be attached to a length of ductwork. For test purposes, the duct shall be attached to the supporting construction with the damper installed at the duct end within the furnace, as shown in Figure 7. This length of ductwork shall be (150 ± 50) mm long and insulated to the extent necessary to ensure that it remains intact throughout the test. The distance between the outer surface of the duct and the furnace wall or floor shall not be less than 500 mm.

6.1.6.2 Outside the furnace

For dampers that are to be mounted onto a section of duct outside the furnace, as shown in Figure 8, the length of duct shall be (500 ± 50) mm.

NOTE An uninsulated damper mounted on a section of a duct outside the furnace does not need to be tested.

6.1.7 Minimum separation between dampers

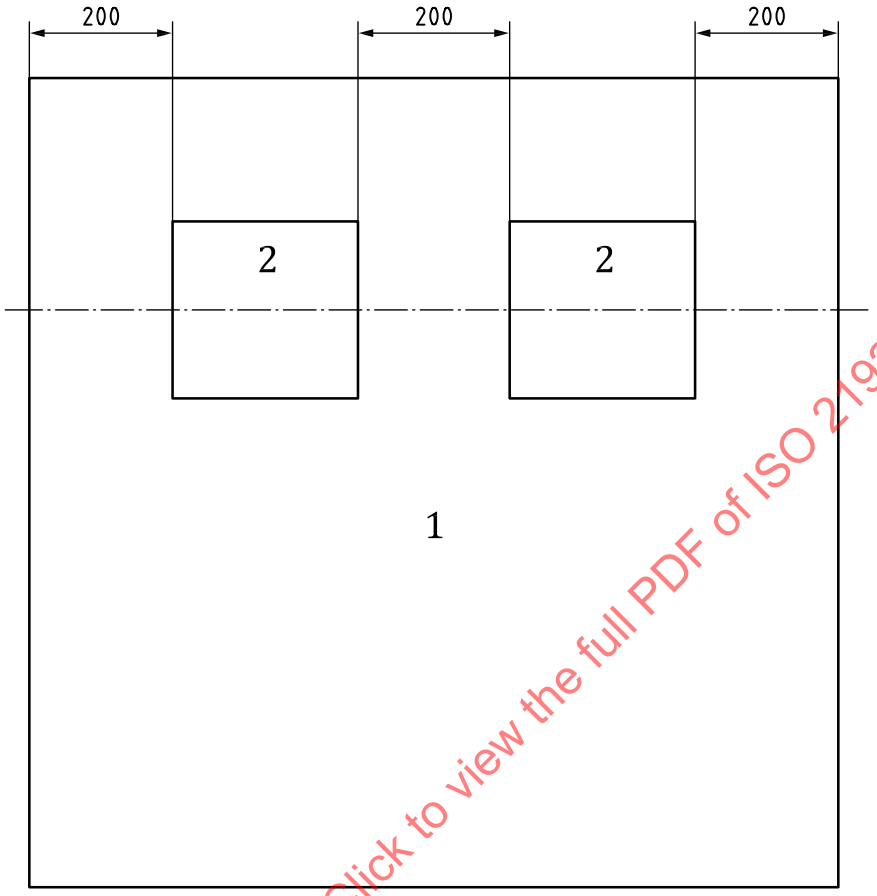
Where two dampers are to be tested at the same time, the distance between the dampers shall not be less than 200 mm, as shown in Figures 9 and 10. Where the dampers are mounted in a wall or partition, but are not located in the same horizontal plane, the required furnace pressure is determined at the horizontal plane of the lower damper; see 9.8 a) and Figure 1.

6.2 Size of specimen

The largest sized damper should be fire tested and, provided the damper satisfies the appropriate fire leakage criteria, the results can be extended to smaller sizes of dampers whose dimensions relative to width, height and length are smaller than that tested, subject to the following verification that all components are the same thickness and cross-sectional shape. Where it is intended that multiple

intumescent dampers will be used in a duct of a size greater than the individual damper size, the maximum number of dampers in the maximum-sized duct including all mullions and transoms together with any other supporting structure shall be tested.

Dimensions in millimetres



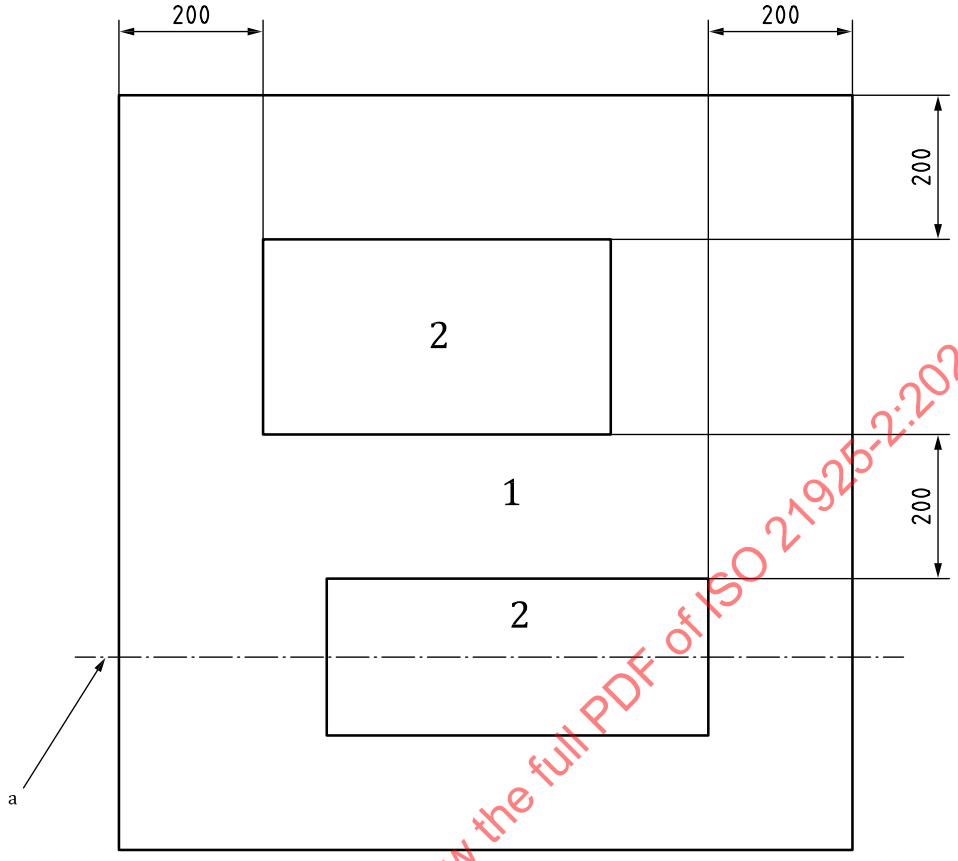
Key

1 supporting construction

2 damper

Figure 9 — Maximum separation between two dampers

Dimensions in millimetres



Key

1 supporting construction

2 damper

a Pressure of 15 Pa maintained on this plane.

