
**Fire resistance tests — Fire dampers
for air distribution systems —**

**Part 1:
Mechanical dampers**

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Published in Switzerland

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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 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*.

This first edition of ISO 21925-1 cancels and replaces ISO 10294-1:1996, ISO 10294-2:1999, ISO 10294-3:1999 and ISO 10294-4:2001, which have been technically revised.

The main changes are as follows:

- integration of the requirements for mechanical dampers, which were published as four separate parts in the former ISO 10294-series, into a single document.

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.

Introduction

The material in the former ISO 10294-series was used to assess the fire resistance of mechanical fire dampers. The separate publications required multiple maintenance work and resources to keep them current and up-to-date. By having the requirements in a single volume, ISO 21925-1 is intended to improve efficiency and to be more user friendly. It is also anticipated that a single volume will serve the continued efforts to promote the alignment of the requirements contained in regional and national standards for testing fire dampers against this document.

ISO 10294-1:1996 addressed the spread of fire and smoke in buildings through ventilation ducts and other openings in fire-separating walls and floors.

ISO 10294-2:1999 provided classification, criteria and field of application for the test method given in ISO 10294-1:1996.

ISO 10294-3:1999 provided a background to the test method and a rationale to the procedures and the criteria selected with respect to the testing of fire dampers, as given in ISO 10294-1:1996.

ISO 10294-4:2001 provided a test method to evaluate the performance of fire damper-operating mechanisms.

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

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Fire resistance tests — Fire dampers for air distribution systems —

Part 1: Mechanical dampers

SAFETY WARNING — For suitable health precautions to be taken, the 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 spreading from one fire compartment to another through an air distribution system.

It is applicable to mechanical fire dampers. It 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 5167-7, *Measurement of fluid flow by means of pressure differential devices — Part 7: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full*

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:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1 test construction

complete test assembly, consisting of the separating element, 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 and the measuring station

3.5

measuring station

equipment consisting of pipe system with an orifice plate or venturi and an air flow straightener (if any), installed between the connecting duct and the exhaust equipment 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 (if any), to apply and maintain the underpressure in the connecting duct

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

actuating mechanism

<damper> mechanism, integral or directly associated with the damper which, when initiated by the damper triggering device, causes the movable component of the damper to change from the "open" to the "closed" position

3.9

insulated damper

damper which satisfies the integrity, leakage and insulation requirements of this document

3.10

uninsulated damper

damper which satisfies the integrity and leakage requirements of this document

3.11

thermal release mechanism

system which evaluates the parameters of temperature in the airflow of the ventilation duct and initiates the closing of the fire damper before a predicted threshold limit is reached

Note 1 to entry: The sensing element may be, for example, a fusible link, memory metal, frangible bulb or electrical sensor.

3.12

threshold limit

maximum operational temperature of the thermal release mechanism

4 Principles of the test

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 in a manner representative of good practice. Tests are performed starting with the damper in the open position so as to expose the actuating mechanism of the damper to furnace conditions. 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. The tightness of the damper in the closed position is also measured at ambient temperature prior to the start of the furnace test.

As the test conditions and tolerances for the beginning of the fire test are not specified in detail, the fire test enables only a limited assessment of the actuating mechanism to be carried out.

[Annex A](#) gives the historical background of the test.

5 Apparatus

The test apparatus specified in [5.1](#) to [5.8](#), including the instrumentation, shall be in accordance with ISO 834-1 except where specifically stated otherwise.

An example of a test arrangement is shown in [Figure 1](#).

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

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

5.3 Connecting duct, of all welded construction fabricated from $(1,5 \pm 0,1)$ mm thick steel with a width and height appropriate to the size of the damper under test. The duct shall have a length of $2 \times$ 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.

5.4 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](#).

5.5 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.

5.6 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.

5.7 Instrumentation for measuring and recording surface temperature, in accordance with ISO 834-1.

It shall be located, depending on the method of mounting the damper selected, in the positions shown in [Figures 3, 4, 5, 6, 7 or 8](#).

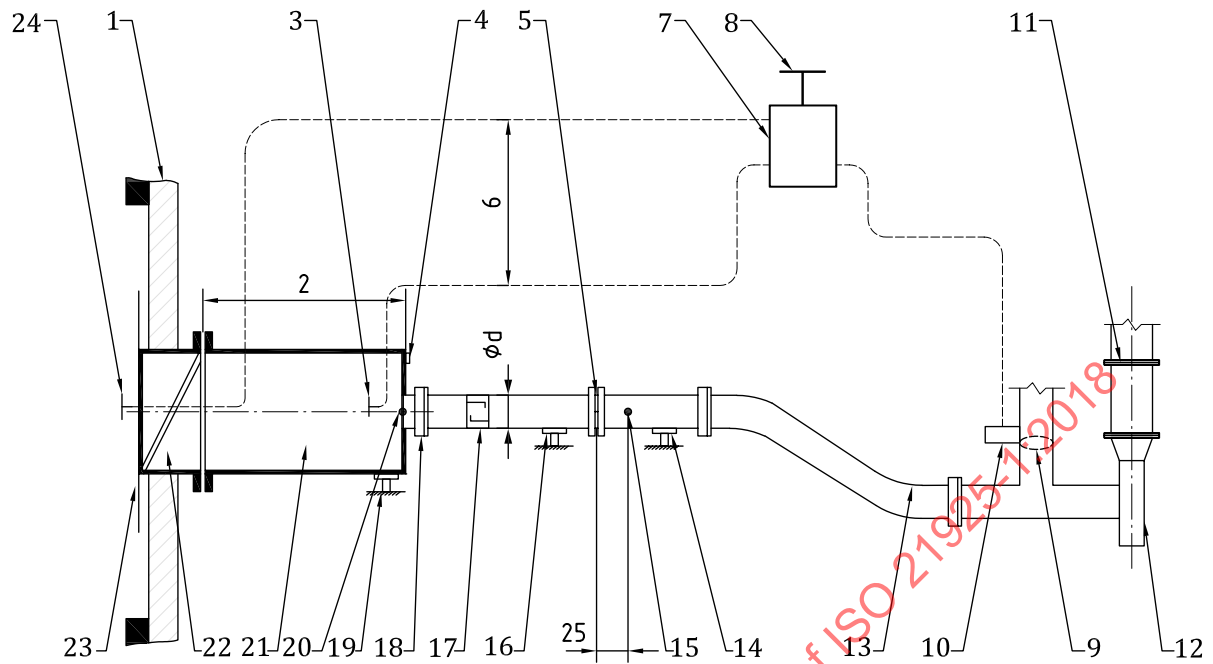
5.8 Instrumentation for measuring pressure differential between the furnace and the connecting duct.

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.

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

5.10 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.

