BS EN 1366-10:2011

BSI Standards Publication

Fire resistance tests for service installations

Part 10: Smoke control dampers

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National foreword

This British Standard is the UK implementation of EN 1366-10:2011.

The UK participation in its preparation was entrusted to Technical Committee FSH/22/-/4, Fire resistance tests for dampers, seals and smoke extraction.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 1366-10:2011) has been prepared by Technical Committee CEN/TC 127 “Fire safety in buildings”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2011, and conflicting national standards shall be withdrawn at the latest by October 2011.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

EN 1366 ‘Fire resistance tests for service installations’ consists of the following

Part 1: Ducts

Part 2: Fire dampers

Part 3: Penetration seals

Part 4: Linear joint seals

Part 5: Service ducts and shafts

Part 6: Raised access and hollow core floors

Part 7: Conveyor systems and their closures

Part 8: Smoke extraction ducts

Part 9: Single compartment smoke extraction ducts

Part 10: Smoke control dampers

Part 11: Fire protective systems for cable systems and associated components (in course of preparation)

Part 12: Fire resistance tests for service installations - Part 12: Non-mechanical fire dampers (in course of preparation)

Part 13: Fire resistance tests for service installations - Part 13: 1-, -2, 3- sided ducts (in course of preparation)

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

When smoke and heat exhaust ventilation are being considered, it becomes apparent that a clear path needs to be made between the area where heat and smoke is being generated (the fire) and the outside of the building.

To create this path there need to be ducts and the smoke extract path needs to remain uninterrupted. This means that smoke control dampers at the fire and along the path have to be open and remain open. Smoke control dampers at branches, or on the surface of the duct, along the path need to be closed and remain closed. In fact, if the duct crosses a compartment boundary it becomes part of the fire compartment in which the fire started.

The purpose of this European Standard is to define test methods to evaluate the abilities of smoke control dampers to

1) be applicable to single compartment and/or multi compartment fire resisting applications;

2) be applicable to automatic systems or systems with manual intervention;

3) change state from closed to open at elevated temperatures, and vice versa;

4) once opened maintain a defined cross sectional area at elevated temperature;

5) maintain a satisfactory leakage performance when subjected to negative pressure at elevated temperatures.

The units need to be mounted for the tests in a manner representative of practice.

Temperature and integrity measurements need to be carried out on various parts of the test construction during the test. Leakage measurements required need to be measured by direct flow measurement at the prescribed pressure differentials. Ambient leakage of the units needs also to be recorded.

Performance of these tests need to allow products to comply with EN 12101-8 and be classified to EN 13501-4. The required temperatures, pressure differentials etc. are stated in EN 12101-8.

Completing the tests within this European Standard does not ensure full compliance with EN 12101-8, as other, additional, requirements are defined in EN 12101-8. Some of these may be required to meet the classification requirements of EN 13501-4 as well.

Caution

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

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

1 Scope

This European Standard specifies test methods for smoke control dampers to assess their performance under elevated temperature or fire conditions.

It needs to be noted that the smoke control damper to be tested may require testing to EN 1366-2 and that this needs to be considered before carrying out these tests.

Smoke control damper tests are required to confirm that the furnace testing requirements of EN 12101-8 are met and EN 12101-8 needs to be considered before carrying out these tests.

Smoke control dampers tested to this European Standard should be classified using EN 13501-4 and this European Standard needs to be considered before carrying out these tests.

To this end this European Standard needs to be read in conjunction with EN 12101-8, EN 13501-4, EN 1366-2 and EN 1363-1, the latter giving further details for fire resistance testing.

For installation details the requirements for smoke extraction ducts need to be considered and these are defined in EN 1366-8 and EN 1366-9.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1363-1, *Fire resistance tests — Part 1: General requirements*

EN 1366-2, *Fire resistance tests for service installations — Part 2: Fire dampers*

EN 1366-8, *Fire resistance tests for service installations — Part 8: Smoke extraction ducts*

EN 1366-9, *Fire resistance tests for service installations — Part 9: Single compartment smoke extraction ducts*

EN 1507, *Ventilation for buildings — Sheet metal air ducts with rectangular section — Requirements for strength and leakage*

EN 1751, *Ventilation for buildings — Air terminal devices — Aerodynamic testing of damper and valves*

EN 13501-4, *Fire classification of construction products and building elements — Part 4: Classification using data from fire resistance tests on components of smoke control systems*

EN ISO 5167-1, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full — Part 1: General principles and requirements (ISO 5167-1:2003)*

EN ISO 13943:2010, *Fire safety — Vocabulary (ISO 13943:2008)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 13943:2010 and the following apply.

3.1
air inlet
device connected to outside air to allow the inlet of air from outside the construction works

3.2
attended control room
room with people, who have the duty to control the smoke exhaust system, permanently (24 h, seven days per week) monitor the incoming signals from the smoke control system and put the smoke control system into operation in case of smoke alarm

NOTE This ensures that the smoke control system is running and items such as the smoke control dampers are in position within the system response time.

3.3
back-up power supply
power supply to operate the system when the normal power supply has failed

3.4
commissioning
act of ensuring that all components and the system are installed and operating in accordance with this European Standard

3.5
elevated temperature
temperature in excess of normal ambient air, below those necessary for fire resistance testing, to which smoke and heat exhaust ducts for single compartments are tested

3.6
fire compartment
enclosed space, comprising one or more separate spaces, bounded by elements of construction having a specified fire resistance and intended to prevent the spread of fire (in either direction) for a given period of time

NOTE Fire compartment often has regulatory connotations. The term should not be confused with "room of origin" or "fire cell".

3.7
HVAC
heating, ventilating and air conditioning (usually used in association with the word system)

3.8
interface control unit
device which controls the operation of the actuator located at the smoke control damper or within the same fire zone as the smoke control damper – usually associated with a smoke control/fire alarm system

3.9
largest size
this refers to the largest size of damper individual unit (as opposed to an assembly of units) proposed for sale/manufacture

3.10
modulating actuators
smoke control damper or fire damper control mechanism which can control the smoke control damper or fire damper to be in a position or number of positions between fully open and fully closed

3.11
multi compartment fire resisting smoke control dampers
smoke control dampers for use in multi compartment areas, which may be associated with smoke control duct tested according to EN 1366-8 and/or may be installed within or on the face of a fire compartment structure

3.12
multi compartment fire resisting smoke control system ducts
fire resisting ducts for use in multi compartment application and that have been tested and met the requirements of EN 1366-8

3.13
natural smoke and heat control system
smoke and heat ventilation system which uses natural ventilation

NOTE Natural ventilation is caused by buoyancy forces due to differences in density of the gases because of temperature differences.

3.14
penetration seal
product used between the smoke control system duct/damper and the fire compartment structure to maintain the fire resistance, when tested and having met the requirements of EN 1366-8, at the position where a smoke control system duct passes through the element, or a smoke control damper or fire damper is mounted in the element

3.15
powered smoke and heat exhaust system
smoke and heat ventilation system which utilises a number of smoke control fans having met the requirements of EN 12101-3 for a defined period of time which causes the positive displacement of gases

3.16
pressure differential systems
system of fans, ducts, vents, and other features provided for the purposes of creating a lower pressure in the fire zone than in the protected space (see prEN 12101-13)

3.17
remote signalling device
device located away from the smoke control damper or fire damper which indicates the damper position, open or closed

3.18
safety position
position (open or closed) into which specific projects may require certain dampers to move, depending upon the fire location within the building

NOTE Specific projects can require certain smoke control dampers to move to an open or closed position, depending upon the fire location within the building.

3.19
single compartment smoke control dampers
smoke control dampers for use in single compartment areas, which may be associated with smoke control ducts tested to EN 1366-9, and/or may be installed in an external wall, floor or roof

3.20
single compartment smoke control system ducts
ducts for use within single fire compartment application and that have been tested and met the requirements of EN 1366-9

3.21
smallest size
this refers to the smallest size of damper individual unit including the minimum width and length proposed for sale/manufacture

3.22
smoke and heat exhaust ventilation system (SHEVS)
system consisting of components jointly selected to exhaust smoke and heat

NOTE The components form a system which complies with the requirements of CEN/TR 12101-4 in order to establish a buoyant layer of warm gases above cooler cleaner air.

3.23
smoke and heat exhaust ventilator (SHEV)
device specially designed to move smoke and hot gases out of construction works under conditions of fire

3.24
smoke barrier
barrier to restrict the spread of smoke and hot gases from a fire, forming part of the boundary of a smoke reservoir or used as a channelling screen, or used as a void edge boundary

3.25
smoke control damper for systems with automatic activation
smoke control damper that is applicable to the systems defined in 3.29

3.26
smoke control damper for systems with manual intervention
smoke control damper that is applicable to the systems defined in 3.30 and 3.31

3.27
smoke control damper
device automatically or manually activated, which can be open or closed in its operational position, to control the flow of smoke and hot gases into, from or within a duct

3.28
smoke control duct
duct used in a system to control the movement and /or containment of smoke and heat

3.29
smoke control system with automatic activation
smoke control system (smoke and heat exhaust ventilation type or pressure differential type), that operates automatically on receipt of a smoke or fire alarm without any manual action/intervention

NOTE A system with an attended control room can also be accepted as an automatic system. Once initiated, the system does not cause the smoke control damper position to be changed.

3.30
smoke control system with automatic activation and with manual override
smoke control system (smoke and heat exhaust ventilation type or pressure differential type), that can be put into operation as 3.29 on receipt of a smoke or fire alarm, but once initiated the system allows the smoke control damper position to be changed by external input/firemen's' override

3.31
smoke control system with manual intervention
smoke control system (smoke and heat exhaust ventilation type or pressurization type), that will be put into operation, on detection smoke or fire, by human intervention (e.g. by pressing a button or pulling a handle) leading to a sequence of automatic actions in the operation of the smoke control system

NOTE Once initiated, the system allows the smoke control damper position to be changed by external input/firemen's' override.

3.32
smoke layer
layer of smoke that stabilises underneath the ceiling due to the affect of temperature gradient

3.33
smoke logging
condition within a building when the hot gases from a fire descend to a level whereby the safe escape of the occupants is hampered and the ingress of firefighters is prevented

3.34
smoke reservoir
region within a building limited or bordered by smoke barriers or structural elements and which in the event of a fire retains a thermally buoyant smoke layer

3.35
smoke zone (zones)
areas into which construction works are divided for the extraction of smoke and hot gases

NOTE Each zone is served by a SHEV (or sub system of a SHEV), which is initiated by a signal from a single or group of initiation devices associated with the zone.

3.36
structural supports
means of retaining the smoke control system duct to the building structure

3.37
system response time
time from the initiation of the smoke control system to it being fully operational

3.38
thermal operating device
temperature sensitive device which responds to initiate a subsequent action

3.39
triggering device
device such as a fire detector system, smoke detector or pushbutton which sends an activating signal to the initiation device(s)

4 Test equipment

4.1 General

In addition to the test equipment specified in EN 1363-1, the following is required (examples of test arrangements are given in Figures 3, 5, 8 and 9):

4.2 Connecting duct for multi compartment fire resisting smoke control damper: maintenance of opening test and EN 1366-2 test

The connecting duct shall be of all welded construction fabricated from (1,5 $\pm$ 0,1) mm thick steel with a width and height appropriate to the size of smoke control damper or fire damper being tested. The duct shall have a length of two times the diagonal dimension of the smoke control damper or fire damper up to a maximum of 2 m (See Figure 6). The connecting duct shall be provided with a gas tight observation window. The general test arrangement showing flow measuring equipment is shown in Figure 6.

4.3 Volume flow measuring station for multi compartment fire resisting smoke control damper: maintenance of opening test and EN 1366-2 test

This shall consist of a Venturi, orifice plate, or other suitable device and (where necessary) an air flow straightener, installed in straight lengths of pipe, all sized in accordance with EN ISO 5167-1. It shall be installed between the connecting duct and the exhaust fan to determine the volume flow rate of gases passing through the smoke control damper or fire damper under test. This shall be done at elevated temperature, unless a condenser is used. The volume flow results shall be expressed at 20 °C. The measuring device shall be capable of measuring to an accuracy of ± 5 %. Regardless of whether vertical or horizontal smoke control damper or fire dampers are being tested, the volume flow measuring station shall always be used in a horizontal direction.

4.4 Plenum for High Operating Temperature (HOT) test

A steel plenum box shall be mounted on the non fire side of the smoke control damper over the whole face area. This is shown in Figure 18. It shall extend out from the standard supporting construction (wall) by 50 mm or past the edge of any blades that will pass beyond the supporting construction when opening by 50 mm. The box shall have an observation hole in the face opposite the damper blades of 50 mm diameter.

4.5 Cycling equipment

Full information on the equipment needed to perform the cycling tests is shown in Annex A. In addition the following shall be considered.

Equipment shall be required to control a supply to allow the smoke control damper actuator to be cycled. This equipment shall be able to provide the nominal operating power/supply less 10 %, plus 15 %, and be variable between these values to confirm that the smoke control damper shall operate at the extremes. If the unit to be tested requires a control signal of any type this shall be provided in addition and shall be able to give the device a signal at each extreme and any in between these.