Figure 10 — Dampers mounted in different horizontal planes

6.3 Specimen installation

The dampers shall be installed as in practice in a supporting construction using methods which are in accordance with the manufacturer's instructions. Damper manufacturers requiring the damper to be tested in a length of insulated ductwork shall specify the length over which the duct is to be insulated as shown in Figure 3.

6.4 Supporting construction

6.4.1 Principles

6.4.1.1 The supporting construction shall be a wall, partition or floor of the type to be used in practice.

6.4.1.2 A test result obtained for a fire damper mounted in a supporting construction made of masonry, concrete or solid partition (without any cavity) is applicable for the same type of supporting construction with a thickness and density equal to or greater than those of the supporting construction used for the test.

6.4.1.3 The supporting construction selected shall have fire resistance slightly greater than the required fire resistance of the damper being tested.

6.4.1.4 If a specific supporting construction different from those described above is selected, the test results obtained are applicable only to that specific wall, partition or floor.

6.4.2 Recommended supporting constructions

6.4.2.1 General

Where the type of supporting construction used in normal practice is not known, then one of the standard supporting constructions described in Tables 1, 2 or 3 shall be used.

Table 1 — Standard rigid wall construction

Type of construction	Thickness mm	Density kg/m³	Test duration t h
Normal concrete/masonry	110 ± 10	2 200 ± 200	$t = 2$
	150 ± 10	2 200 ± 200	$2 < t \leq 3$
	175 ± 10	2 200 ± 200	$3 < t \leq 4$
Aerated concrete[a]	110 ± 10	650 ± 200	$t = 2$
	150 ± 10	650 ± 200	$2 < t \leq 4$
[a] This supporting construction may be made from blocks bonded together with mortar or adhesive.			

Table 2 — Standard flexible-wall constructions (gypsum plasterboard)

Fire resistance min	Wall constructions			
	Number of layers on each side	Thickness mm	Insulation[a] D/ρ	Thickness[b] mm
30	1	12,5	40/40	75
60	2	12,5	40/40	100
90	2	12,5	60/50	125
120	2	12,5	60/100	150
180	3	12,5	60/100	175
240	3	15,0	80/100	190
[a] D is the thickness in mm of mineral wool insulation inside the wall; ρ is the density in kg/m³ of mineral wool insulation inside the wall. [b] Tolerance of ±10 %.				

Table 3 — Standard floor constructions

Type of construction	Thickness mm	Density kg/m³	Test duration t h
Normal concrete	110 ± 10	2 200 ± 200	$t = 1,5$
	150 ± 10	2 200 ± 200	$1,5 < t \leq 3$
	175 ± 10	2 200 ± 200	$3 < t \leq 4$
Aerated concrete	125 ± 10	650 ± 200	$t = 2$
	150 ± 10	650 ± 200	$2 < t \leq 4$

6.4.2.2 Non-standard supporting constructions

When the test specimen is intended for use in a form of construction not covered by the standard supporting constructions, it shall be tested in the supporting construction intended for use.

6.5 Conditioning

After installation of the damper into a supporting construction, the assembly shall be subject to a conditioning procedure in accordance with the requirements of ISO 834-1. The moisture content of the supporting construction and any infill material used between the damper and supporting construction can have an influence on the performance of the damper, in particular in relation to the insulation criterion. Where practical, the moisture content of all the component items, including any infill material, shall be controlled to ensure that equilibrium has been reached, and the final value measured and recorded. If the supporting construction has been assembled and has been fully conditioned prior to the installation of the test specimen and if a water-based infill material (or other similar infill material which requires curing) is used to seal any small gaps between the supporting construction and the damper, then a minimum of 14 days shall be allowed for the assembly to reach equilibrium.

7 Determination of leakage of connecting duct and measuring station

7.1 Shut the damper manually and seal the inlet aperture using impervious material.

7.2 Assemble the connecting duct measuring station and exhaust fan as shown in Figure 1. The joints between each component shall be well sealed with high temperature gaskets and/or sealants.

7.3 Connect an orifice plate, venturi or other suitable device to a suitable recording instrument calibrated and complying with the requirements of ISO 5167-1. It can be necessary to use a different size of orifice plate, venturi or other suitable device for the determination of the leakage of the connecting duct and measuring standard to that used for the leakage tests described in Clauses 7 and 8. The leakage is calculated from the recorded pressure differential from the orifice plate, venturi or other suitable device using the formulae for volume flow rates given in ISO 5167-1.

7.4 Adjust the exhaust fan so that the air leakage through the connecting duct and measuring station can be measured at 200 Pa, 300 Pa, 400 Pa and 500 Pa. The pressure differential at each value should be maintained for 60 s before the leakage is recorded. For higher pressure differential than 300 Pa, the control of leakage shall be performed at a test pressure 200 Pa higher than the test pressure chosen, in five equal increments.

7.5 Plot the values on graph paper to determine the leakage at 300 Pa, or at a higher selected pressure differential.

7.6 If the leakage at 300 Pa is more than 12 m^3/h, improve the sealing of joints and stability of test construction until this leakage criterion is met. For pressure differentials higher than 300 Pa, the leakage of 12 m^3/h may be increased by a factor $(P_{test}/300)$ 0,5.

7.7 Remove sealing from the inlet aperture of the damper.

8 Opening and closing cycles

8.1 The 50 opening and closing cycles as specified for mechanical dampers are not applicable to this product.

NOTE The reason for the 50-cycle test for mechanical dampers is to demonstrate the likelihood of their functioning when called upon to do so, without jamming or disintegrating. A product that is activated by an irreversible chemical activity cannot be activated more than once. There are no parts moving mechanically in an intumescent fire damper, only the swelling of the intumescent material when activated by heat.

8.2 Time to close: There is no requirement for the damper to close before 2 min, but it shall satisfy leakage requirements after 5 min into the test.

NOTE The 2 min limit in the test for mechanical dampers is the time beyond which it is deemed that dampers that have not closed will not do so; therefore, continuation of the test would be irrelevant. Since the time deemed necessary for the furnace to stabilize is 5 min and no sensor values are considered accurate enough to record until that time has elapsed, the 2 min period has no relevance in the case of intumescent dampers.