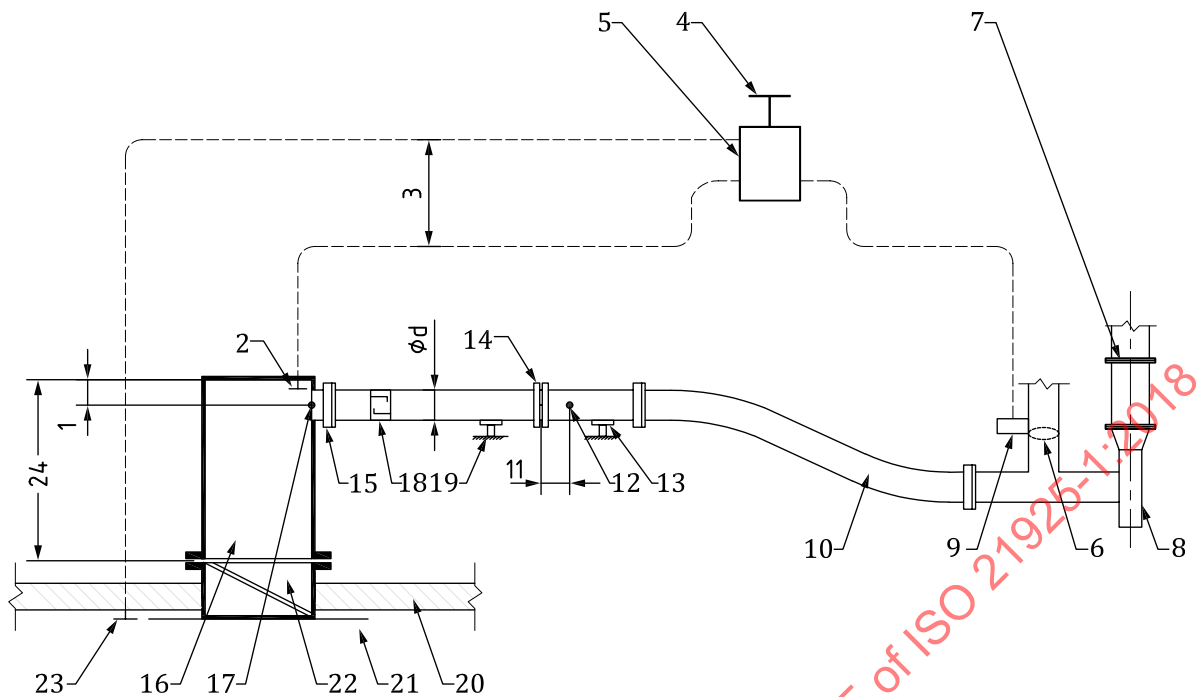
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Key

- 1 supporting construction (wall)
- 2 2× diagonal (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)
- 25 distance: thermocouple to orifice plate = 2 d

Figure 1 — Example of general test arrangement



Key

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

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

Dimensions in millimetres

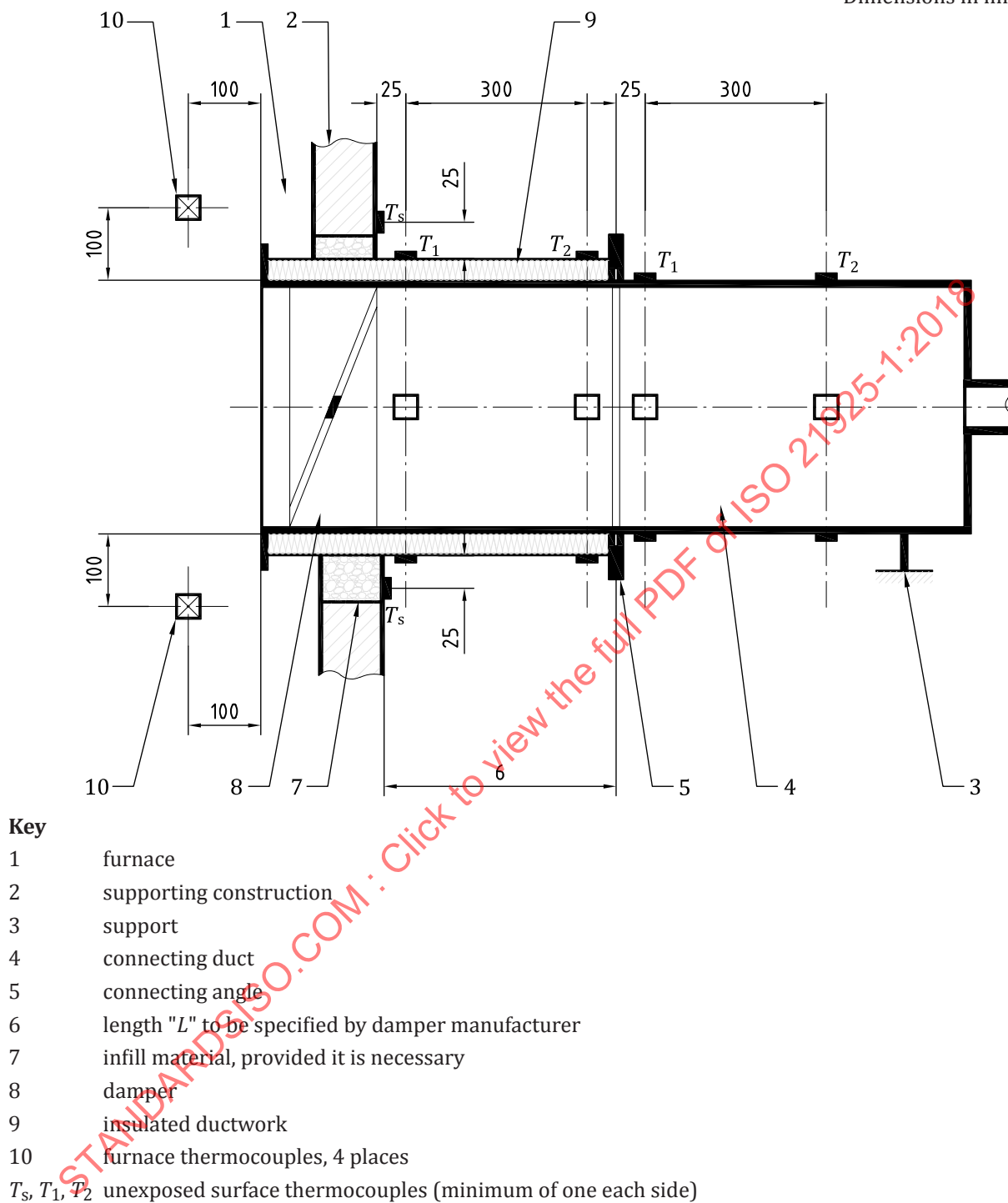
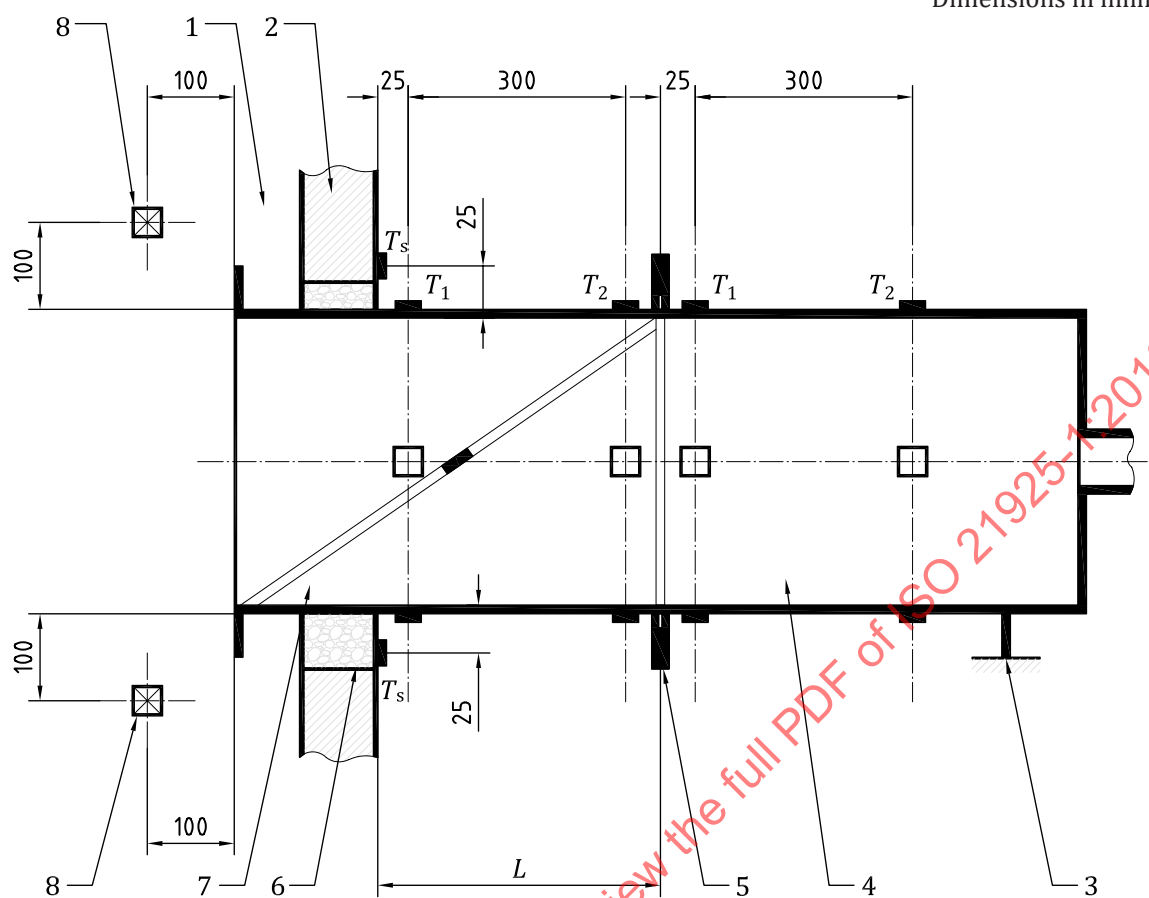