Methods of loading the smoke control damper shall be required (See Annex A).

NOTE A device that allows the smoke control damper to be cycled automatically, together with a method of recording completed cycles, would be useful, so that a test could be set to run without attendance, noting that each cycle could potentially take 120 s.

4.6 Condensing unit

Where materials used in the construction of the test duct or the smoke control damper may generate quantities of steam during the fire test, a condensing unit having provisions for drainage shall be installed between the smoke control damper or fire damper and the flow measuring device. When using the condensing device, the temperature recorded by the thermocouple positioned downstream of the flow measuring device described in 4.3 shall not exceed 40 °C.

NOTE A suitable condensing device may be considered to be 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 providing that there is a means for removal of the condensate. Custom devices designed by individual laboratories that meet the 40 °C condition and allow condensate removal are allowable.

4.7 Gas temperature measuring devices

These shall be positioned adjacent to the flow measuring device. A suitable device is a 1,5 mm diameter sheathed thermocouple (Type K) orientated vertically with its measuring junction located at the centre line 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 6, 14 and 15).

4.8 Exhaust fan system

This shall be capable of controlling the flow rates and maintaining the specified pressure differential between the connecting duct and the furnace when the smoke control damper or fire damper is closed.

The pressure differential shall be regulated by means of a dilution damper installed just before the fan inlet. The pressure shall be controlled to within ± 5 % of the specified value. A balancing damper shall be fitted at the outlet of the fan to adjust the pressure range of the systems to suit the smoke control damper or fire damper under test. A variable speed fan may be used instead of the dilution damper.

4.9 Perforated plate

The perforated plate controls the flow through the duct so that the required differential pressure, see Table 1, can be achieved. Depending on the end-use conditions, a pressure level from Table 1 shall be selected: These levels correspond to typical values used in smoke extraction design.

The plate shall be positioned (250 ± 50) mm from where the duct passes through the furnace wall (see Figures 3, 8, 9 and 14).

These plates shall be made from heat resisting steel, 19 % min. Cr content and 11 % min. Ni content (Euronorm (X2Cr-Ni19-11). Full details of the number of holes and dimensions are given in Figures 12a and 12b. The thickness of the plates shall be 2,5 mm.

Figure 13 shows details for the mounting of the perforated plate in different duct types.

Table 1 — Differential pressures between inside and outside the duct for smoke extraction ductwork

Pressure level	Operating differential pressure at ambient temperature Pa	Differential pressure for the fire test Pa
1	-500	-150
2	-1 000	-300
3	-1 500	-500

4.10 Flow measurement nozzles (fire test)

Each nozzle shall have an internal dimension of 160 mm (see Figures 15 and 16, suitable for the standard size of duct specified in 5.2.1) in accordance with EN ISO 5167-1 and shall be suitably mounted to the end of the duct with its piezometric ring connected to appropriate differential pressure measuring equipment. The measuring device shall be capable of measuring to an accuracy of ± 5 %.

4.11 Ambient leakage measuring device

Equipment shall be in accordance with EN ISO 5167-1 and suitably mounted to the end of the duct, connected to appropriate differential pressure measuring equipment. The measuring device shall be capable of measuring to an accuracy of ± 5 %. Ambient leakage measuring equipment may be used as described in EN 1751, where this is more practical.

4.12 Pressure sensors for differential pressure control

A tube sensor as specified in EN 1363-1 shall be located at the end of the duct, inside the duct, at the level of its centre line. A second sensor (e.g. an open end of a measuring tube) shall be located on the same level outside the duct differential pressure fine control device.

A flow control damper shall be provided for a fine control for maintaining the required differential pressure. Alternatively, another suitable device such as a variable speed fan may be used. Any flow control damper shall be attached to the extract fan connecting duct (see 4.14).

4.13 Welded connecting tube

A welded connecting tube is a tube that shall provide a suitable gas tight connection between the inlet nozzles and the oxygen measuring probes.

4.14 Extract fan connecting duct

An extract fan connecting duct shall be used to connect between the test specimen and the extraction fan. An inlet opening may be provided if a flow control damper is used for fine control of the differential pressure (see 4.12).

4.15 Extraction fan

The extraction fan provided by the laboratory shall be capable of exceeding the test requirements stated in this European Standard.

4.16 Thermocouples

1,5 mm sheathed thermocouples shall be provided for measuring the gas temperature adjacent to the nozzles. An alternative thermocouple may be used, provided it can be shown to have equivalent response time.

4.17 Oxygen measuring equipment

Equipment for measuring the oxygen content of gases shall be provided. This system shall consist of paramagnetic cell oxygen analysers together with appropriate equipment for cooling, filtering and drying the gases. The accuracy of the oxygen volume measurement shall be better than $\pm$ 0,1 %. Appropriate connecting tubes and probes shall be provided. Where a single paramagnetic cell oxygen gas analyser is used, the 90 % response time of the complete system shall be 20 s maximum. Where two paramagnetic cell oxygen gas analysers are used, the 90 % response time of the complete system shall be 40 s maximum. Just prior to starting the fire test the gas analysers shall be calibrated. This shall be done using reference gases, such as oxygen free nitrogen to set zero and another gas of known oxygen content to set the equipment span.

4.18 Observation windows

Provision shall be made to provide suitable observation windows to allow the test observations to be made safely.

5 Test specimen

5.1 Cross-section

The size of smoke control damper subjected to the elevated temperature tests shall be the largest size (3.9). Cold leakage shall be required to be determined also on the smallest size (3.21). Test duct defines the maximum damper size which can be tested.

5.2 Design

5.2.1 General

The test shall be made on a test specimen representative of the smoke control damper range. This shall be the largest size. The duct used shall have been previously tested as a smoke control duct and shall have the standard tested cross section of 1 000 mm wide $\times$ 250 mm high (see Figures 3, 8 and 9).

5.2.2 Supporting constructions

5.2.2.1 General

The installation shall be representative of that intended to be used in practice, reproducing as far as practical the method of fixing the damper to the duct.

In the case of mounting in a compartment boundary the installation, this shall also be representative of that used in practice, using a penetration seal of known performance (refer to EN 1366-2 for standard supporting construction).

The damper shall include all ancillaries such as actuators, end switches, interface control units, etc.

5.2.2.2 Duct for single compartment smoke control dampers

A duct tested to EN 1366-9 shall be used.. The penetration seal shall be made as that penetration seal that was tested when the duct was tested.

5.2.2.3 Duct for multi compartment smoke control dampers

A duct tested to EN 1366-8 shall be used. The penetration seal shall be made as that penetration seal that was tested when the duct was tested.

5.2.3 Inclusion of grilles

Where grilles are to be supplied with the smoke control damper and the distance between the grille and the smoke control damper is less than 200 mm, testing of the smoke control damper shall also include the grilles as part of the assembly.

In this case, the surface thermocouples which are taken into account for the insulation criteria are the ones which are fixed onto the grill and onto the damper.

Where a smoke control damper and grilles are to be supplied as separate entities and they are to be installed greater than a distance of 200 mm, this arrangement shall not require testing as an assembly, only the smoke control damper on its own.

In this case, the surface thermocouples which are taken into account for the insulation criteria are the ones which are fixed onto the damper.

6 Test methods

6.1 General

Smoke control dampers shall be tested according to their proposed end use application to enable classification to be made. They are broadly split into the two main groups of multi and single compartment applications. Within these applications there are further tests to which each type may be subjected and these shall be considered before embarking on a test sequence. The required initiation regime and number of cycles to be tested shall be included within the sequence of testing.

6.2 Initiation regimes for elevated temperature and fire tests

6.2.1 Smoke control damper for systems with automatic activation

This clause describes the timing criteria to be used when testing the above (see Figure 1).

T = 0 s - furnace ignition

The smoke control damper mounted in the furnace shall be closed;

The smoke control damper mounted outside the furnace shall be open, unless if in its application it will never be open at the commencement of a smoke situation.

T = 30 s

Signal the smoke control damper mounted in the furnace to move to the open position;

Signal the smoke control damper mounted outside the furnace to close, or the smoke control damper remains in the closed position, if in its application it will never be open at the commencement of a smoke situation.

T = 90 s – smoke control dampers shall reach their end positions (otherwise failure results)

6.2.2 Smoke control damper for systems with manual intervention:

This section describes the timing criteria to be used when testing the above (see Figure 2).

T = 0 min – when furnace reaches 50 °C as defined in EN 1363-1

The smoke control damper mounted in the furnace shall be closed;

The smoke control damper mounted outside the furnace shall be open, unless if in its application it will never be open at the commencement of a smoke situation.

T = 25 min

Signal the smoke control damper mounted in the furnace to move to the open position;

Signal the smoke control damper mounted outside the furnace to close, or the smoke control damper remains in the closed position, if in its application it will never be open at the commencement of a smoke situation.

T = 26 min – Smoke control dampers shall reach their end positions (otherwise failure results)

6.3 Cycling test requirements (to form part of the sequences of testing defined below)

6.3.1 General

Full details of the test and the loading to be used is given in Annex A.

6.3.2 Smoke control damper to be used in dedicated Smoke control systems, operated only in the case of emergency

6.3.2.1 General

100 cycles at nominal operating supply, followed by

100 cycles at nominal operating supply less 10 %, followed by

100 cycles at nominal operating supply plus 15 %

The results shall record that the cycles were fully completed and that on average each travel took not longer than 60 s. The time for the first and last operations shall be recorded.

6.3.2.2 Smoke control damper to be used as part of a general HVAC system as well as a smoke control systems, or as part of a smoke control systems that is cycled every day to check operation

10 000 cycles at nominal operating supply, followed by

100 cycles at nominal operating supply less 10 %, followed by

100 cycles at nominal operating supply plus 15 %

The results shall record that the cycles were fully completed and that each travel took on average not longer than 60 s. The time for the first and last operations shall be recorded.

6.3.2.3 Smoke control damper to be used as part of a general HVAC system as well as a smoke control systems, that uses a modulating actuator

10 000 cycles at nominal operating supply (0 to 90°), followed by

10 000 cycles at nominal operating supply (half open to two thirds open)

The results shall record that the full cycles were fully completed and that each travel took on average not longer than 60 s. The time for the first and last operations shall be recorded.

6.3.3 Differential pressure conditions

Depending on the end-use conditions, a pressure level from Table 1 shall be selected. These levels correspond to typical values used in smoke extraction design.

6.4 Single compartment smoke control dampers mounted on the surface of a duct

6.4.1 Sequence

Two smoke control damper samples representing the largest size shall be selected. Each unit shall be tested for ambient leakage. The two units shall then be subjected to a cycling test, the number of cycles dependent upon their final proposed application. The units shall be fitted to the test duct and each unit shall be tested for ambient leakage prior to elevated temperature testing. The results shall then be used for classification and the application of any direct or extended fields of application.

6.4.2 Ambient leakage

The two samples representing the largest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded.

In addition, a sample of the smallest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded. This sample does not have to undergo the cycling tests and fire tests described in the following clauses.

6.4.3 Cycling test

The two samples representing the largest size shall be cycle tested (see Annex A), the number of cycles being selected from 6.3.

6.4.4 Elevated temperature test

The test samples (as previously tested 6.4.2 and 6.4.3) shall be mounted in the arrangement shown in Figure 3.

The units shall be tested for ambient leakage.

The units shall be tested for leakage at elevated temperature, if "S" classification is envisaged.

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 until the selected elevated temperature is reached. After the temperature has been reached it shall be maintained between +25 °C and 0 °C for the rest of the test.

The furnace pressure shall be controlled in accordance with EN 1366-2 throughout the test at the mid-height position of the ducts in the furnace.

The tests shall be carried out using a pressure selected from Table 1.

The equipment shown in Figure 3 shall be supported by the following:

Figure 4 - arrangement of furnace thermocouples

Figure 10 - arrangement for surface thermocouples for the smoke control damper mounted external to the furnace

Figures 12a and 12b - details of perforated plate pressure control device

Figure 13 - details for mounting the perforated plate pressure control device

Figures 14, 15, 16, 17 - arrangement and mounting details of gas testing probes and nozzles

The initiation regime shall be selected from 6.2.

6.5 Multi compartment fire resisting smoke control dampers

6.5.1 Fire resistance test according to EN 1366-2 (for units mounted within or on the face of a compartment structure)

6.5.1.1 General

Units shall be tested in the orientation of proposed installation (i.e. vertically and horizontally).

6.5.1.2 Sequence

One smoke control damper sample representing the largest size shall be selected. This shall be tested for ambient leakage. The unit shall then be subjected to a cycling test, the number of cycles dependent upon their final proposed application. The units shall be fitted within or on the face of a compartment structure and onto the test duct and be tested for ambient leakage prior to the fire test. The results shall then be used for classification and the application of any direct or extended fields of application.

6.5.1.3 Ambient leakage

A sample of the largest size shall be tested for ambient leakage using the method shown in EN 1751, Damper and Valve leakage with the qualification at ambient temperature and the results recorded.

In addition, a sample of the smallest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded. This sample does not have to undergo the cycling tests and fire tests described in the following clauses.

6.5.1.4 Cycling test

The sample shall be cycle tested (see Annex A), the number of cycles being selected from 6.3.