9 Fire test

9.1 Latch the damper into its open position, then if not already in position, mount the test specimen onto the furnace.

9.2 Connect all instrumentation required by this document.

9.3 With the damper fully open, set the exhaust fan system to produce an air velocity of 0,15 m/s across the damper opening. This may be measured by the orifice plate, venturi or other suitable device located within the measuring duct. The air velocity shall be maintained to an accuracy of ±15 %.

9.4 Switch off the exhaust fan, but leave it at its pre-set value given in 9.3.

9.5 Ignite the furnace. Start the timing device and switch on all measuring devices.

9.6 Switch on the exhaust fan as soon as the furnace has ignited.

9.7 When the damper has closed, adjust the exhaust fan to maintain an underpressure of 300 Pa (or higher) in the connecting duct, relative to the furnace. Record the time at which the damper closes.

9.8 Throughout the test, carry out the following:

a) Control and record the furnace temperature and pressure in accordance with ISO 834-1. The furnace pressure at the horizontal centreline of a vertical damper shall be maintained at (15 ± 2) Pa.

b) Maintain a pressure differential between the connecting duct and furnace of (–300 ± 15) Pa, (or higher underpressure).

c) Record the pressure differential across the orifice plate, venturi or other suitable device and the local gas temperature at not more than 2-min intervals.

   Constants for orifice plate, venturi or other suitable devices shall be calculated in accordance with ISO 5167-1 over the range of anticipated gas temperatures. As a function of time and measured gas temperatures, select the corresponding orifice plate, venturi or other suitable device constants and calculate the volume flow rate at the measuring station gas temperatures using the formulae for volume flow rates given in ISO 5167-1. Correct the measured volume flow rate to 20 °C. Deduct the value for the leakage of the connecting duct and measuring station determined in Clause 7 from the measured leakages.

d) Record the temperature on the external surface of the connecting duct at the time intervals specified in ISO 834-1.

e) The effect of gaps, orifices or openings on the integrity at the junction between the supporting construction and connecting duct shall be determined by the use of the cotton pad and/or gap gauges as defined in ISO 834-1.

f) Where practical, record any observations of the general behaviour of the damper assembly during the test. In practice this is limited to observations taken on the furnace side and to the duct/damper junction and adjacent area on the non-furnace side.

10 Classification and criteria

10.1 General

Depending on the classification required, the size of the fire damper to be tested and the criteria to be applied are given in Table 4.

Table 4 — Fire test performance criteria

Classification[a]	Size to be tested	Leakage at ambient temperature $m^3/(h \cdot m^2)$	Fire test		
			Leakage limit $m^3/(h \cdot m^2)$	Temperature rise limit °C Mean/Max.	Perimeter integrity[b]
E	max.	Not required	360[c]	Not required	GG/SF
ES	max.	200	200[c]	Not required	GG/SF
	min.	200	Not required	Not required	Not required
EI	max.	Not required	360[c]	140/180	CP/GG/SF
EIS	max.	200	200[c]	140/180	CP/GG/SF
	min.	200	Not required	Not required	Not required

In relation to the criteria for leakage (S), the values given shall be satisfied in both the ambient temperature (smallest damper and largest damper in the range) and the fire test (largest damper in the range).

NOTE 1 The maximum temperature rise limit (180 °C) can be determined at any of the thermocouples T_1, T_2 and T_s (or the roving thermocouple described in ISO 834-1) and the mean (average) temperature rise (140 °C) is determined from thermocouples T_2. Locations of the thermocouples are shown in Figures 3 to 8.

NOTE 2 For the purposes of calculating conformance with the leakage criteria in this table, the area of a damper can be taken to be the cross-sectional area of the duct to which the damper is connected.

NOTE 3 Classification of integrity is according to whether or not the damper is also classified for insulation. Where a damper is classified for integrity, *E*, and insulation, *I*, the integrity is that determined by whichever of the three criteria fails first. Where a damper is classified E but without an I classification, the integrity value is defined as the time to failure of only the cracks/openings or sustained flaming criteria, whichever fails first.

[a] E is the integrity (gas flow corrected to 20 °C);

I is the insulation (see NOTE 1);

S is the leakage classification (see NOTE 2) (gas leakage corrected to 20 °C).

[b] CP is the cotton pad (see NOTE 3);

GG is the gap gauge (see NOTE 3);

SF is the sustained flaming (see NOTE 3).

[c] Leakage limits only apply after 5 min from the start of the test.

10.2 Number of tests required

The test method has been designed to cover as many potential applications for damper installation as possible. It is not intended that all the options have to be covered in a test programme.

Guidance is given below in Tables 5 and 6 on the number of tests required. Experience can show that not all tests need to be undertaken, as some installation options can be found to represent the most onerous condition, in which case the number of tests required may be reduced.

Table 5 — Fire damper standard installation application

Fire damper installation application in practice standard application	Number of tests asymmetrical fire damper	Number of tests symmetrical fire damper
Installed within a wall	2	1
Installed within a floor	2	1

Table 6 — Fire damper special installation application

Fire damper installation application in practice special application	Number of tests asymmetrical fire damper	Number of tests symmetrical fire damper
Installed on face of wall	2	1
Installed on face of floor	2	1
Damper mounted on section of duct in the fire compartment (wall and floor application)	1 for wall application, 1 for floor application	1 for wall application, 1 for floor application
Insulated damper mounted on section of duct outside the fire compartment (wall only)	1	1

11 Test report

The test report shall state:

a) the name of the testing laboratory;

b) the name of the sponsor;

c) the date of the test;

d) the name of the manufacturer, the trade name and the type reference of the product;

e) details of the construction and conditioning of the test specimen, including detailed information on the specification of materials and components used, together with drawings illustrating the essential features and installation details, including the dimension from the exposed face of the supporting construction to the centreline of the plane of operation of the damper;

f) description of the method and materials, used to seal the damper into the test construction;

g) a record of the following relating to the leakage at ambient temperature test as a function of time:

- measuring station pressure differential;
- calculated volume flow rate;

h) a record of the following relating to the fire test as a function of time:

- furnace temperature;
- furnace pressure;
- connecting duct pressure;
- temperatures measured by all surface mounted thermocouples;
- gas temperature at exit of connecting duct plenum;
- measuring station gas temperature;

— measuring station pressure differential;

— calculated volume flow rate converted to ambient (laboratory) temperature;

i) the time at which the damper closes after the start of the test and the test duration;

j) any observations which were made during the course of the test, particularly with respect to loss of integrity at the joints between the damper and its connecting duct and the damper assembly and the supporting construction of the test arrangement;

k) where the test has been undertaken using a higher underpressure than 300 Pa, then this shall be clearly stated, together with a statement giving the basis for such a value being selected. All calculated volume flows should be clearly identified as relating to the selected higher underpressure;

l) a reference to the international standard used (including year of publication);

— any deviations from the procedure;

— any unusual features observed.