Figure 3 — Position of surface thermocouples when damper is installed in an insulated duct

Dimensions in millimetres

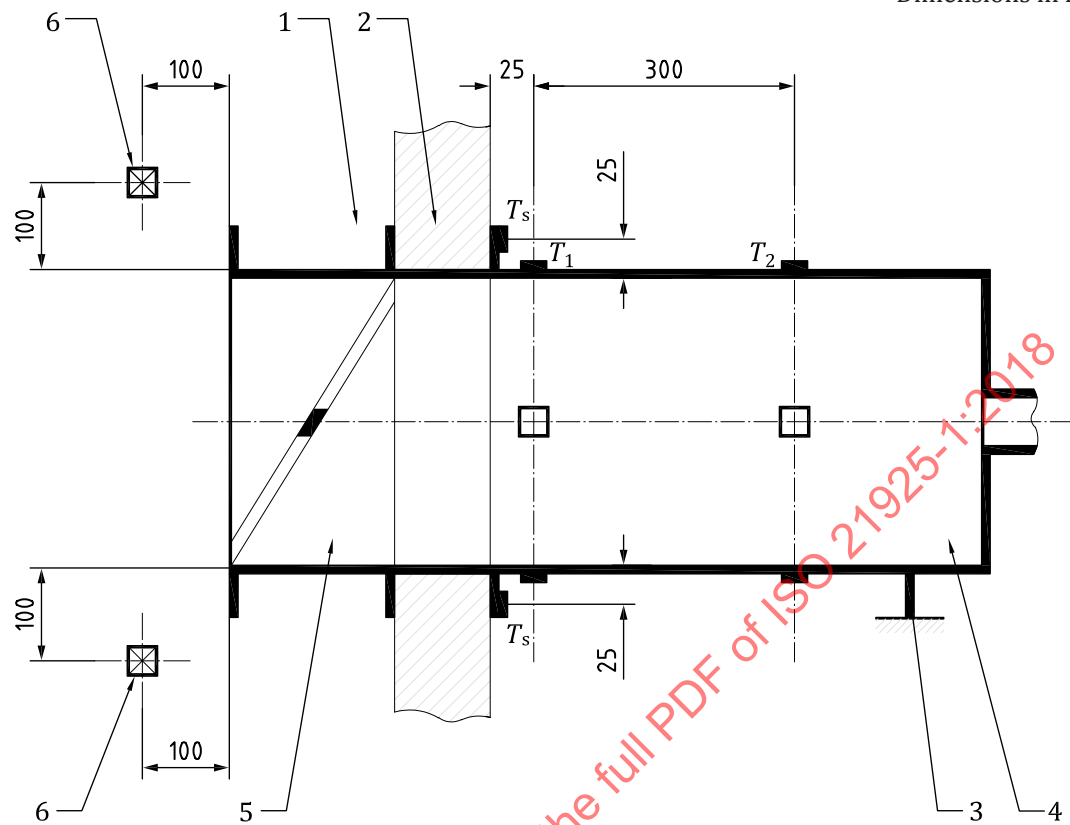


Key

- 1 furnace
- 2 supporting construction
- 3 support
- 4 connecting duct
- 5 connecting angle
- 6 infill material, provided it is necessary
- 7 damper
- 8 furnace thermocouples, 4 places
- L length to be specified by damper manufacturer
- T_s , 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