6.5.1.5 Fire resistance test

The test sample shall be mounted in the test equipment shown in EN 1366-2. It shall be tested for ambient leakage using the method described in EN 1366-2 and then fire tested using a pressure selected from Table 1. No fusible element is required or allowed.

The initiation regime shall be selected from 6.2. Units shall be open at the start of the test, unless if in its application it will never be open at the commencement of a smoke situation.

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 following the standard curve and tolerances.

The furnace pressure shall be controlled to EN 1366-2 throughout the test at the mid-height position of the ducts in the furnace.

6.5.2 Maintenance of opening test (for units mounted within a compartment structure)

6.5.2.1 General

Units shall be tested in the orientation of proposed installation (i.e. vertically and horizontally).

6.5.2.2 Sequence

One smoke control damper sample shall be selected. This shall be tested for ambient leakage. The unit shall then be subjected to a cycling test, the number of cycles dependent upon their final proposed application. The units shall be fitted to the test duct and be tested for ambient leakage prior to fire resistance testing. The results shall then be used for classification and the application of any direct or extended fields of application.

6.5.2.3 Ambient leakage

A sample of the largest size shall be tested for ambient leakage using the method shown in EN 1751, Damper and Valve leakage with the qualification at ambient temperature and the results recorded.

In addition, a sample of the smallest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded. This sample does not have to undergo the cycling tests and fire tests described in the following clauses.

6.5.2.4 Cycling test

The sample shall be cycle tested (see Annex A), the number of cycles being selected from 6.3.

6.5.2.5 Fire resistance test

The test sample shall be mounted in the test equipment shown in Figure 5. It shall be tested for ambient leakage using the method described in EN 1366-2 and then fire tested using a pressure selected from Table 1.

The initiation regime shall be selected from 6.2. Units shall be closed at the start of the test and then opened at the correct time.

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 following the standard curve and tolerances.

The furnace pressure shall be controlled to (15 $\pm$ 3) Pa throughout the test at the mid-height position of the smoke control damper in the furnace. For smoke control dampers installed in a horizontal separating element, the pressure shall be controlled to (20 ± 3) Pa At 100 mm below the underside of the separating element..

The equipment shown in Figure 5 shall be supported by the following:

Figure 6 - arrangement for leakage measurement

Figure 7 - arrangement for surface thermocouples

6.5.3 Horizontal duct test for surface mounted smoke control dampers on a horizontal duct

6.5.3.1 Sequence

Two smoke control damper samples of the largest size shall be selected. Each unit shall be tested for ambient leakage. The two units shall then be subjected to a cycling test, the number of cycles dependent upon their final proposed application. The units shall be fitted to the test duct and each unit shall be tested for ambient leakage prior to fire resistance temperature testing. The results shall then be used for classification and the application of any direct or extended fields of application.

6.5.3.2 Ambient leakage

The two samples of the largest size shall be tested for ambient leakage using the method shown in EN 1751, Damper and Valve leakage with the qualification at ambient temperature and the results recorded.

In addition, a sample of the smallest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded. This sample does not have to undergo the cycling tests and fire tests described in the following clauses.

6.5.3.3 Cycling test

The two samples shall be cycle tested (see Annex A), the number of cycles being selected from 6.3.

6.5.3.4 Fire resistance test

The test samples (as previously tested 6.5.3.2 and 6.5.3.3) shall be mounted in the arrangement shown in Figure 8.

The units shall be tested for ambient leakage.

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 following the standard curve and tolerances.

The furnace pressure shall be controlled to (15 $\pm$ 3) Pa throughout the test at the mid-height position of the ducts in the furnace.

The tests shall be undertaken using a pressure selected from Table 1.

The equipment shown in Figure 8 shall be supported by the following:

Figure 4 - arrangement of furnace thermocouples

Figure 10 - arrangement for surface thermocouples for the smoke control damper mounted external to the furnace

Figures 12a and 12b - details of perforated plate pressure control device

Figure 13 - details for mounting the perforated plate pressure control device

Figures 14, 15, 16, 17 - arrangement and mounting details off gas testing probes and nozzles

The initiation regime shall be selected from 6.2.

6.5.4 Vertical duct test for surface mounted smoke control dampers

6.5.4.1 Sequence

Two smoke control damper samples of the largest size shall be selected. Each unit shall be tested for ambient leakage. The two units shall then be subjected to a cycling test, the number of cycles dependent upon their final proposed application. The units shall be fitted to the test duct and each unit shall be tested for ambient leakage prior to fire resistance testing. The results shall then be used for classification and the application of any direct or extended fields of application.

6.5.4.2 Ambient leakage

The two samples of the largest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded.

In addition, a sample of the smallest size shall be tested for ambient leakage using the method shown in EN 1751 and the results recorded. This sample does not have to undergo the cycling tests and fire tests described in the following clauses.

6.5.4.3 Cycling test

The two samples shall be cycle tested (see Annex A), the number of cycles being selected from 6.3.

6.5.4.4 Fire resistance test

The test samples (as previously tested 6.5.4.2 and 6.5.4.3) shall be mounted in the arrangement shown in Figure 9.

The units shall be tested for ambient leakage.

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 following the standard curve and tolerances.

The furnace pressure shall be controlled to EN 1366-2 throughout the test at the mid-height position of the ducts in the furnace.

The tests shall be undertaken using a pressure selected from Table 1 (differential pressure for the fire test).

The equipment shown in Figure 9 shall be supported by the following:

Figure 4 - arrangement of furnace thermocouples
- Position shall be 100 mm from the duct side, at opposite sides of the duct where no damper is mounted:
- 2 furnace thermocouples at 100 mm from the underside of the furnace roof,
- 2 TC up 100 mm from the bottom of the duct
- 2 TC at same distance from bottom and top TC.

Figure 10 - arrangement for surface thermocouples for the smoke control damper mounted external to the furnace

Figures 12a and 12b - details of perforated plate pressure control device

Figure 13 - details for mounting the perforated plate pressure control device

Figures 14, 15, 16, 17 - arrangement and mounting details off gas testing probes and nozzles

The initiation regime shall be selected from 6.2.

6.6 Multi compartment fire resisting smoke control dampers (HOT Classification)

6.6.1 Fire resistance test (for units mounted within or on the face of a compartment structure)

6.6.1.1 General

Units shall to be tested in the orientation of proposed installation (i.e. vertically and horizontally).

6.6.1.2 Sequence

A smoke control damper of the largest area/size shall be subjected to a fire resistance test (6.6.1.3). Another sample will be provided of the smallest size to allow leakage measurement to confirm the application of the smoke leakage classification.

An actuator and enclosure and any associated interface control units shall be subjected to the standby temperature test (6.6.1.4).

A further sample smoke control damper of the largest area/size incorporating the actuator and enclosure and associated interface control units tested above will be presented for the high operating temperature test (6.6.2).

The results shall then be used for classification and the application of any direct or extended fields of application.

As an option a further smoke control damper sample representing the largest area/size incorporating the actuator without any insulation enclosure may be selected and cycle tested. This shall be first tested for ambient leakage. The unit shall then be subjected to a cycling test, the number of cycles dependent upon their final proposed application as described.

6.6.1.3 Fire resistance test

The test sample shall be mounted in the test equipment shown in EN 1366-2. It shall be tested for ambient leakage using the method described in EN 1366-2 and then fire tested using a (300 ± 15) Pa pressure difference.

NOTE If a damper of identical construction, but including a thermal fuse has been demonstrated to pass this test, this is acceptable).

Units shall be open at the start of the test and be closed within the time stipulated within EN 1366-2.

The heating conditions and the furnace atmosphere shall conform to those specified in EN 1363-1 following the standard curve and tolerances.

The furnace pressure shall be controlled to EN 1366-2 (15 ± 3) Pa throughout the test at the mid-height position of the ducts in the furnace.

6.6.1.4 Standby temperature test

Depending on their electronics, actuators may develop heat in the standby condition. Additional insulation due to the enclosure and mounting into the supporting construction could cause elevated temperature around the actuator and overheating as a consequence. A temperature transmitting element shall be placed inside the insulated enclosure and another in the ambient air surrounding the

enclosure. The actuator shall be connected to its electrical supply and the temperature increase over ambient inside the enclosure recorded over a period of 72 h. The maximum ambient temperature in the foreseen installation plus the recorded temperature increase shall not exceed the maximum allowed ambient temperature specified by the actuator manufacturer.

6.6.2 High operating test (HOT 400/30 - cycling and maintenance of opening test)

Units shall to be tested in the vertical plane. The smoke control damper shall be fitted into the supporting construction with the actuator and any insulation enclosure on the furnace side of the installation. It shall be mounted as described in subclause 4.4 and Figure 18.

The furnace shall follow the curve in Table 2 levelling out at 400 °C (approximately 7 min) and remaining at that temperature until a time of 30 min is reached.

Table 2 — HOT 400/30 test curve

mins	0	1	2	3	4	5	6	7	8	9	10
°C	amb	50	88	134	189	252	324	400	400	400	400
mins	30	33	36	39	42	45	48	51	54	57	60
°C	400	550	700	881	892	902	912	921	930	938	945

During the next 8 min (minute 31 to end of minute 38) the furnace will be set to correct back up to the standard time temperature curve, which will be at 877 °C at this time. The test will continue following the time temperature curve until 60 min have been completed.

The test will start with the unit open. During the first 30 min the damper will be cycled (closed and opened equals one cycle) every (150 ± 5) s. The first cycle will start at furnace ignition and the final cycle will be completed by the end of the 30 min.

The damper will be observed to have stayed open for the remainder of the test.

If the sponsor wishes to gain further information for different temperatures and times (e.g. HOT YYY/XX) the test may be done so as to reach the temperature (YYY) to be tested at in 9 min, remain at that temperature for the operational period (XX). The furnace shall then ramp up to the standard time temperature curve in an 8 min period following the operational period. The test shall continue following the standard time temperature curve for a 30 min period after the operational period.

7 Test procedure

7.1 Pre-test calibration

7.1.1 Oxygen-measuring instrument

Calibrate the measuring instrument prior to the fire test.

7.1.2 Perforated plate

The following shall be undertaken with the dampers fitted to the duct. Switch on the extract fan. Check that both the required operating differential pressure at ambient temperature selected in Table 1 and air velocity of 2 m/s are obtained under ambient conditions. Ensure the air velocity is within ± 15 % and the differential pressure is within ± 3 %.

The initial check on the perforated plate shall be undertaken on a duct section provided for the purpose and not the test specimen where the removal of the plate may create problems.

7.1.3 Leakage measurement at ambient temperature

Close the dampers in the duct that are located inside and outside the furnace.

Switch on the extract fan, making any fine adjustments so that the differential pressure reading is within ± 3 % of the prescribed value given in Table 1 throughout the time over which the leakage measurements are taken.

NOTE The pressure level may be selected by the sponsor; alternatively it is possible to progressively work up from pressure level 1 to pressure level 3, subject to compliance with 6.3.3.

Switch on measuring equipment related to the ambient leakage measuring device.

After stable conditions have been achieved for a period of not less than five minutes, measure and record the pressure differential through the ambient leakage measuring device at the selected pressure level. Where information is required on leakage at other pressure levels, repeat the procedure. Calculate the airflow in accordance with the methods in EN ISO 5167-1.

Switch off measuring equipment and the extraction fan.

Remove sealing from openings.

Operate the dampers so that they are in accordance with the selected initiation regime indicated in 6.2.

7.2 Fire test

7.2.1 Extraction fan

Switch on the extraction fan and make any adjustments to the dilution damper or fan to maintain the differential pressure at the selected pressure level given in Table 1 (operating differential pressure at ambient temperature). This done with the smoke control damper outside the furnace closed and the smoke control damper inside the furnace open.

The fan shall then be switched off. The smoke control damper mounted outside the furnace shall be opened (unless if in its application it will never be open at the commencement of a smoke situation, in which case it will remain closed). The smoke control damper mounted inside the furnace shall be closed.

After ignition of the furnace, the fan will be switched back on at the previous settings (at T = 90 s for AA smoke control dampers and at T = 0 s for MA smoke control dampers). If the damper mounted outside the furnace is closed, control will then take place to maintain the selected differential pressure for the fire test given in Table 1. If the smoke control damper mounted outside the furnace is open an arbitrary flow will pass through it. When the smoke control damper inside the furnace opens, and the smoke control damper mounted outside the furnace closes, the fan will then be controlled to maintain the selected differential pressure for the fire test given in Table 1.

7.2.2 Ignition of furnace

After switching on all the measuring equipment, ignite the furnace and start the clock (refer to clauses in 6.2, which define T = 0).

7.2.3 Furnace conditions

Throughout the test, maintain the furnace conditions to comply with the requirements of Clause 6. Make any adjustments necessary to maintain the differential pressure readings inside the duct to within ± 3 % of the selected differential pressure for the fire test given in Table 1 after 5 min of the start of the test.

7.2.4 Temperatures and pressures

Record all temperatures and pressures at the intervals specified in EN 1363-1.