12 Direct field of application of the test results

12.1 Size of fire damper

A test result obtained for the largest fire damper in the range is applicable to all dampers of the same type (including any aspect ratio) provided that the maximum dimensions do not exceed those tested and that the components remain in the same orientation as that tested.

12.2 Fire dampers installed within structural openings

A test result obtained for an installed fire damper is only applicable to dampers installed in the same orientation as that tested.

12.3 Fire dampers mounted onto the face of a wall

A test result obtained for a fire damper installed onto the face of a wall or floor is only applicable to dampers installed onto the face of a separating element in the same orientation as that tested.

12.4 Fire dampers remote from a wall or floor

A test result obtained for a fire damper remote from a wall or floor (of the same fire resistance as the damper) is applicable to the following dampers:

a) for mounting remote from a wall and attached to a length of a horizontal fire-resisting ductwork when tested remote from a wall (two tests, see Figure 7 and Figure 8);

b) for mounting remote from a floor and attached to a length of vertical fire-resisting ductwork on the side above the floor when tested above the floor;

c) for mounting remote from a floor and attached to a length of vertical fire-resisting ductwork on the side below the floor when tested below the floor.

12.5 Separation between fire dampers and between fire dampers and construction elements

A test result obtained for only one fire damper or for two fire dampers with a minimum clear separation of 200 mm between the dampers is applicable to a minimum separation, in practice, of:

a) 200 mm between dampers installed in separate ducts;

b) 75 mm between damper and a construction element (wall/floor).

12.6 Supporting constructions

12.6.1 A test obtained for a fire damper mounted in or on the face of a supporting construction made of masonry, concrete or homogeneous partition (without continuous cavity) is applicable for the same type of supporting construction with a thickness and density equal to or greater than those of the supporting construction used in the test. The test result can apply to cellular or hollow masonry blocks or slabs that have a fire resistance time equal to or greater than the fire resistance required for the fire damper installation.

12.6.2 Test results obtained with the dampers installed in flexible vertical supporting constructions may be applied to rigid supporting construction of a thickness equal to or greater than that of the element used in the tests, but not vice-versa provided that the classified fire resistance of the rigid supporting construction is greater than or equal to the one used for the test.

12.6.3 If a specific supporting construction different from those described in 6.4.2 is selected, the test results obtained are applicable only to that specific wall, partition or floor having a thickness and/or density greater than that tested.

Annex A
(normative)

Durability

A.1 General

The durability tests for intumescent dampers shall consist of an expansion pressure test before and after specimens are exposed to conditions specified in A.2.1, A.2.2 and A.2.3. A sample set shall consist of a minimum of 5 specimens for each exposure condition. (See Annex B for a description of a typical apparatus used to conduct expansion pressure tests).

A.2 Temperature and controlled humidity exposure

A.2.1 Temperature exposure to 70 °C

Sample sets shall be placed in a circulating air oven at a temperature of (70 ± 3) °C for a minimum of 100 days.

A.2.2 Controlled humidity exposure

Sample sets shall be placed in a chamber with a controlled humidity of 97% to 100 % at (35 ± 1,5) °C for a minimum of 100 days.

A.2.3 Ambient temperature exposure

Sample sets shall be placed in ambient laboratory conditions at a temperature of (23 ± 4) °C and a humidity of 50 % for a minimum of 7 days.

A.3 Acceptance criteria after temperature and controlled humidity exposure

A.3.1 Each specimen of the sample exposed to conditions in accordance with A.2.1 and/or A.2.2 shall retain at least 80 % of the average maximum peak expansion pressure or average expansion factor of that recorded for the sample set exposed to the conditions specified A.2.3.

A.3.2 The average of the peak expansion pressures or expansion factors of the set of specimens shall be within ±20 % of the average peak expansion pressure or expansion factor of the set of specimens exposed to the conditions specified in A.2.3.

A.3.3 The peak expansion pressure shall not occur more than 20 s after the average time of the peak expansion pressure of the sample set conditioned in the laboratory.

A.3.4 Alternatively, a fire resistance test in accordance with Clause 4 may be used to assess the product after exposure. In this case, a small damper from the range is sufficient.

Annex B
(informative)

Test apparatus

The general characteristics and operation of the expansion measuring apparatus can be described as in a) to e); the numbers in parentheses refer to keyed parts in Figure B.1.

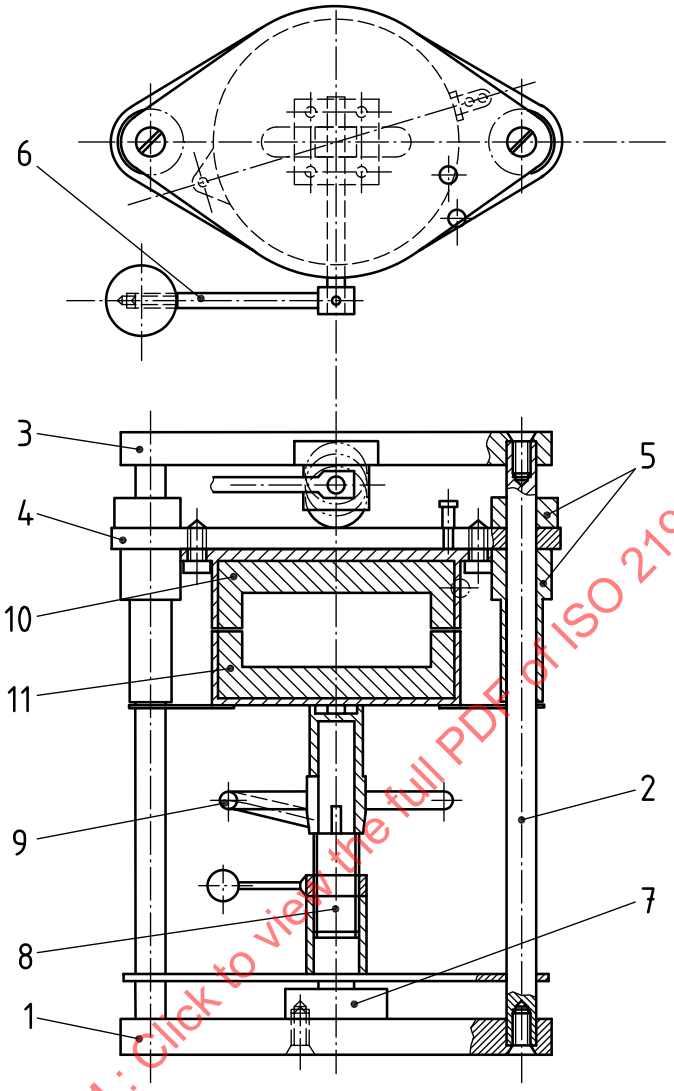
a) The measuring equipment for determining the expansion pressure, acting at given temperatures by an intumescent material, is built into a frame consisting of a base plate (1), two pillars (2) and a pressure plate (3).