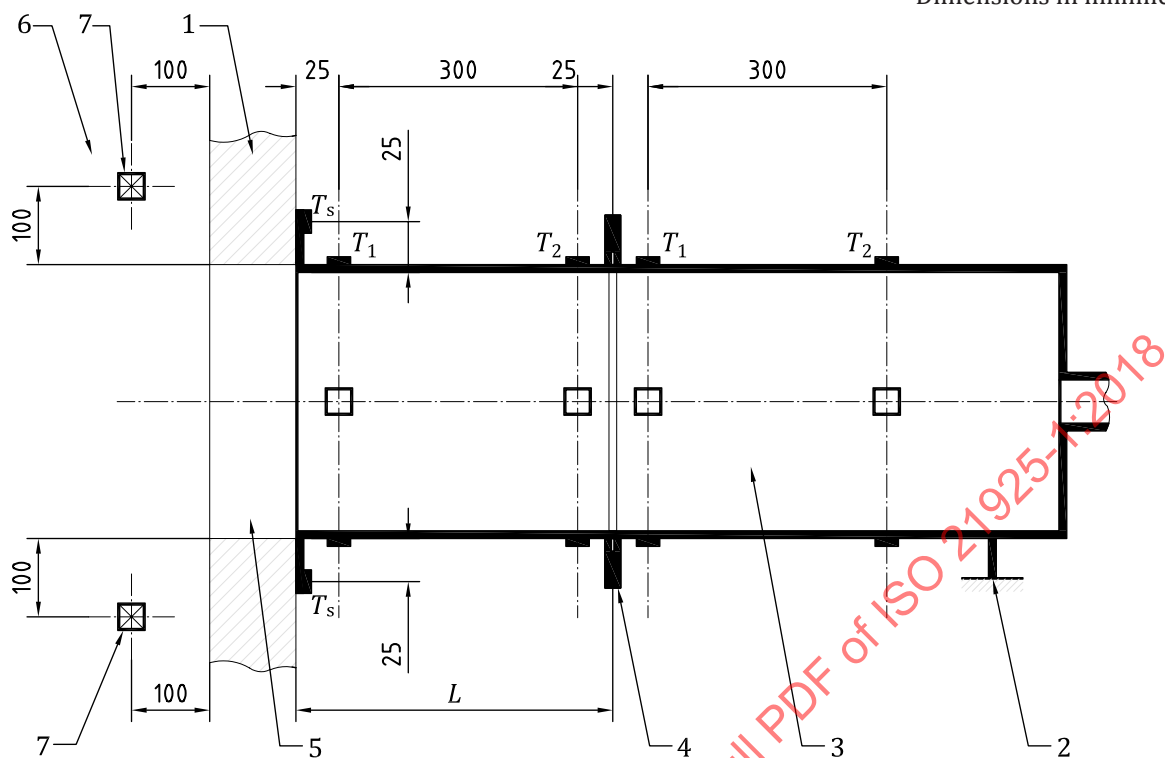


Key

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

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

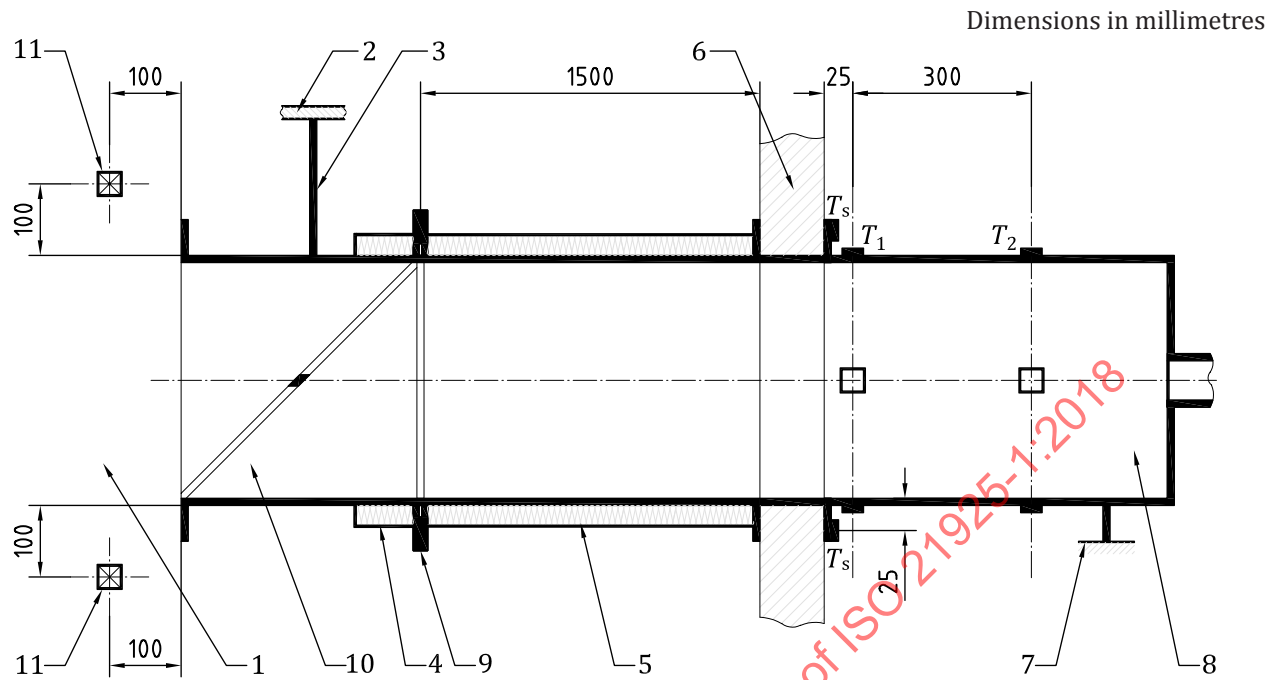
Dimensions in millimetres



Key

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

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

**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 damper
- 11 furnace thermocouples, 4 places

T_s , 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

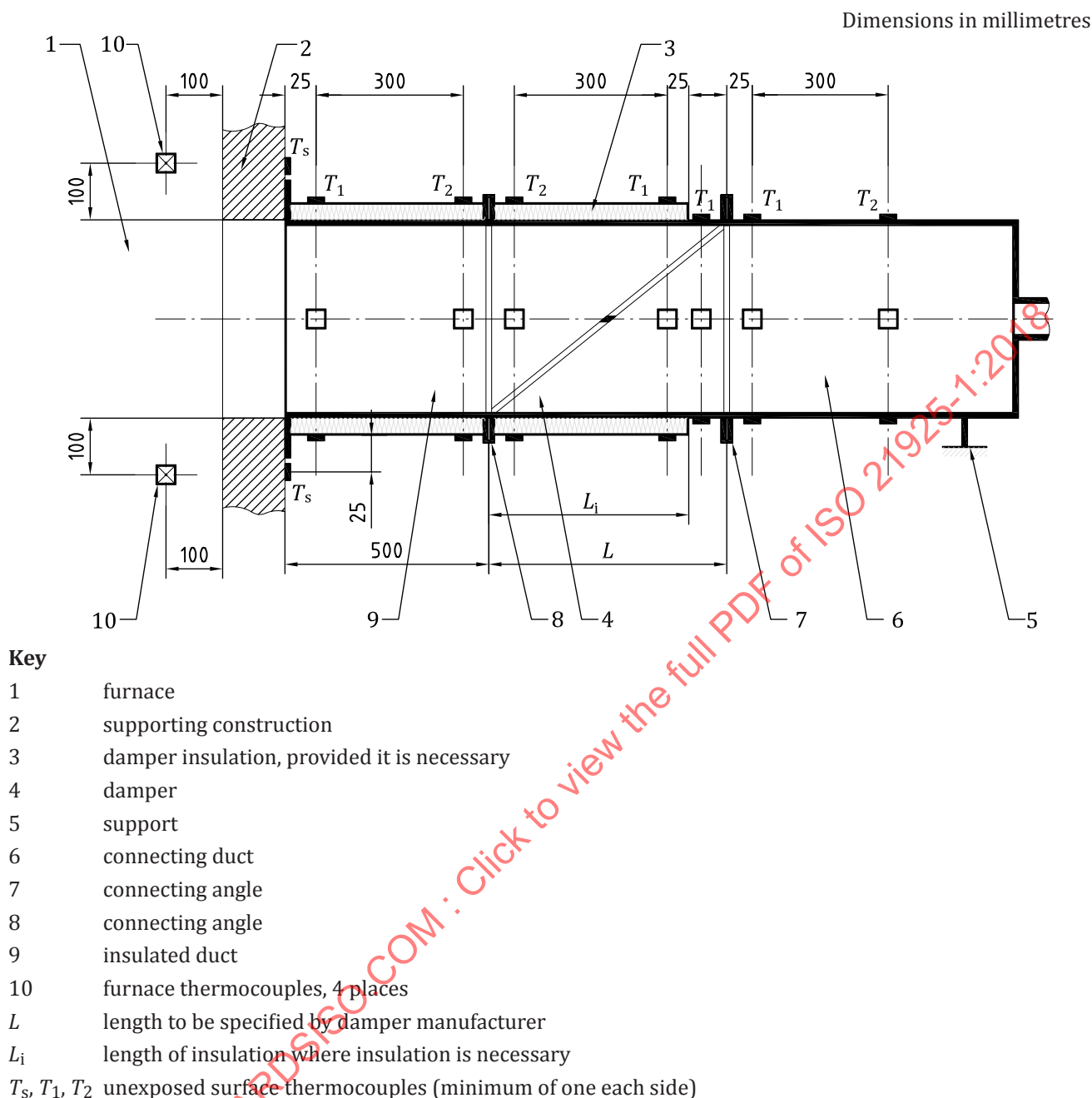


Figure 8 — Damper mounted remote from the supporting construction and outside the furnace chamber

6 Test construction

6.1 General

The test construction shall contain all construction details relevant for test results. Only a maximum of two dampers may be tested at one time.

6.1.1 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. For the purposes of determining whether a damper is symmetrical, the presence of the actuating mechanism can be ignored. However, in such a case, the damper shall be installed so