7.2.5 Oxygen measurements

7.2.5.1 Smoke Control damper for systems with automatic activation

After the first 5 min of the test, start recording the oxygen measurement. The readings are to be taken at the furnace location and then at the nozzle location and recorded at the same time as temperatures and pressures are recorded (see 7.2.4).

7.2.5.2 smoke control damper for systems with manual intervention

After the first 30 min of the test, start recording the oxygen measurement. The readings are to be taken at the furnace location and then at the nozzle location.

7.2.6 General observations

Take observations on the general behaviour of the dampers throughout the test.

7.2.7 Reduction of cross-section/ maintenance of opening

To confirm the maintenance of opening of the smoke control damper mounted on the duct inside the furnace, the following measurement and calculation shall be undertaken.

To confirm the maintenance of opening for a smoke control damper mounted in to or on the compartment structure, the fan shall be set maintain 2 m/s through the open damper and keep the pressure selected in Table 1.

The actual total mass M_{actual} of hot gases exhausted throughout the open smoke control damper shall be recorded.

The theoretical maximum total mass M_{max} assuming the smoke control remained fully open all throughout the test shall be calculated.

The details of the calculation are shown in Annex C

The test will be deemed failed at the point that M_{actual} / M_{max} falls below 0.75.

7.2.8 Leakage calculations

Determine the leakage volume flow V_L (m^3/s) from the oxygen measurements taken using the calculations in Annex B. This shall be used to determine compliance with EN 13501-4.

7.3 Termination of test

The test may be terminated

a) at the request of the sponsor;

b) at end of a classification period (or if a serious failure occurs);

c) when a criteria such as leakage is exceeded.

NOTE The sponsor may wish to continue the test up to any period to generate extra information that may be useful for development purposes or to aid in the extended field of application for the product.

8 Test report

In addition to the items required by EN 1363-1, the following shall also be included in the test report:

a) The method of fixing, support and mounting, as appropriate for the type of damper and the application, i.e. mounted on a duct or mounted as part of the compartment boundary.

b) The details of the duct used as the standard supporting construction.

c) Other observations made during the test including a complete record of the following test parameters as a function of time:

— furnace temperature;

— furnace pressure;

— volume flow measuring station gas temperatures;

— volume flow measuring station pressure differential;

— calculated volume flow rate;

— differential pressure between inside and outside the duct (negative values indicate underpressure).

d) Details of the leakage calculated in accordance with Clause 7.

e) Where the test is terminated before the occurrence of failure under the relevant criteria, this shall be reported.

f) Where steel ducts are used, the thickness, leakage class according to EN 1507 and details of any external stiffening or internal stiffeners if incorporated.

g) Full calculations in accordance with Clause 7, including the leakage and the maintenance of opening details.

9 Direct field of application of test results

9.1 General

The requirements for direct field of application for all fire dampers tested to EN 1366-2 apply, together with the following.

9.2 Smoke control damper sizes

Dampers of sizes between the smallest size tested for ambient leakage and the largest size subjected to ambient leakage and to the elevated temperature tests shall be used.

They shall be installed in all duct sizes permitted within the direct field of application stated in EN 1366-8 and EN 1366-9.

9.3 Pressure difference

The test results of the smoke control dampers are applicable to smoke control dampers with an underpressure or overpressure up to the relevant values as specified in Table 3.

Table 3 — Pressure difference

Tested pressure level (see Table 1)	Underpressure up to	Overpressure up to
1	500 Pa	500 Pa
2	1 000 Pa	500 Pa
3	1 500 Pa	500 Pa

9.4 Elevated temperatures

Multi compartment smoke control dampers tested to the EN 1363-1 standard fire test curve are suitable for single compartment applications for the same time period and other application data.

Single compartment smoke control dampers tested to elevated temperatures are applicable to all temperatures below the temperature tested for the same time period and other application data.

9.5 Cycling tests

9.5.1 Smoke control dampers meeting the cycling requirements for modulating applications

The results for smoke control dampers meeting the above requirements are also applicable to

a) systems for use with combined smoke control and general HVAC applications;

b) systems with smoke control dampers that are cycle checked every day;

c) systems where the smoke control dampers are operated only in the case of emergency.

9.5.2 Smoke control dampers meeting the cycling requirements for use with combined smoke control and general HVAC applications and for smoke control systems that are cycle checked every day

The results for smoke control dampers meeting the above requirements are also applicable to

a) systems where the smoke control dampers are operated only in the case of emergency.

9.5.3 Smoke control dampers meeting the cycling requirements for smoke control dampers that are operated only in the case of emergency

The results for smoke control dampers meeting the above requirements are not applicable to other installations.

9.6 Initiation method

Smoke control dampers that have been tested for systems with manual intervention are suitable for application in automatic systems, but not vice versa.

9.7 Application to duct constructions other than that tested

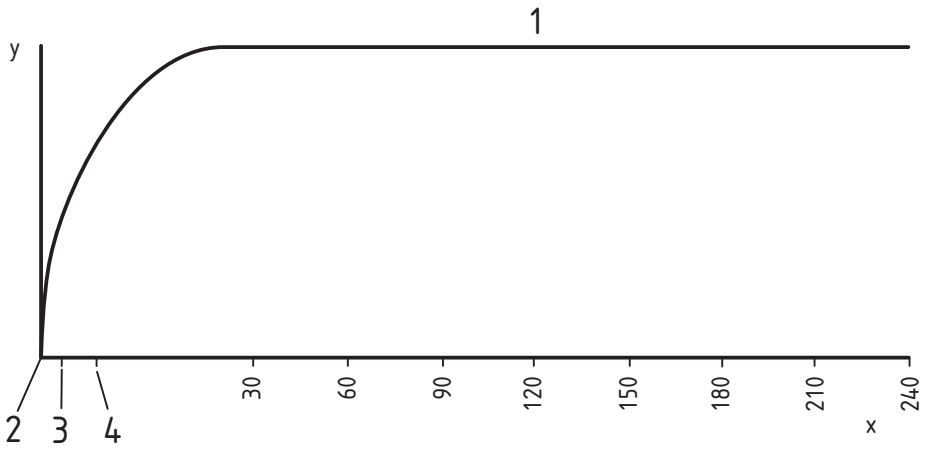
9.7.1 Single compartment smoke control dampers

Single compartment smoke control dampers may be applied to ducts that have been tested to EN 1366-9, constructed from materials of the same density as those tested or of the same material with a greater density or thickness. Application may not be made where there is a change in the surface protection materials. Any paint surface finish shall be as the duct tested or assessed.

9.7.2 Multi compartment smoke control dampers

Multi- compartment smoke control dampers may be applied to ducts that have been tested to EN 1366-9 and EN 1366-8 as appropriate, constructed from materials of the same density as those tested or of the same material with a greater density or thickness. Application may not be made where there is a change in the surface protection materials. Paint surface finish, shall be as the duct tested or assessed.

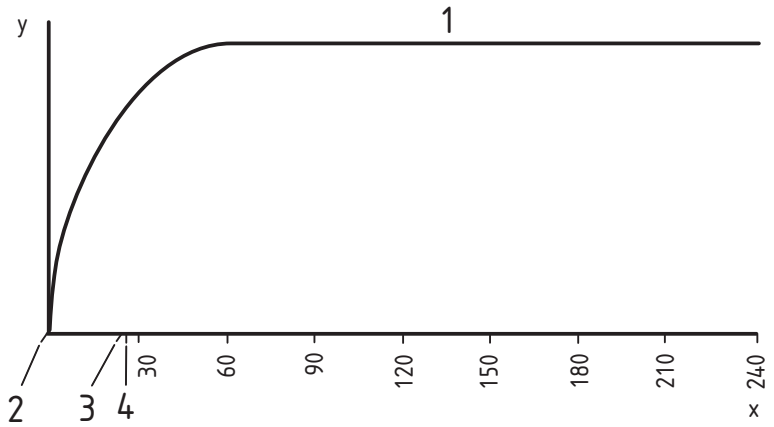
Multi-compartment smoke control dampers tested to this standard may be used in association with fire resisting ductwork tested to EN 1366-1, as flow control damper.



Key

x time in minutes
y temperature
1 fire test curve or single compartment temperature
2 classification T = 0: furnace ignition (not furnace reaches 50 °C)
3 T = 30 s (ignition + 30 s) – command actuators to operate (open and close)
4 T = 90 s (ignition + 90 s) – actuators to have completed movement

Figure 1 — Curve and classification details for smoke control dampers suitable for systems with automatic activation

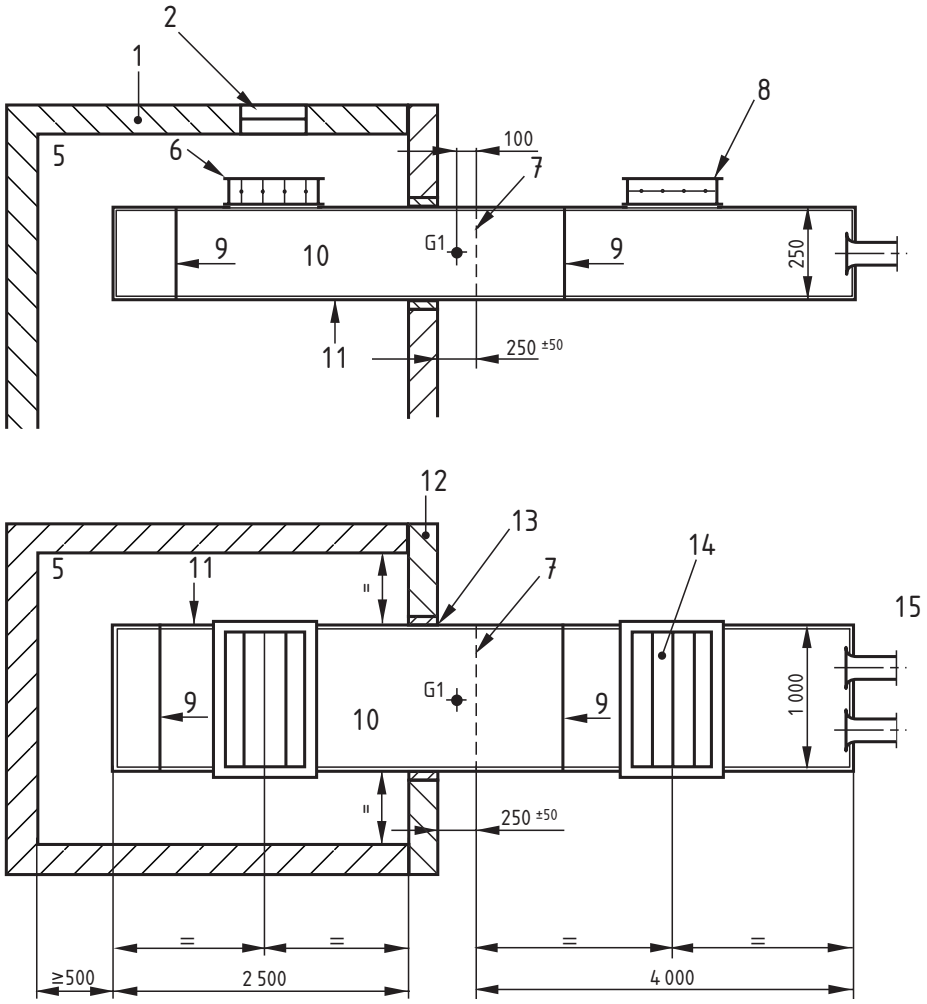


Key

x classification time in minutes
y temperature
1 fire test curve or single compartment temperature
2 classification T = 0: furnace reaches 50 °C
3 T = 25 min – command actuators to operate (open and close)
4 T = 26 min – actuators to have completed movement

Figure 2 — Curve and classification details for smoke control dampers suitable for systems with manual intervention

Dimensions in millimetres



Key

1 furnace roof

2 observation window

5 furnace chamber

6 smoke control damper, inside furnace

NOTE The distance between the open damper blade(s) and the top of the furnace and the bottom of the duct is minimum 100 mm. Extension pieces should be added to the damper casing, if necessary, to achieve this – see examples on Figure 9.

7 perforated plate

8 smoke control damper, outside furnace

NOTE The distance between the open damper blade(s) and the bottom of the duct is minimum 100 mm. Extension pieces should be added to the damper casing, if necessary, to achieve this – see examples on Figure 9.