b) The heated upper pressure receptor (10), which is rigid during the test but can be swung out for cleaning purposes, is connected with the frame through a guide system (5). In order to enable the specimens to be quickly inserted, the top plate can be adjusted in height by 15 mm by means of the lever (6).

c) The heated lower pressure receptor (11) transmits the force occurring during the test via a transmission device to the force transducer (7) mounted on the base plate.

d) The transmission device has a hand-wheel adjustment that accommodates specimens with a thickness of up to 32 mm. The spindle (8) serves as a locking device for the mechanism.

e) For testing specimens placed in a steel restraining ring, the heating receptors shall be spaced at a distance exceeding the height of the ring by 1 mm.



Key

1 base plate
2 pillars
3 pressure plate
4 top plate
6 guide system components
5 lever
7 force transducer
8 spindle
9 hand-wheel
10 heated upper pressure receptor
11 heated lower pressure receptor

Figure B.1 — Disc pressure test apparatus

Annex C
(informative)

Reaction to fire tests — Intumescent materials

C.1 General

To ensure some equivalence with a mechanical damper, the following tests are described that allow an assessment of the reliability of intumescent materials used for intumescent fire dampers. These tests can be used as an initial type test to obtain the performance of an intumescent material tested. The result is normally used to define the specification for the material. In this case 10 specimens shall normally be tested. For the purpose of factory control, two specimens are normally used to show conformance with the specification.

Thermal activation and faulty set-off are normally tested only in the course of the initial type test but all three alternatives for "expansion pressure" are suitable tests for factory control.

Expansion pressure is normally determined at various temperatures during the initial type test to find out the range of minimum temperature dependence. For the purposes of factory production control these tests are normally conducted at a temperature in the range of temperature independence to ensure that the effect of temperature variation on the results is minimized.

Complete components or sections of components of the damper, in sufficient quantity to complete the range of testing required by the test authority and manufacturer, shall be nominated as representative specimens for initial type testing and all subsequent production control conformity tests, as dictated by local certification/approval needs.

Sample sets shall be placed in ambient laboratory conditions consisting of a temperature of (23 ± 4) °C and a humidity of 50 % for a minimum of seven days.

C.2 Thermal activation temperature test

C.2.1 General

This test is used to assess the activation temperature of the intumescent material used in the damper.

C.2.2 Apparatus

C.2.2.1 Oven, with an operating temperature range of 25 °C to 350 °C to within better than ±3 °C.

C.2.2.2 Temperature-measuring and display device for the oven, with an accuracy of ±1 °C.

C.2.3 Test specimens

Three specimens of the smallest-sized damper in the range of critical reactive intumescent components shall be tested.

C.2.4 Test method

Each specimen or critical reactive component shall be placed in the oven. The oven shall be set at 30 °C below the activation temperature given by the manufacturer for the intumescent material under test. The oven temperature shall be maintained for at least 15 min and intumescent activity observed. If

no intumescent development occurs, the temperature shall be increased by increments of 5 °C and maintained for a minimum of 15 min at each stage until activation does commence.

C.3 Faulty set-off test

C.3.1 General

This test method is intended to cover standard operating conditions (60 °C; see ISO 21925-1). However, the test method may be adapted to cover situations where the intumescent damper is intended to be operated at either lower or higher temperatures, for example dampers used in cold climates or those installed in warm-air ducts, by using the appropriate operating temperature as the test temperature. Except for the temperatures/threshold limits, there shall be accordance with all other conditions specified in this document.

C.3.2 Apparatus

C.3.2.1 Oven, with a standard temperature operating range of 25 °C to at least 80 °C or a range compatible with the chosen operating temperature to within better than ±3 °C.

C.3.2.2 Temperature-measuring and display device for oven, with an accuracy of ±1 °C.

C.3.2.3 Thickness-measuring device, with an accuracy of ±0,05 mm.

C.3.3 Test specimens

Three specimens of the smallest-sized damper in the range or three critical reactive intumescent components shall be tested. Where the intumescent material is covered by a protective skin that can be affected by the chosen operating temperature, the critical reactive intumescent component shall be composed the intumescent material and the skin.

C.3.4 Test method

The thickness of each specimen shall be measured at a minimum of four different locations on the intumescent reactive components and the values recorded. The specimens shall then be placed in a pre-heated oven that is at the chosen temperature. The specimens shall be removed from the oven after 60 min and the thickness at the previously measured locations measured and recorded.

C.3.5 Performance

The thickness shall not vary by more than 5 % of the measurements taken prior to placing in the oven.

C.4 Expansion pressure tests

C.4.1 General

This test is used to assess the pressure, and in the case of the pipe pressure test and the die-set pressure test also the expansion factor, of an intumescent material created during expansion on heating.

For intumescent material that is employed in an uncovered state and is not subject to any further processing prior to incorporation in the damper assembly, both the “disc pressure test” and the “pipe pressure test” are suitable.

Where the original intumescent material is covered, skinned, specially shaped or processed in such a way as to:

a) change the performance characteristics,

b) improve or reduce resistance to moisture,

c) increase or decrease chemical or gas resistance, and/or

d) improve or reduce durability,

the coverings of intumescent materials can cause a variation of characteristics from the material in its uncovered state. Therefore, such specimens shall be selected complete with covering to provide authentic characteristics and normally the die-set pressure test is suitable. The specimens shall be of a shape and dimensions compatible with the product design.