that the actuating mechanism is on the side away from the furnace, as this is considered to be the more onerous condition because, as it will be further from the furnace, the time to its operation will be consequently longer.

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

6.1.2 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.

6.1.3 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.

6.1.4 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](#).

6.1.5 Dampers remote from wall or floor

6.1.5.1 Within the furnace

Dampers mounted 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.

6.1.5.2 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 In the case of an uninsulated damper, mounted on a section of a duct outside the furnace, this does not need to be tested.

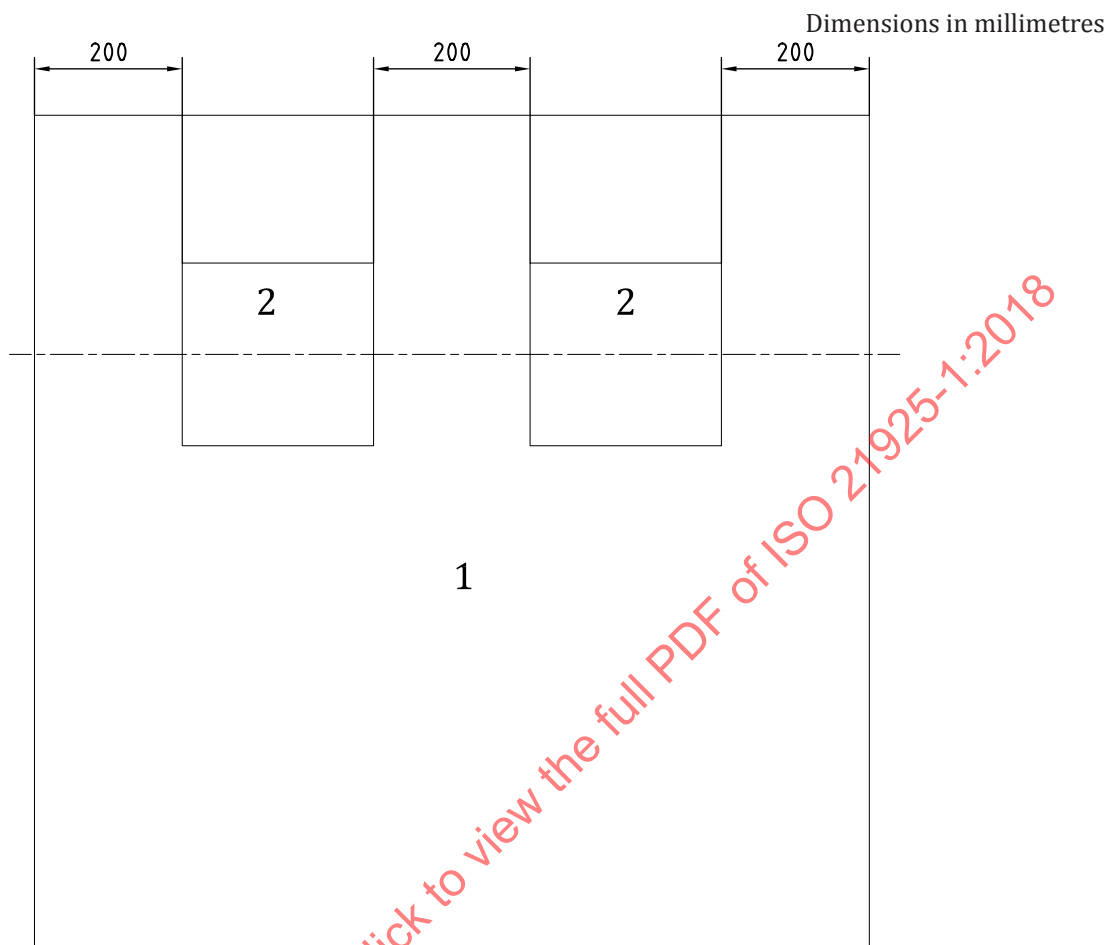
6.1.6 Minimum separation between dampers

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 [Figure 9](#). 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 size 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