9 joints

10 duct (EN 1366-9)

11 duct surface

12 supporting construction (wall)

13 fire stopping as in practice

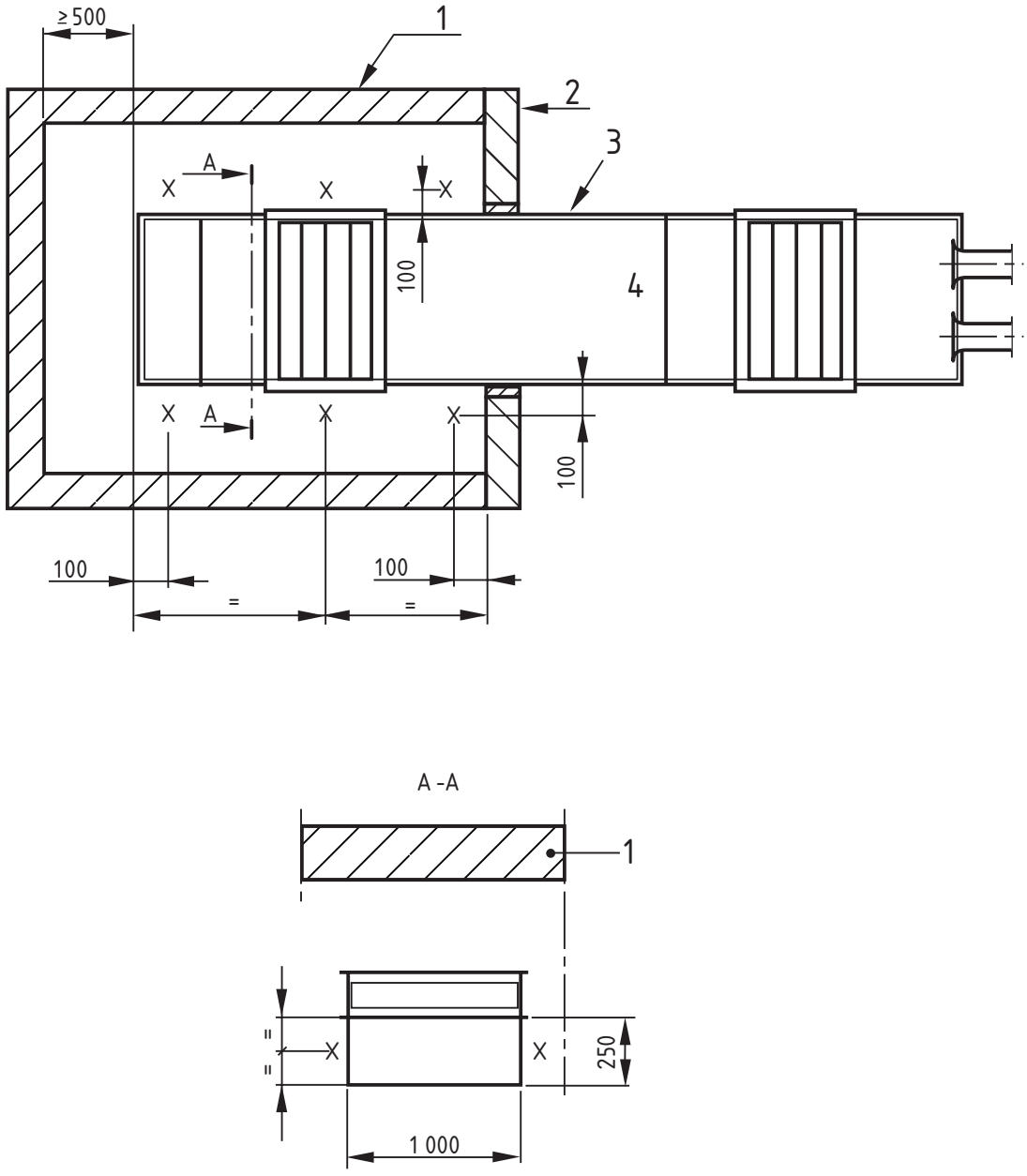
14 thermocouples on damper/grille (see Figure 10)

15 flow measurement nozzles (see Figure 15)

G1 gas sample sensor at the perforated plate

Figure 3 — Test arrangement for single-compartment smoke control dampers mounted on the surface of a duct

Dimensions in millimetres

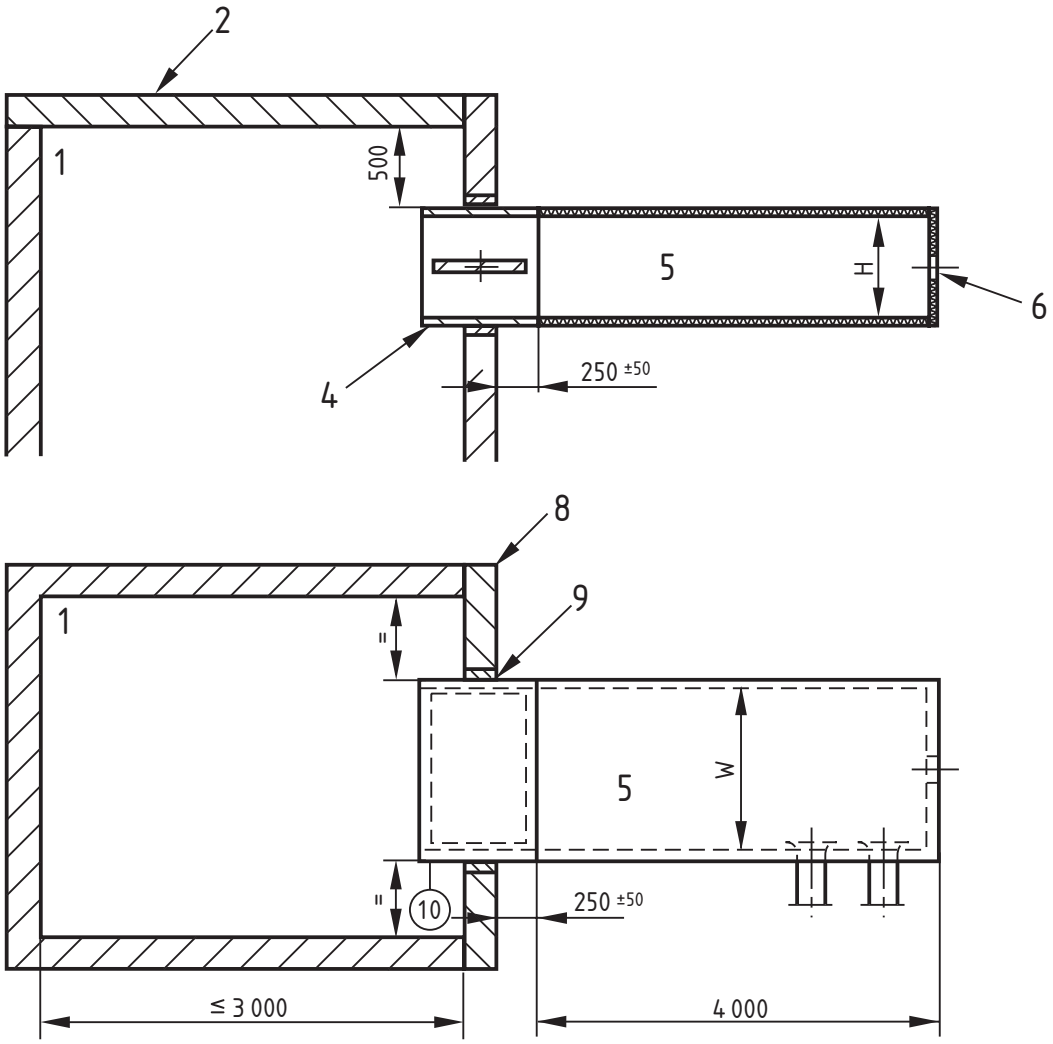


Key

1 furnace roof
2 supporting construction (wall)
3 duct surface
4 duct
x thermocouples

Figure 4 — Arrangement of furnace thermocouples for both single and multi-compartment smoke control damper tests

Dimensions in millimetres



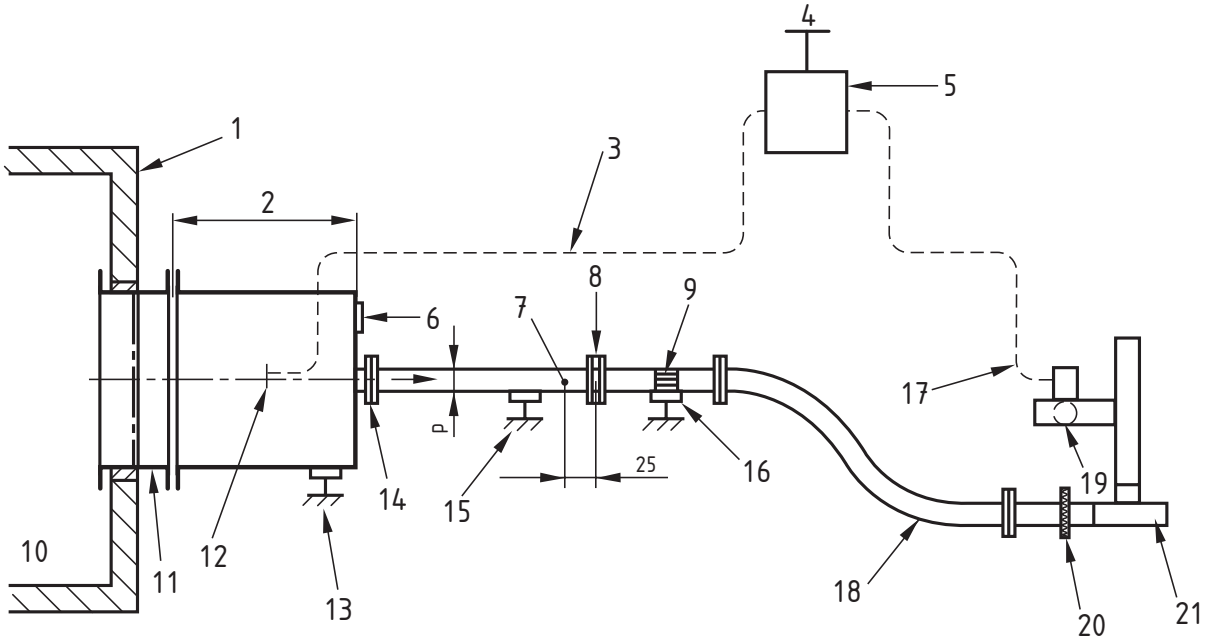
Key

1	furnace chamber	8	supporting construction (wall)
2	furnace roof	9	fire stopping as in practice
4	smoke control damper	10	motor inside
5	duct	W	width
6	observation window	H	height

NOTE For test according to 6.5.1.5 the damper is in open position by the start of the test; for test according to 6.5.2.5 the damper is in closed position by the start of the test.

Figure 5 — Test arrangement for smoke control dampers to be mounted in a compartment boundary (for more information see EN 1366-2)

Dimensions in millimetres

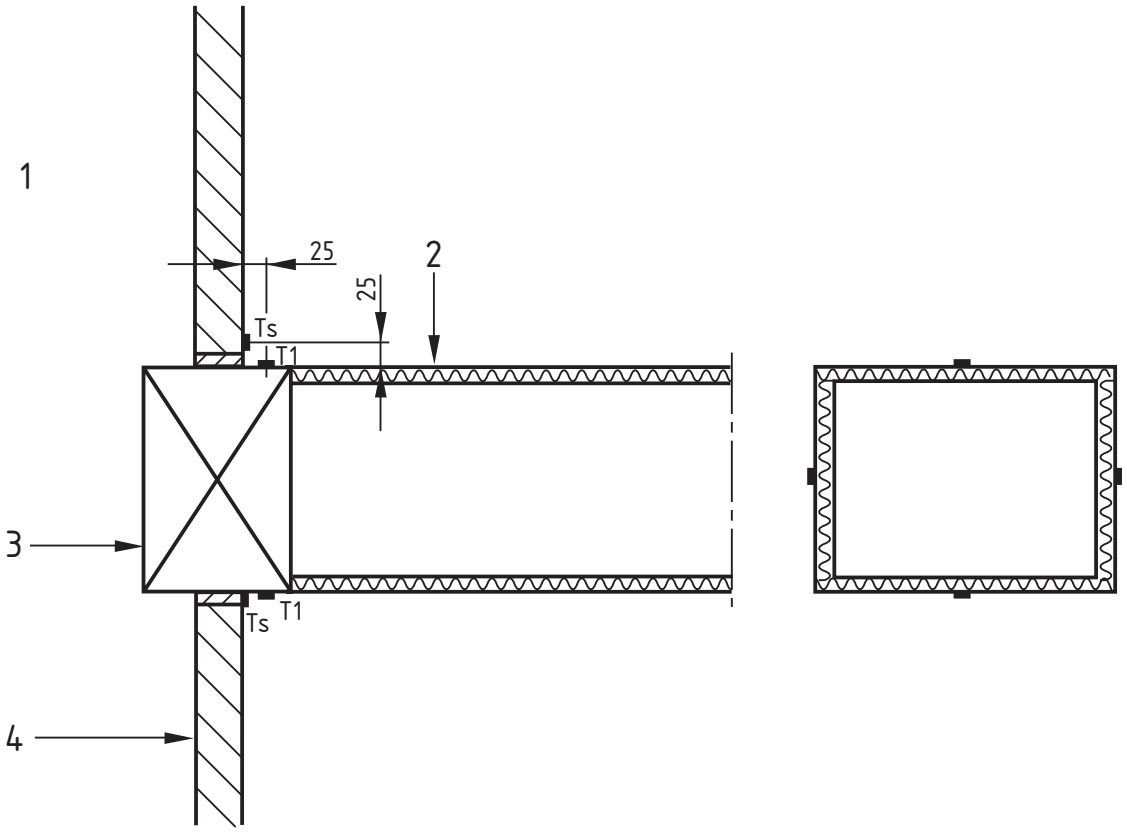


Key

1 supporting construction (wall)	10 furnace	19 pressure control dilution damper
2 connecting duct (to a maximum of 2 m)	11 damper	20 condenser unit
3 pressure probe	12 pressure sensor (on centre	21 fan
4 pressure sensor in laboratory	13 support	
5 pressure differential control box	14 flange	
6 observation window	15 support	
7 thermocouple, 1,5 mm diameter	16 support	
8 orifice plate or Venturi	17 feedback control	
9 flow straightener (where necessary)	18 flexible connecting duct	