C.4.2 Expansion pressure — Disc pressure test method

C.4.2.1 Apparatus

The test apparatus consists of two heating plates provided with a means of adjusting the distance between them. The lower plate is connected to a strain gauge/pressure transducer capable of measuring the pressure exerted by the expansion of the specimen. The strain gauge/pressure transducer is connected to a recorder that continuously records the measured pressure relative to time; see Figure B.1.

C.4.2.2 Test specimens

The specimens shall be circular and die-cut to a size to suit the internal diameter of the test apparatus from the intumescent material used in the fabrication of the damper. Each specimen shall be weighed and measured after being die-cut and examined to ensure that there are no voids between the specimen and the internal face of the test apparatus.

C.4.2.3 Test method

For uncovered sheet material, the specimen shall be placed in a steel cylinder whose height is equal to the thickness of the specimen. The inside diameter of the cylinder shall be the same size as the specimen.

The test apparatus shall be set such that there is an initial load between 0,1 N/mm^2 and 0,5 N/mm^2, the heating plates of the apparatus are preheated to a minimum of 300 °C for standard applications or to the appropriate temperature above the activation temperature for other applications, to within better than ±3,0 °C. The steel cylinder with the specimen in it shall be placed between two sheets of aluminium foil and centred between the two plates of the test apparatus. As the specimen heats and expands, the pressure peaks and then declines. The test shall be discontinued after a decline in pressure for at least three consecutive minutes. The maximum expansion pressure of the specimen shall be recorded.

C.4.3 Expansion pressure — Pipe pressure test method

C.4.3.1 Apparatus

C.4.3.1.1 Stainless steel pipe, with an inside diameter equal to the specimen (for uncovered or non-skinned sheet material).

C.4.3.1.2 Cylindrical stainless steel weights, with a diameter close to the inner diameter of the pipe and having masses which can result in pressures of 0,000 49 N/mm^2, 0,000 98 N/mm^2, 0,001 47 N/mm^2, 0,001 96 N/mm^2.

NOTE Pressure is equal to the mass multiplied by the acceleration of gravity divided by the area. For the above pressures, weights with masses of 5 g, 10 g, 15 g, or 20 g are often convenient.

The mass of the stainless steel weight shall have an accuracy of ±2,5 %.

The configuration of the stainless steel pipe and weights is shown in Figure C.1.

C.4.3.1.3 Muffle furnace, capable of maintaining the chosen temperature with an accuracy of ±3 °C.

C.4.3.2 Test specimens

Sheet material shall be tested in a disc form with a diameter to suite the internal diameter of the pipe and a minimum thickness of 3 mm.

C.4.3.3 Test method

The thickness of specimen shall be measured to the nearest 0,1 mm at five locations. The five measurements shall be used to obtain the average thickness.

Each specimen shall be placed inside the steel pipe. The specimen shall be totally covered with the weight selected depending on the anticipated expansion pressure of the material. The pipe containing the specimen shall be placed in the preheated muffle furnace for 30 min. After 30 min, the steel pipe shall be removed from the muffle furnace and cooled to ambient temperature.

After cooling, the height of the char shall be measured to the nearest 0,1 mm. This can be accomplished by measuring the displacement of the steel weight from its original position.

The expansion factor is the ratio of the expanded thickness to the initial measured thickness.

C.4.4 Expansion pressure - Die-set pressure method for covered, skinned or shaped specimens

C.4.4.1 Apparatus

C.4.4.1.1 Oven or muffle furnace, capable of maintaining the chosen temperatures with an accuracy of ±3 °C.

C.4.4.1.2 Two-piece die-set, produced with a minimum thermal mass using materials of good thermal conductivity to minimize thermal lag.

Both upper and lower dies shall incorporate contours that match the profile of the specimens as closely as practicable to minimize voids between the specimen and the die components; see Figures C.2 and C.3.

C.4.4.1.3 Weights, made of brass as shown in Figure C.2.

The combined weight of upper die and brass weight shall be evenly distributed to ensure that the point of balance is at the centre of gravity and that the total weight provides the appropriate pressure (typically 0,000 49 N/mm^2, 0,000 98 N/mm^2, 0,001 47 N/mm^2 or 0,001 96 N/mm^2). This can be adjusted by removing metal from the weight.

C.4.4.1.4 Height gauge - Mechanical Digit Height Gauge (or similar), capable of measuring to nearest 0,1mm

C.4.4.2 Test specimens

For components of products that are covered, specially shaped, skinned or processed materials, the specimens shall be of a shape and dimensions compatible with establishing authentic characterization performance.

C.4.4.3 Test method

The specimen shall be measured and all dimensions recorded. The thickness shall be measured at each corner of the specimen and in the centre. The measurements shall be aggregated to establish the mean thickness to ±0,15 mm.

The specimen shall be placed in the lower part of the die-set and the upper die placed on top of the specimen. The weight shall be placed so that the shoulders on the shouldered face fit on either side of the flanges of the upper die. Tissue paper may be used to line the die faces to minimize adhesion when heated and prevent the escape of friable intumescent materials through penetrations or gaps in the die faces. A measurement shall be made from the bottom of the lower die to the highest point of the upper die using a height gauge.

The specimen contained within the die-set shall be placed in an oven pre-heated to (300 ± 3,0) °C.

The die-set shall be removed from the oven after 30 min and as soon as cooling allows, the measurement shall be taken from the bottom of the die-set to the uppermost point of the upper die using a height gauge.

The change in height shall be added to the original mean thickness and the sum of these values shall be divided by the original mean thickness to establish the expansion ratio for the specimen at the prescribed pressure.

A temperature higher than 300 °C may be selected if intumescent materials of different temperature characteristics are used.

C.4.5 Test report

The test report shall contain at least the following information:

a) name and address of the testing laboratory and the location where the test has taken place, if the latter is not the same as the address of the testing laboratory;

b) unique reference identification of the report (e.g. serial number) and of each page of the report, as well as specification of the total number of pages of the report;

c) name and address of the sponsor;

d) description and name of the tested item, including details of the intumescent component construction and material specifications;

e) date of receipt of the tested item and date(s) of the test;

f) test specification or description of the test method or testing instruction;

g) description of the sampling method if necessary;

h) all deviations, additions or limitations relative to the test specification, as well as other information that is important for the specific test;

i) data concerning all non-standard test methods or procedures used;

j) results of measurements, examinations and interpolated results; if necessary, complementary tables, graphs, sketches and photos;

k) indications concerning the accuracy of measurement (if relevant);

l) signature and title or corresponding indication of the persons responsible for the technical content of the test report, as well as the date of issue;

m) indication that the test results refer only to the tested items;

n) notice that the report may not be duplicated in extracts without permission of the testing laboratory;