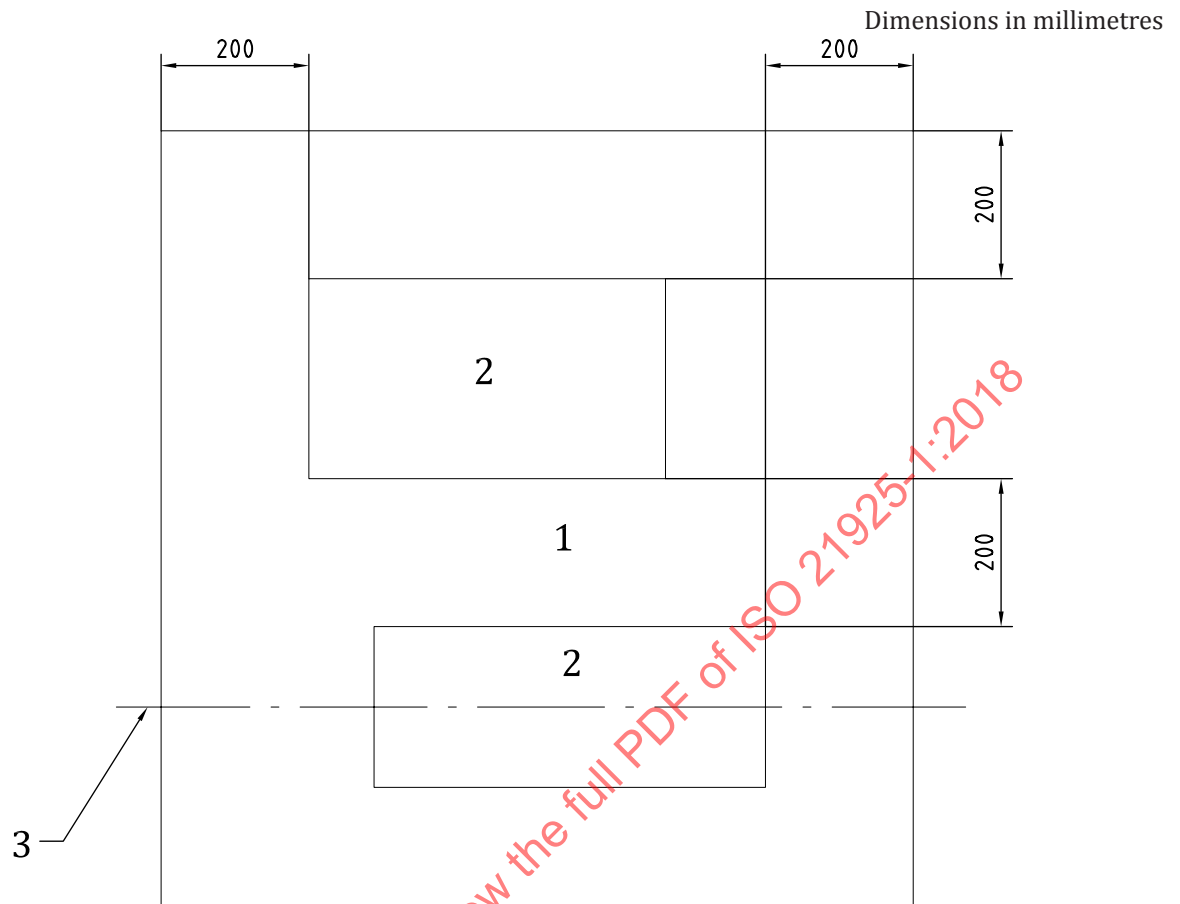
components, in particular the damper blade(s), are the same thickness and cross-sectional shape with respect to curtain and multi-blade dampers and blade width.



Key

- 1 supporting construction
- 2 damper

Figure 9 — Maximum separation between two dampers

**Key**

- 1 supporting construction (wall)
- 2 damper
- 3 pressure of 15 Pa maintained on this plane

Figure 10 — Dampers mounted in different horizontal planes

6.3 Thermal release mechanism

The thermal release mechanism shall be included in the specimen construction. If there are alternative release mechanisms where these are in series with the basic thermal release and can be shown to not inhibit the basic release then only the one thermal release mechanism is required to be tested. (See optional requirements in [Annexes B, C and D](#))

NOTE Where a damper design is modified solely with respect to the thermal release mechanism, it is not necessary to continue the test after closure provided that the release mechanism does not affect the maintenance of the closed state of damper.

6.4 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](#).

6.5 Supporting construction

6.5.1 Principles

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

6.5.1.2 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.

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

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

6.5.2 Recommended supporting constructions

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/m ³	Test duration <i>t</i> h
Normal concrete/masonry	110 ± 10	2 200 ± 200	<i>t</i> = 2
	150 ± 10	2 200 ± 200	2 < <i>t</i> ≤ 3
	175 ± 10	2 200 ± 200	3 < <i>t</i> ≤ 4
Aerated concrete ^a	110 ± 10	650 ± 200	<i>t</i> = 2
	150 ± 10	650 ± 200	2 < <i>t</i> ≤ 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 <i>D</i> / <i>ρ</i>	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/m ³	Test duration <i>t</i> h
Normal concrete	110 ± 10	2 200 ± 200	<i>t</i> = 1,5
	150 ± 10	2 200 ± 200	1,5 < <i>t</i> ≤ 3
	175 ± 10	2 200 ± 200	3 < <i>t</i> ≤ 4
Aerated concrete	125 ± 10	650 ± 200	<i>t</i> = 2
	150 ± 10	650 ± 200	2 < <i>t</i> ≤ 4

6.5.2.1 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.

6.6 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 may 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 may 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 m³/h, improve the sealing of joints and stability of test construction until the leakage criterion referred to above can be met. For pressure differentials higher than 300 Pa the leakage of 12 m³/h may be increased by a factor ($P_{\text{test}}/300$) 0,5.

7.7 Remove sealing from the inlet aperture of the damper.

8 Determination of leakage at ambient temperature

8.1 Subject the damper to 50 opening and closing cycles.

8.2 After the 50th cycle, check that the damper still locks in the closed position and that it shows no mechanical damage that will affect the operation of the damper.

8.3 Close the damper.

8.4 Adjust the exhaust fan to maintain an underpressure of 300 Pa (or higher underpressure) in the connecting duct relative to the laboratory.

8.5 Record the pressure differential across the orifice plate, venturi or other suitable device at not more than 2-min intervals for a period of 20 min or until stable readings are reached.

8.6 Calculate the leakage 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. Deduct the value for the leakage of the connecting duct and measuring station determined in [Clause 7](#) from the measured leakage.

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 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. If the damper fails to close after 2 min from igniting the furnace, discontinue the test.

9.8 During 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

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 $\text{m}^3/(\text{h} \cdot \text{m}^2)$	Fire test		
			Leakage limit $\text{m}^3/(\text{h} \cdot \text{m}^2)$	Temperature rise limit $^{\circ}\text{C}$ 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_3 (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 compliance 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.

10.1 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 that may be required. Experience may show that not all tests need to be undertaken, as some installation options may be found to represent the most onerous condition, in which case the number of tests required can 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 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.

12 Direct field of application of the test results

12.1 Size of fire damper

If the S classification is not required, 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.

If the S classification is required, an additional fire damper, representing the smallest size in the range, shall satisfy the smoke leakage criteria when tested according to the procedure described in [Clause 8](#).

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 6.5.2 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.

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Annex A **(informative)**

Historical background of the test methods

A.1 Philosophy

A.1.1 General

The test described in this document is designed to measure the ability of a damper to:

- a) close in the event of a fire under dynamic conditions;
- b) to resist the spread of fire and gases from one compartment to another through an air distribution system.

During the early stages of developing the test, the requirements for air distribution systems in various countries were examined in relation to spread of fire, and it became clear that the design philosophy varied considerably from country to country. The principle differences in philosophy and practice that were identified are as given in [A.1.2](#) to [A.1.5](#).