Figure 6 — General test arrangement showing flow measuring equipment

Dimension in millimetres

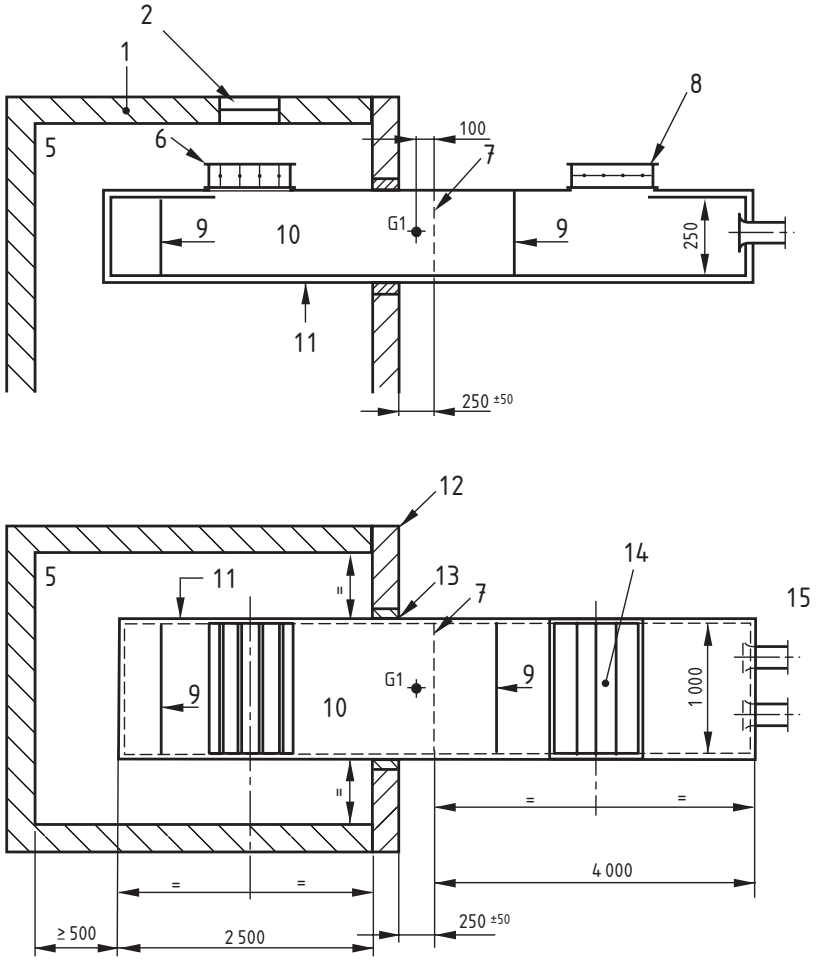


Key

1 furnace
2 duct EN 1366-8 or EN 1366-9
3 damper
4 supporting construction
TS maximum temperature at supporting construction
T1 duct surface thermocouples for determining maximum temperature
Ts,T1 minimum of one each side of the duct
- surface thermocouples

Figure 7 — Location of surface thermocouples for test configurations shown in Figures 5 and 6

Dimensions in millimetres



Key

1 furnace roof

2 observation window

5 furnace chamber

6 smoke control damper, inside furnace

NOTE The distance between the open damper blade(s) and the top of the furnace and the bottom of the duct is minimum 100 mm. Extension pieces should be added to the damper casing, if necessary, to achieve this – see examples on Figure 9.

7 perforated plate

8 smoke control damper, outside furnace

NOTE The distance between the open damper blade(s) and the bottom of the duct is minimum 100 mm. Extension pieces should be added to the damper casing, if necessary, to achieve this – see examples on Figure 9.

9 joints

10 duct (EN 1366-8)

11 duct surface

12 supporting construction (wall)

13 fire stopping as in practice

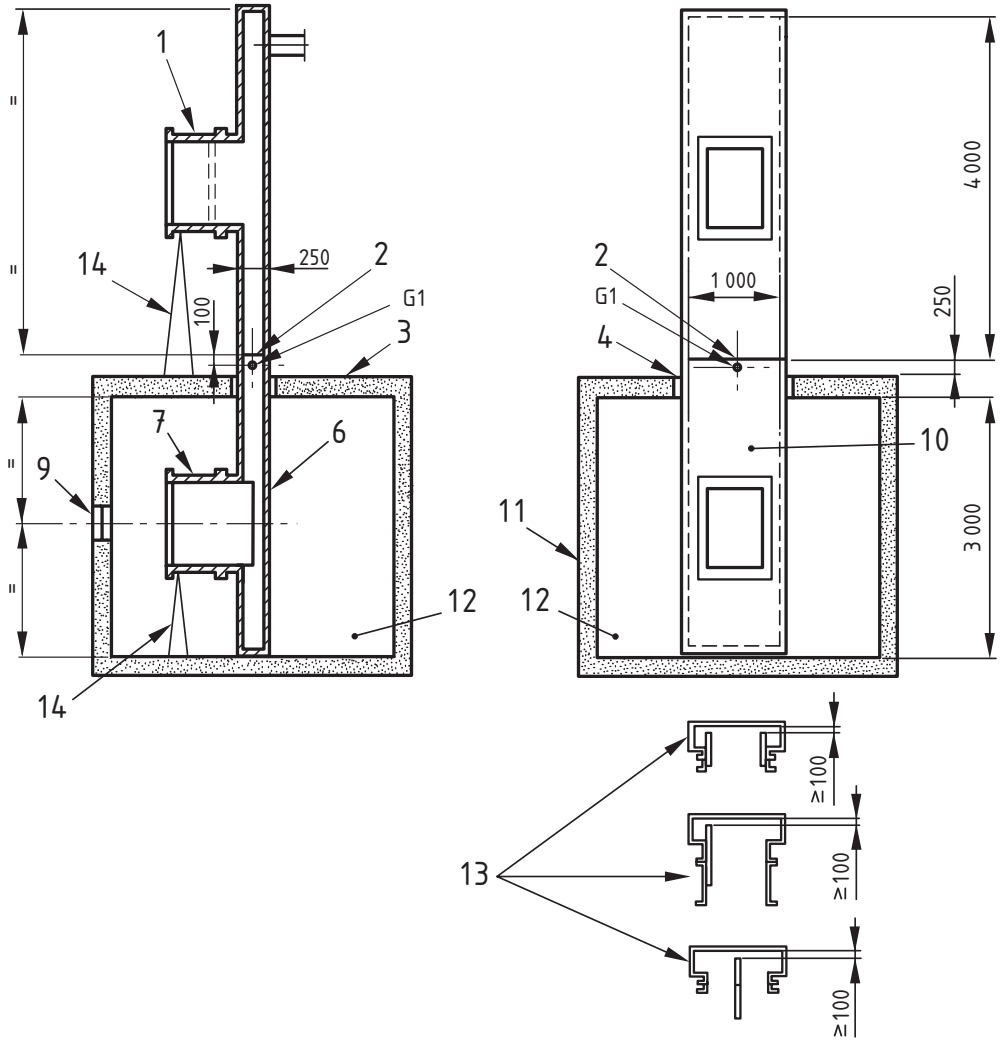
14 thermocouples on damper/grille (see Figure 10)

15 flow measurement nozzles (see Figure 15)

G1 gas sample sensor at the perforated plate

Figure 8 — Test arrangement for multi-compartment smoke control dampers mounted on the surface of a duct

Dimensions in millimetres



Key

1 smoke control damper, outside furnace
NOTE The distance between the open damper blade(s) and the top of the furnace and the bottom of the duct is minimum 100 mm. Extension pieces should be added to the damper casing, if necessary, to achieve this – see point 13.

2 perforated plate

3 furnace roof

4 fire stopping as in practice

6 duct surface

7 smoke control damper, inside furnace
NOTE The distance between the open damper blade(s) and the wall of the furnace and the bottom of the duct is minimum 100 mm. Extension pieces should be added to the damper casing, if necessary, to achieve this – see point 13.

9 observation window

10 duct (EN 1366-8)

11 furnace wall

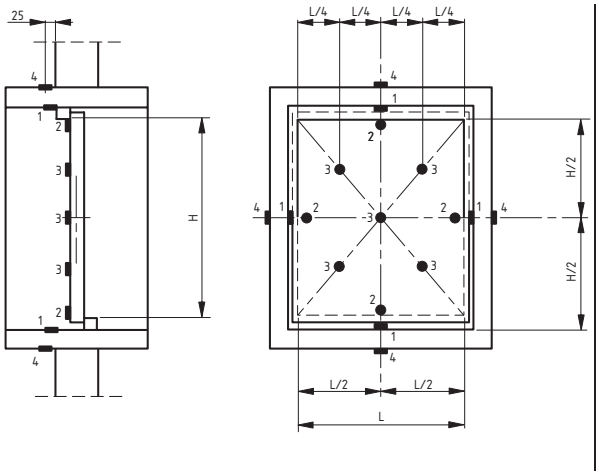
12 furnace chamber

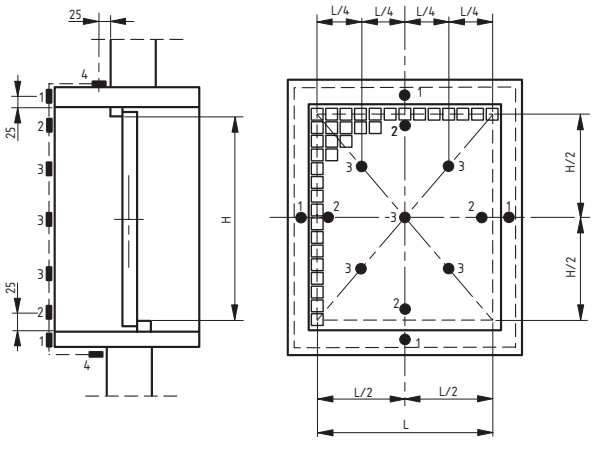
13 examples showing gap between the blades and the inside of the duct

14 mechanical support for dampers

G1 gas sample sensor at the perforated plate

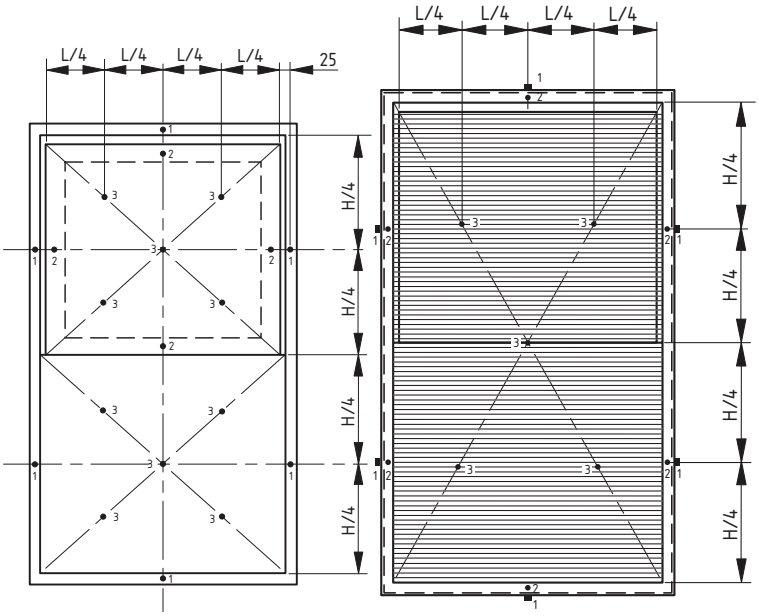
Figure 9 — Test arrangement for multi-compartment smoke control dampers mounted on the surface of a vertical duct





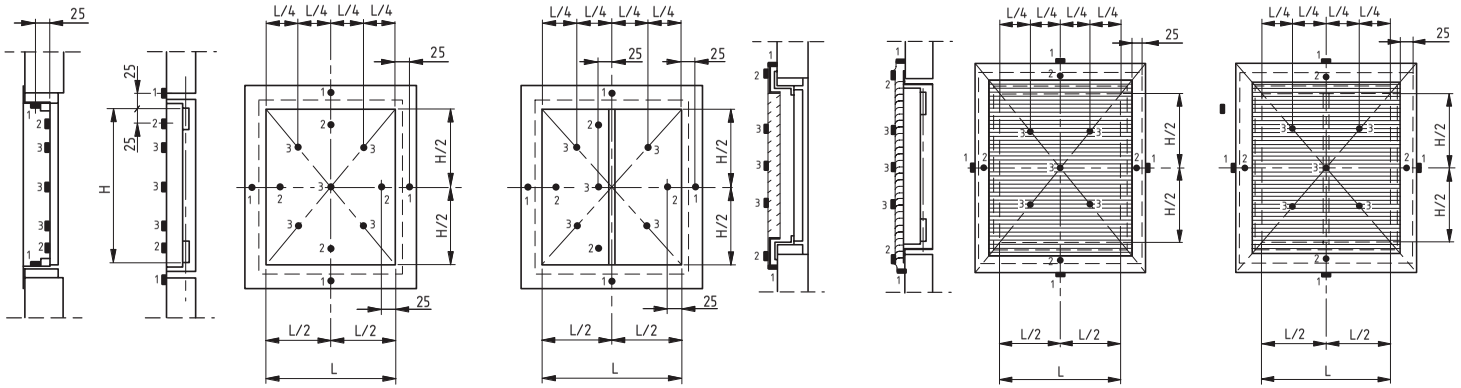
Key
1 Thermocouples on the inside of the housing (or on the stop), 25 mm away from the blade
2 Thermocouples on the blade 25 mm from the housing (or on the stop)
3 Thermocouples on the blade (remaining surfaces)
4 Thermocouples on the outside of the housing 25 mm away from the duct