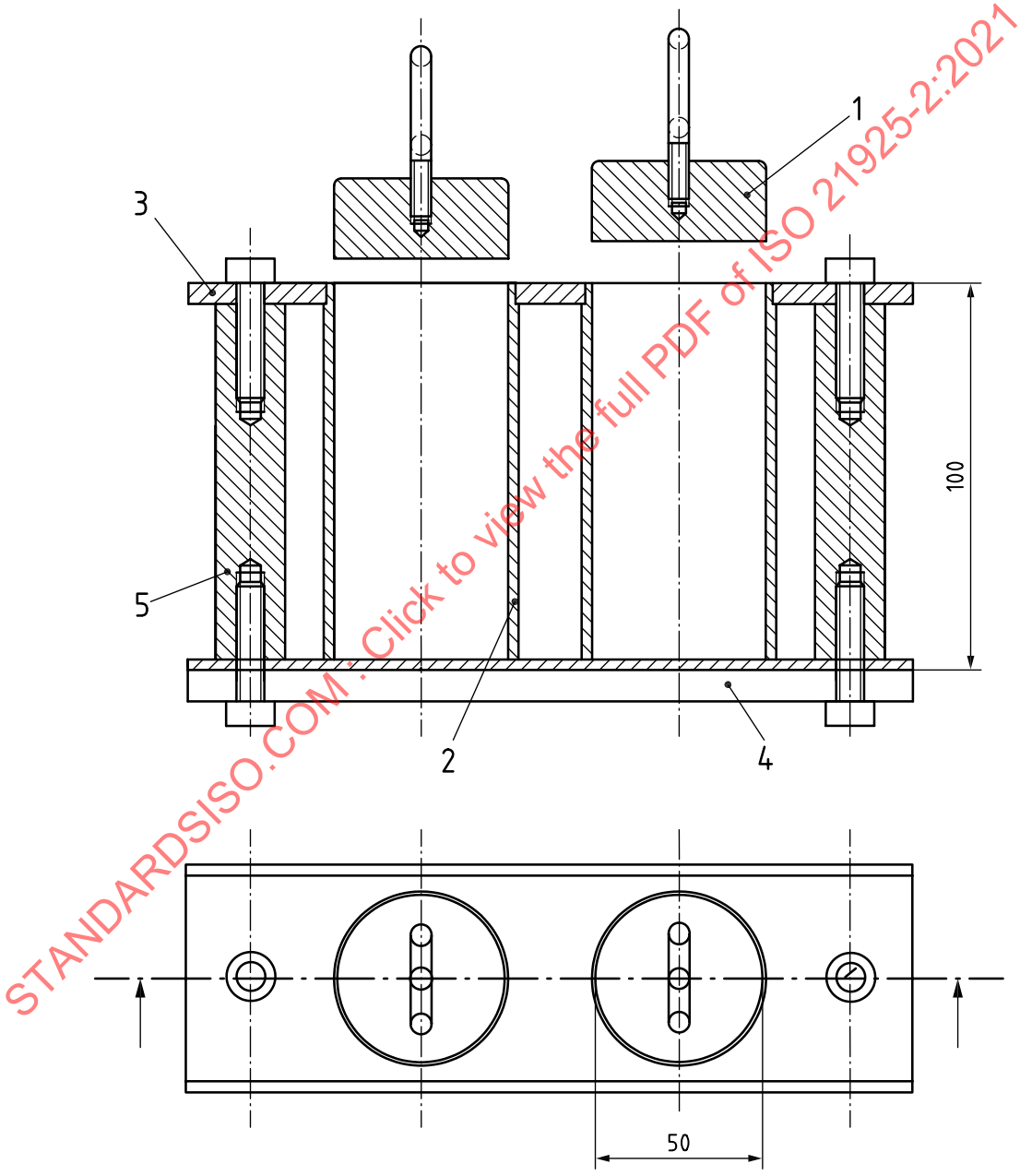
o) data from the tests described in Clauses 4 and 5;

p) test temperatures;

q) mass of the weights used in the pipe pressure test or die-set pressure test;

r) a reference to the International Standard used (including its year of publication).