A.1.2 Fan on/off

Design philosophies vary. In some applications, air distribution systems are designed so that in the event of a fire occurring the fans switch off. Others are required to continue to provide air handling to parts of the building remote from the fire. In such a situation, the dampers have to close under dynamic conditions and, once they are closed, they may be subjected to high underpressures with a corresponding higher risk of leakage and consequently with potentially more rapid spread of fire.

It cannot be guaranteed under fire conditions that a fan will be off and therefore a dynamic condition may exist. A system failure can occur and the fan may not switch off. Therefore it is considered to be important to test the damper under dynamic conditions. The standard underpressure of 300 Pa was chosen as it corresponded to the underpressure used in ISO 6944-1. This was considered adequate to cover most applications. It was recognized that for special industrial applications dampers may be designed to withstand higher underpressures. To allow for these special applications, allowance has been made to allow the test to be undertaken at increased underpressures.

The 0,15 m/s fire test velocity is a compromise between the need for a dynamic air flow test and fire safety within the fire test laboratory. For these safety reasons, closure testing at higher velocities/pressures, if considered necessary, should be carried out under ambient air flow conditions and not when the furnace is ignited at high temperatures.

A.1.3 Installation practice

Some countries and some design practices require that the dampers be installed within the plane of the wall and floor and do not permit the damper to be remote from the separating construction. Other countries or design practices allow the damper to be installed either on the face or remote from the wall or floor. The test method provides guidance for testing all such possible installations but it is only necessary to test the installation method(s) applicable to the individual country concerned.

A.1.4 Insulation

Dampers are available both insulated and uninsulated. The method provides for the testing of all types of dampers.

A.1.5 Integrity

Measurement of integrity is based on measurement of gap leakage through the damper, together with conventional integrity measurements around the outside perimeter. The dynamic leakage measurements described in [Clause 8](#) of this document, give a more precise indication of integrity performance.

A.2 Test principles

A.2.1 General

Prior to the determination of leakage the damper is subjected to 50 opening and closing cycles. This is intended to represent approximately two inspections per year on an installed damper to check its correct operation. This number of cycles may be inadequate for dampers which provide an air flow control function.

The fire test is started with the damper in the open position. This is intended to test the primary actuating mechanism attached to the damper. Secondary control devices remote from the damper are not covered by this test. It is considered important to start the test in this way as not only does it test the actuating mechanism, but it also checks that during the time that the damper remains open it does not distort and prevent closure once the actuating mechanism operates.

Whilst some difficulties may be experienced in controlling the furnace temperature and pressure whilst the damper is open, there is adequate time provided the damper closes within the specified time of 2 min, to be within the defined limits of the time-temperature curve defined in ISO 834-1 at 5 min.

A.2.2 Determination of leakage of connecting duct and measuring station

The limit of 12 m³/h appropriate to the fire test was selected as this represented the lowest leakage that could be accurately measured in accordance with ISO 5167-1. Consideration was given to measuring an actual leakage and then deduct this value from the leakages recorded during the test. However it was considered that this approach would create problems as the leakage of the test rig might increase during the test. The approach adopted is to make the seals as tight as possible so that any increase in rig leakage during the test will be minimal. It is essential that considerable care be taken to ensure good tight seals at all joints and that a suitable high-temperature joint sealant is used.

A.2.3 Determination of leakage at ambient temperature

Leakage of the damper at ambient temperature is measured only for dampers intended to be classified to the S designation. Both the largest and the smallest sizes of dampers in a product are evaluated.

A.2.4 Fire test

The air velocity of 0,15 m/s was selected because experimental work indicated that at the moment a damper closes a very high underpressure can exist across the damper. This low air velocity was selected as it has been demonstrated during tests that at the point of closure the underpressure would not be substantially in excess of the required underpressure of 300 Pa.

The 0,15 m/s fire test velocity is therefore a compromise between the need for a dynamic air flow test and fire safety within the fire test laboratory. For these safety reasons, closure testing at higher velocities/pressures, if considered necessary, should be carried out at ambient air flow conditions and not when the furnace is ignited at high temperatures.

Any failure of the damper to close within the allowable time of 2 min is regarded as a failure. If the damper is closed manually and the test continued to determine leakage rates, such data can only be regarded as for information only as an essential requirement for a damper has not been met.

The leakage is determined from the recorded local temperature and the recorded pressure differential from the orifice plate, venturi, etc. using formula for volume flow rates given in ISO 5167-1.

A.3 Commentary on criteria and classification

Tests in accordance with the test method were undertaken on a range of European and North American fire dampers, all of which satisfied conventional measurements for integrity. It was established that the existing products were capable of satisfying a leakage limit of $360 \text{ m}^3/(\text{h} \cdot \text{m}^2)$, and this limit was adopted for evaluation of compliance of integrity using gas flow measurements (E designation).

In relation to smoke leakage, available analytical data was examined, taking into account such parameters as acceptable concentrations of smoke, required degree of dilution, time for escape, which led to an acceptable smoke leakage of $200 \text{ m}^3/(\text{h} \cdot \text{m}^2)$, being derived. This is the limit used for checking compliance with the S designation.

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Annex B

(informative)

Alternative thermal release mechanisms

B.1 The following procedure can be agreed between the sponsor and the testing laboratory to evaluate alternative thermal release mechanisms.

B.1.1 The thermal release that is installed with the damper is randomly selected from five identical units. Three of the remaining release mechanisms shall be evaluated to the requirements in [Annex C](#) to determine a threshold response time. The threshold shall be the average response time of three links when tested to the requirements of [Annex C](#). The response time is used to evaluate the comparative performance of other alternative thermal release mechanisms that are evaluated to the requirements of [Annex C](#). [Annex D](#) specifies a reliability tests for thermal release mechanisms.

Annex C (informative)

Test of thermal release mechanisms

C.1 Introduction

This Annex specifies the test requirements identified as response behaviour and faulty set-off that are related to thermal release mechanisms used in fire dampers. Only the thermal release mechanism is subjected to the tests described in this annex.

The responsive behaviour test is designed to ensure that under fire conditions the thermal release mechanism complies with the expected functions so that the damper closes completely so as to prevent the spread of fire.

The faulty set-off test is intended to ensure the thermal release mechanism does not close the damper in non-fire conditions.

These tests are only applicable to thermal release mechanisms installed within the damper or duct. It does not cover thermal release mechanisms that are located outside the ventilation duct.

The tests can provide information on comparative performance between one thermal release mechanism and another and thus provide a means of testing of thermal release mechanisms that have not been included in the damper assembly that was tested for fire resistance.

The test method specified in this Annex determines whether the thermal activation system for the closing device of a fire damper system:

- is suitable for a fire damper assembly to be tested for fire resistance in accordance with this standard;
- is suitable for a fire damper already qualified according to this standard with an alternative system of the same class (temperature-load);
- is intended to provide information on comparative performance between one thermal release mechanism and another and thus provides for the testing of thermal release mechanisms that have not been included in the fire damper assembly that was used in the fire resistance test.