Key
1 Thermocouples on the grille, 25 mm from the housing towards the outside
2 Thermocouples on the grille, 25 mm from the housing towards the inside
3 Thermocouples on the grille (remaining surfaces)
4 Thermocouples on the outside of the housing 25 mm away from the duct



Key
1 Thermocouples on the frame 25 mm from the leaf
2 Thermocouples on the leaf 25 mm from the aperture
3 Thermocouples on the leaf (remaining surfaces)

Key
1 Thermocouples on the grille on the bound edge
2 Thermocouples on the grille at the middle of the frame
3 Thermocouples on the grille (remaining surfaces)



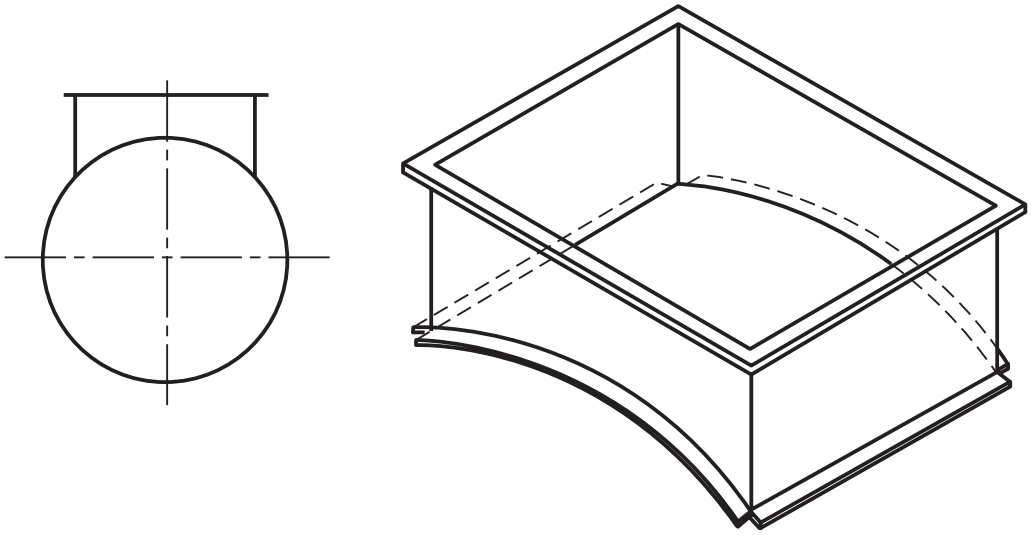
Key
1 Thermocouples on the frame 25 mm from the leaf or aperture
2 Thermocouples on the leaf 25 mm from the aperture limits
3 Thermocouples on the leaf (remaining surfaces)

Key
1 Thermocouples on the grille on the bound edge
2 Thermocouples on the grille at the middle of the frame
3 Thermocouples on the grille (remaining surfaces)

NOTE 1 For smoke control dampers having grilles as part of their construction (right hand above), the thermocouples are mounted on the grille and on the blades (left hand above) to determine whether a smoke control damper tested with a grille may be installed, in practice, without one.

NOTE 2 Thermocouples are placed as shown, or moved to positions as close as possible to those shown following the rules in EN 1363-1.

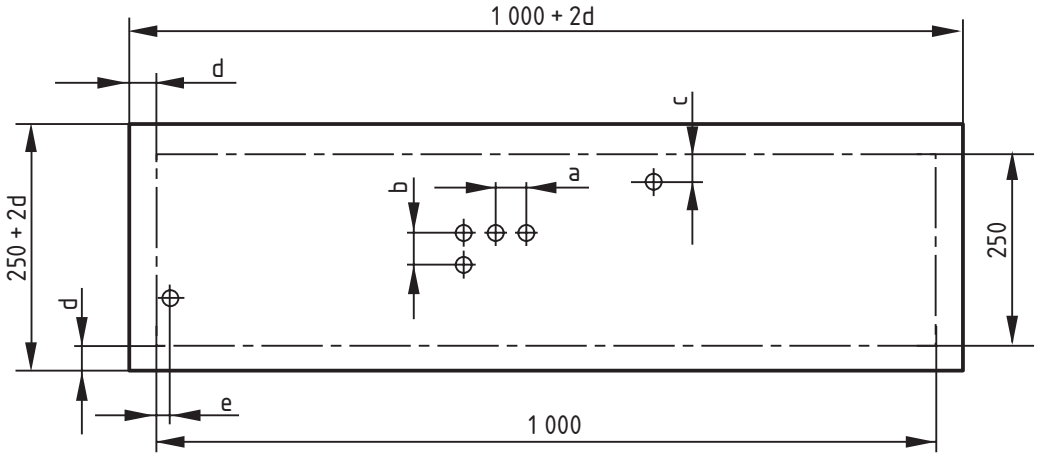
Figure 10 — Arrangement of surface thermocouples for smoke control damper mounted outside the furnace



NOTE The test results during the test Figure 3 are applicable to spiral piping when using a saddle piece.

Figure 11 — Connection of smoke control dampers with spiral duct

Dimensions in millimetres



Key:

"d" width of the flange, plate thickness = 2,5 mm

Material: heat resisting steel
percentage of chrome minimum 19 %
percentage of nickel minimum 11 %

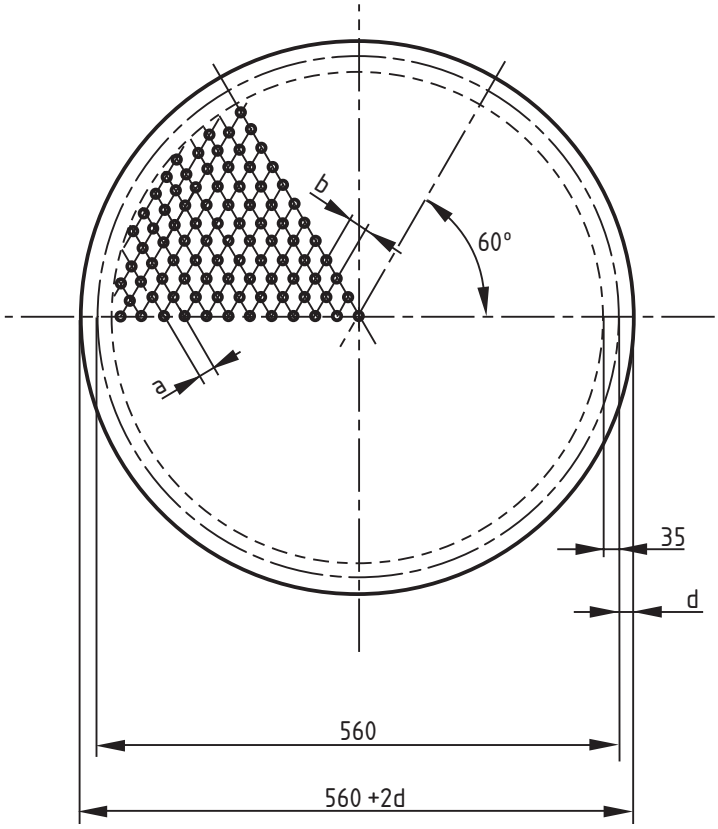
NOTE For installation details see Figure 13.

Pressure stage		1	2	3
Pressure differential at ambient temperature (Pa)		-500	-1 000	- 1 500
Pressure differential during the fire test (Pa)		-150	-300	- 500
Diameter of hole (mm)		10	10	10
Number of holes horizontal (piece)		50	37	36
Number of holes vertical (piece)		11	11	9
Total number of holes		550	407	324
Distance rim horizontal e (mm)	minimum	15	15	20
	Maximum	100	100	100
Distance rim vertical c (mm)	minimum	15	15	20
	Maximum	100	100	100
Mounting hole a separation (mm)	minimum	19,8	26,9	27,4
Mounting hole b separation (mm)	minimum	21,8	22,0	26,3

The table given in value for rectangular duct minimum size 1 000 mm × 250 mm. For smaller sizes the number of holes shall be reduced proportional to the smaller cross section and for bigger sizes the number of holes shall be increased proportional to the bigger cross section.

Figure 12a — Rectangular perforated plate details

Dimensions in millimetres



Key:

"d" width of the flange, plate thickness = 2,5 mm

Material: heat resisting steel
percentage of chrome minimum 19 %
percentage of nickel minimum 11 %

NOTE For installation details see Figure 13.

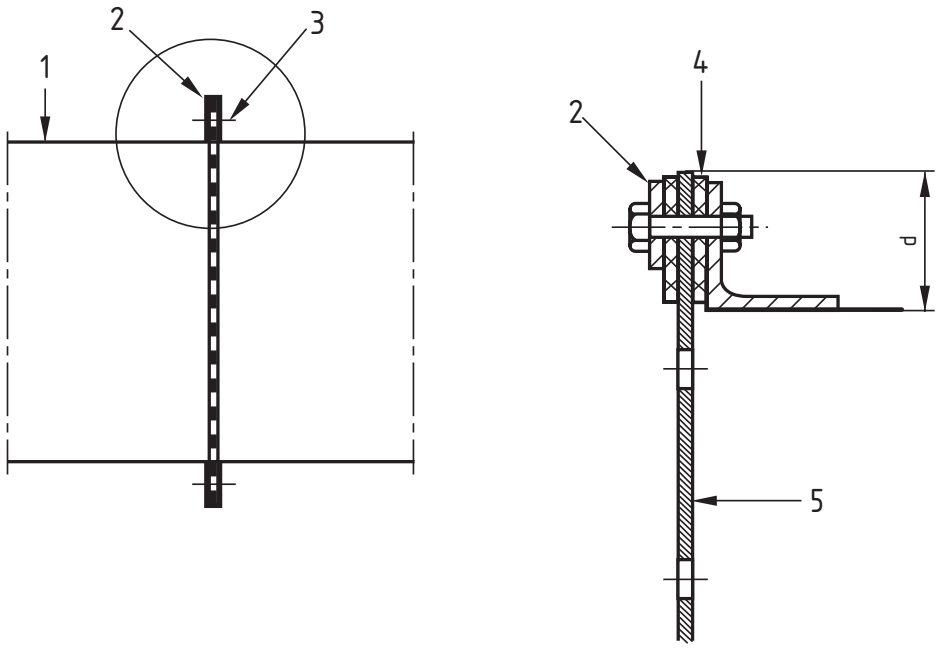
Pressure stage		1	2	3
Pressure differential at ambient temperature (Pa)		- 500	-1 000	- 1 500
Pressure differential during the fire test (Pa)		- 150	-300	- 500
Diameter of hole (mm)		10	10	10
Number of holes (piece)		541	403	319
Mounting hole separation (mm)	minimum	20,0	23,0	25,5

The table gives values for a circular duct size diameter 560 mm. For smaller sizes the number of holes shall be reduced proportional to the smaller cross section and for bigger sizes the number of holes shall be increased proportional to the bigger cross section.