Dimensions in millimetres



Key

1 weight

2 specimen tube

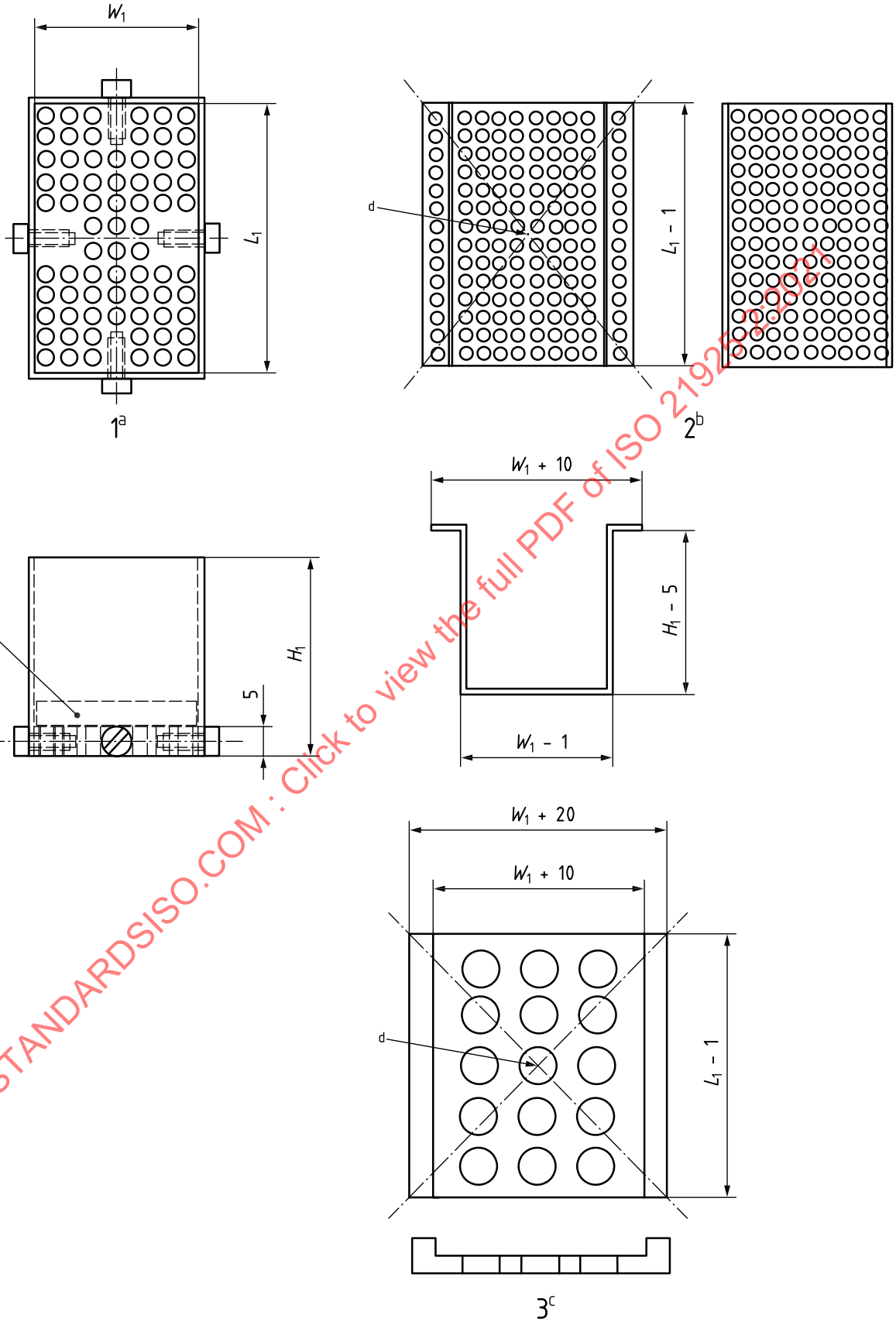
3 upper frame

4 lower frame

5 spacer bar

Figure C.1 — Pipe pressure test apparatus

Dimensions in millimetres



Key

1 lower die

2 upper die

3 weight

4 cross-section of specimen under test

a Dimension H_1 appropriate for the specimen expansion ratio; dimension W_1 to accommodate the width of the specimen; length L_1 to suit the specimen but typically 1,5 ± W_1; materials: 5 mm brass plate and 1,0 mm brass sheet.

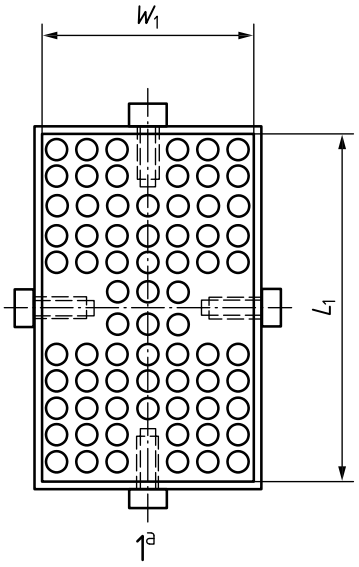
b Dimensions as shown: material: 1,00 mm perforated brass sheet.

c Dimensions as shown: material: brass plate.

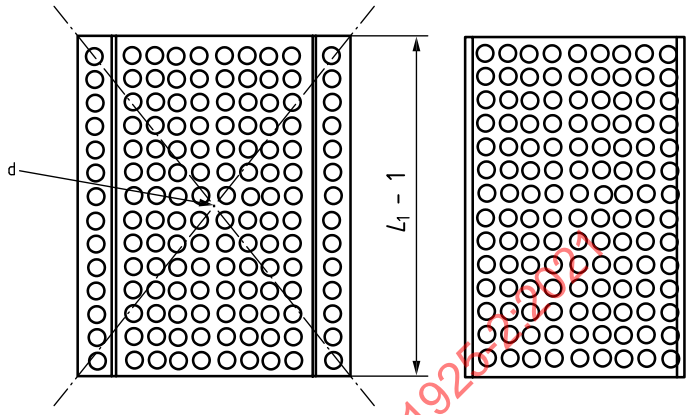
d Centre of gravity.

Figure C.2 — Die-set for rectangular specimens

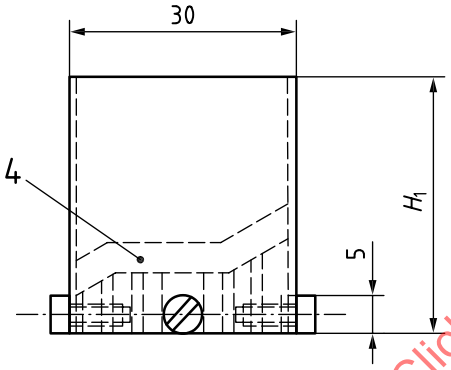
Dimensions in millimetres

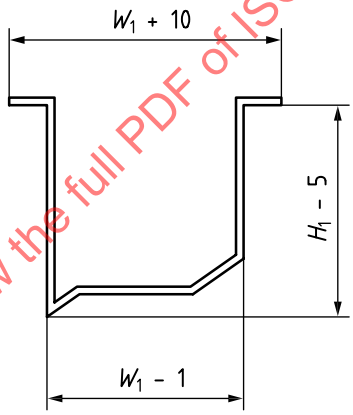


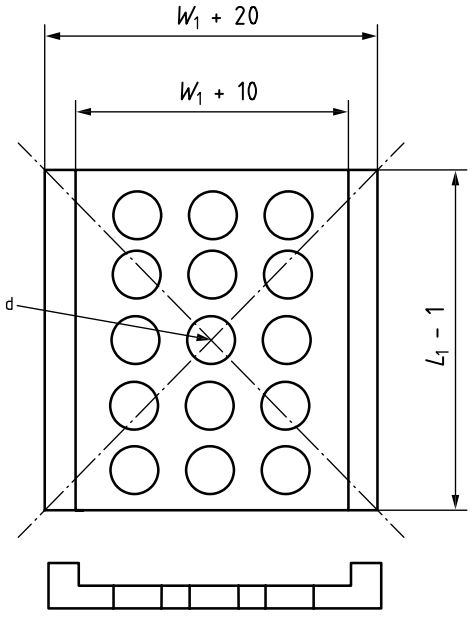
1[a]



2[b]







3[c]

Key

1 lower die

2 upper die

3 weight

4 cross-section of specimen under test

a Dimension H_1 appropriate for the specimen expansion ratio; dimension W_1 to accommodate the cross-section of the specimen; length L_1 to suit the specimen but typically 1,5 ± W_1; materials: 5 mm brass plate and 1,0 mm brass sheet.

b Dimensions as shown: material: 1,00 mm perforated brass sheet.

c Dimensions as shown: material: brass plate.

d Centre of gravity.

Figure C.3 — Die-set for contoured section specimens