C.2 Requirements

C.2.1 Thermal release

The thermal release mechanism is installed in the centreline of the cross section of the thermal release test duct, which is part of the test arrangement according to [Figure C.1](#) or [Figure C.2](#). The test arrangement shall include a heating arrangement that can expose the thermal release mechanism to the conditions specified in [C.2.2](#), also a fan and velocity measuring equipment. A suitable method of controlling the air temperature and velocity shall be provided.

The position in which the thermal release mechanism is installed shall be chosen such that the airflow conditions near the heat-sensitive element are in accordance with the practical conditions. If the test specimens are not absolutely symmetrical, the test of response behaviour described in [C.2.2](#) and the test of faulty set-off described in [C.2.3](#) shall be performed in both possible directions of airflow.

C.2.2 Response behaviour

Starting at an initial temperature of $(25 \pm 2) ^\circ\text{C}$, the thermal release mechanism shall be exposed to an increasing air temperature such that it follows the relationship (see [Figure C.3](#)):

$$T = (25 + 20t) \pm 2$$

where

T is the temperature, in degrees Celsius;

t is the time from the start of the test period, in minutes.

The mean air velocity at the start of this test shall be $(1 \pm 0,1)$ m/s. The test shall be performed three times for each orientation and location of the thermal release mechanism. The thermal release mechanism shall operate before the threshold limit is exceeded on each of the samples tested.

NOTE The threshold limit is established by the manufacture of the thermal release mechanism. Thermal release mechanisms are designed for use in various environments such as typical interior conditioned air, cold climates and within warm air ducts. Threshold limits such as $50 ^\circ\text{C}$ (cold countries), $120 ^\circ\text{C}$, $180 ^\circ\text{C}$ or $350 ^\circ\text{C}$ are available.

The threshold response time, or the time when the thermal response mechanism operates during the response behaviour test, shall not exceed:

- a) The time equalling the average of the threshold time $+10\%$ determined from a minimum of three tests on links representative of the link used in the fire damper test specimen for the fire resistance test.

A thermal release mechanism that has been previously tested to the fire damper fire resistance test shall be used to determine a threshold response time. Three thermal release mechanisms, selected from a batch of five shall be evaluated using the response behaviour test. The threshold response time shall be determined as the average response time of these three thermal release mechanism for each orientation required (see [C.2.5.1](#)) or

- b) The time required for the thermal response mechanism, when tested in accordance with the response behaviour test, to rise above the threshold limit designated for the thermal response mechanism.

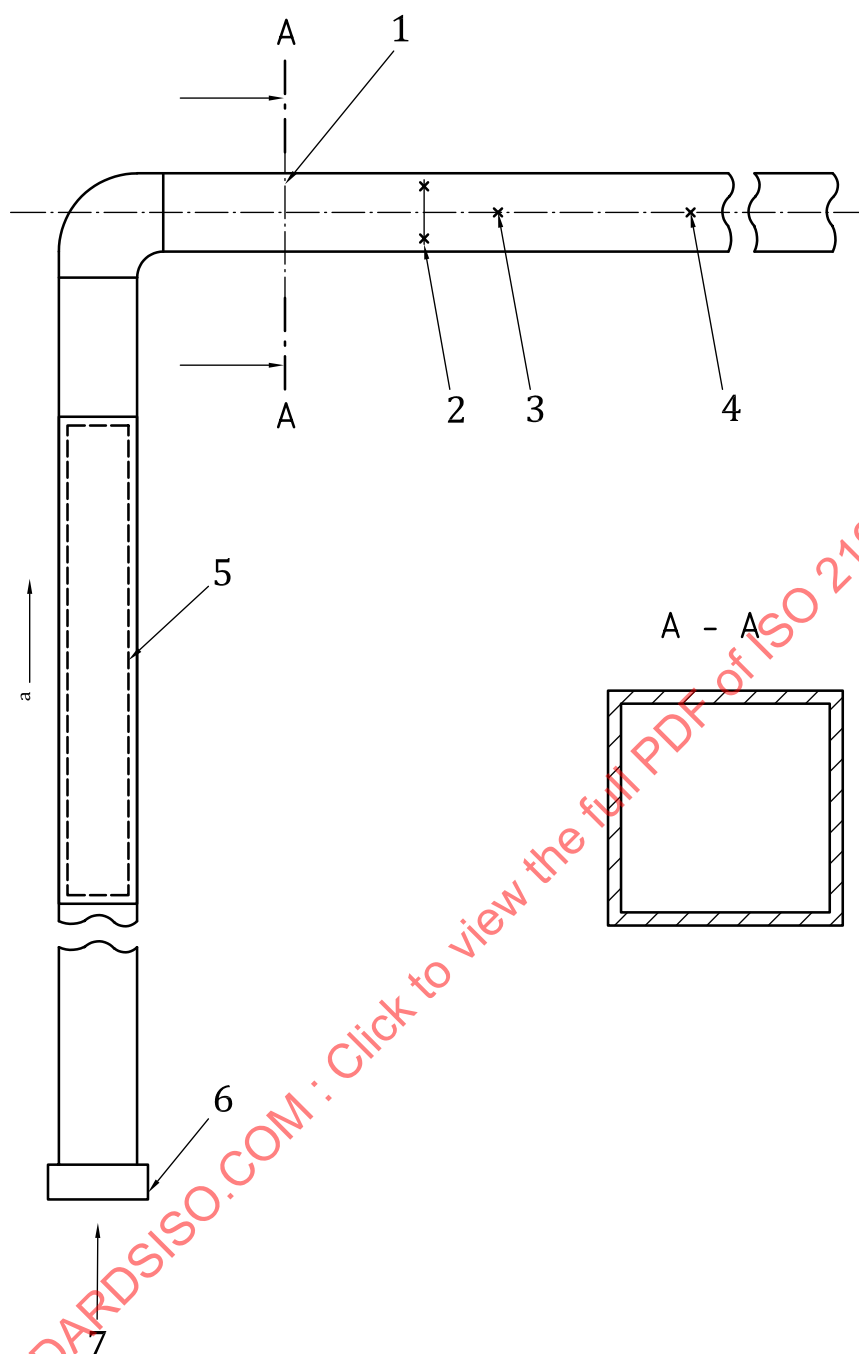
C.2.3 Faulty set-off

For 1 h the specimen shall be exposed to an air temperature of $(60 \pm 2) ^\circ\text{C}$. The thermal release mechanism shall be under the same loading as would be applied under normal service conditions. The mean airflow velocity (mass flow) for this test shall be $(1 \pm 0,1)$ m/s. The test shall be performed once for each orientation and location of the thermal release mechanism.

The thermal release mechanism shall not release in any of the samples tested.

C.2.4 Test apparatus

The recommended types of devices with opened and closed airflow are shown in [Figure C.1](#) and [Figure C.2](#). Larger and smaller cross sections may be used provided the requirements for the air temperature and the airflow velocity are met.



Key

- 1 baffles for airflow
- 2 thermocouples
- 3 thermal release mechanism
- 4 anemometer, distance 4 D from the fan
- 5 heating zone
- 6 fan
- 7 ingress of air
- a Flow.

Figure C.1 — Test arrangement