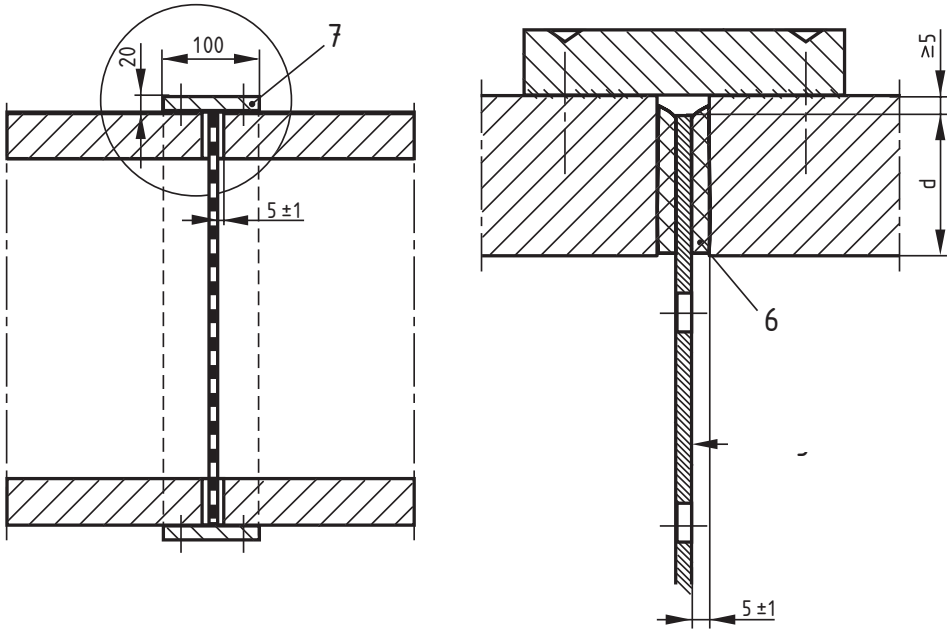
Figure 12b — Circular perforated plate details

Dimensions in millimetres

a) Installation of the perforated plate into the duct of sheet steel



b) Installation of the perforated plate into the duct of fire resisting boards

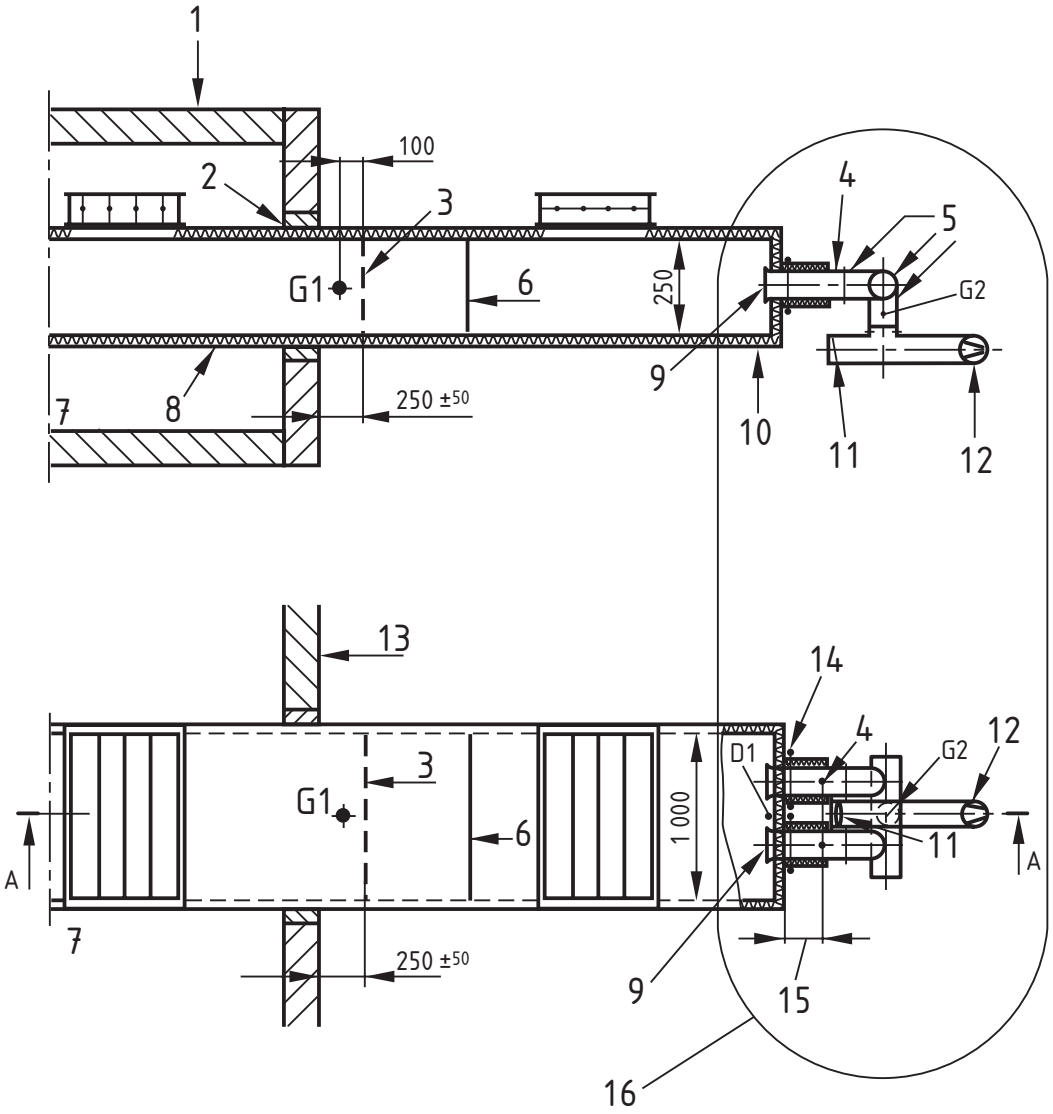


Key

1 duct
2 flange
3 bolt
4 ceramic felt strip
5 perforated plate
6 ceramic wool stuffed
7 fire resisting board strip

Figure 13 — Mounting of perforated plate

Dimensions in millimetres

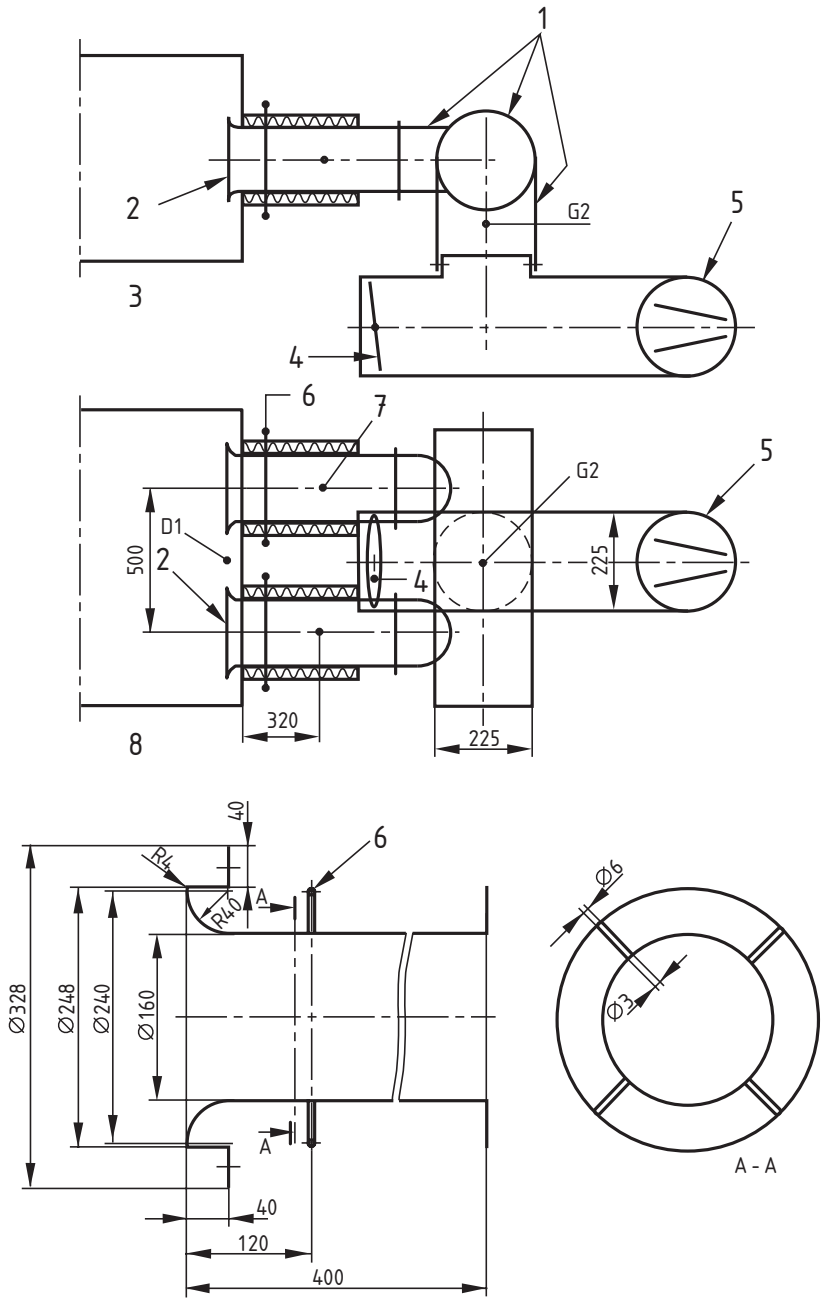


Key

1 furnace roof
2 fire stopping as in practice
3 perforated plate
4 thermocouple 1,5 mm diameter
5 connecting tube
6 joint
7 furnace chamber
8 duct surface
9 inlet nozzle
10 test duct
11 flow pressure control
12 fan
13 supporting construction (wall)
14 piezometric ring
15 distance: inlet nozzle to thermocouple = 2d according to Figure 6
16 detail - see Figure 15
G1 gas-testing probe at the perforated plate
G2 gas-testing probe at nozzles
D1 pressure probe

Figure 14 — Arrangement of gas-testing probes

Dimensions in millimetres



Key

1 connecting tube (tightly welded, inlet nozzles pos. 20 welded on)
2 inlet nozzle
3 duct – side view
4 flow pressure control
5 fan
6 piezometric ring
7 thermocouple 1,5 mm diameter
8 duct – plan view
G2 gas-testing probe
D1 Pressure probe

Figure 15 — Flow measurement equipment detail

Dimensions in millimetres

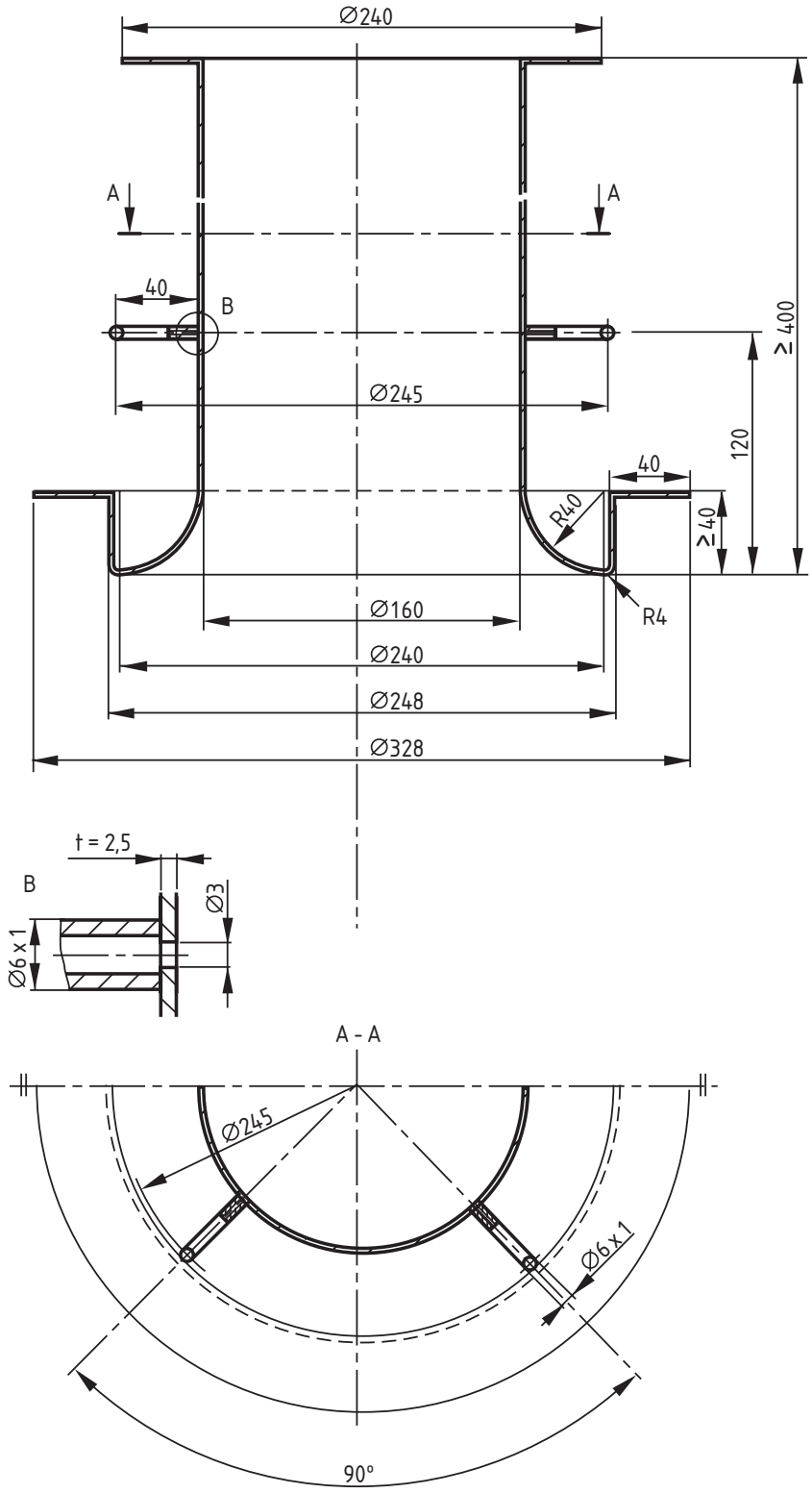
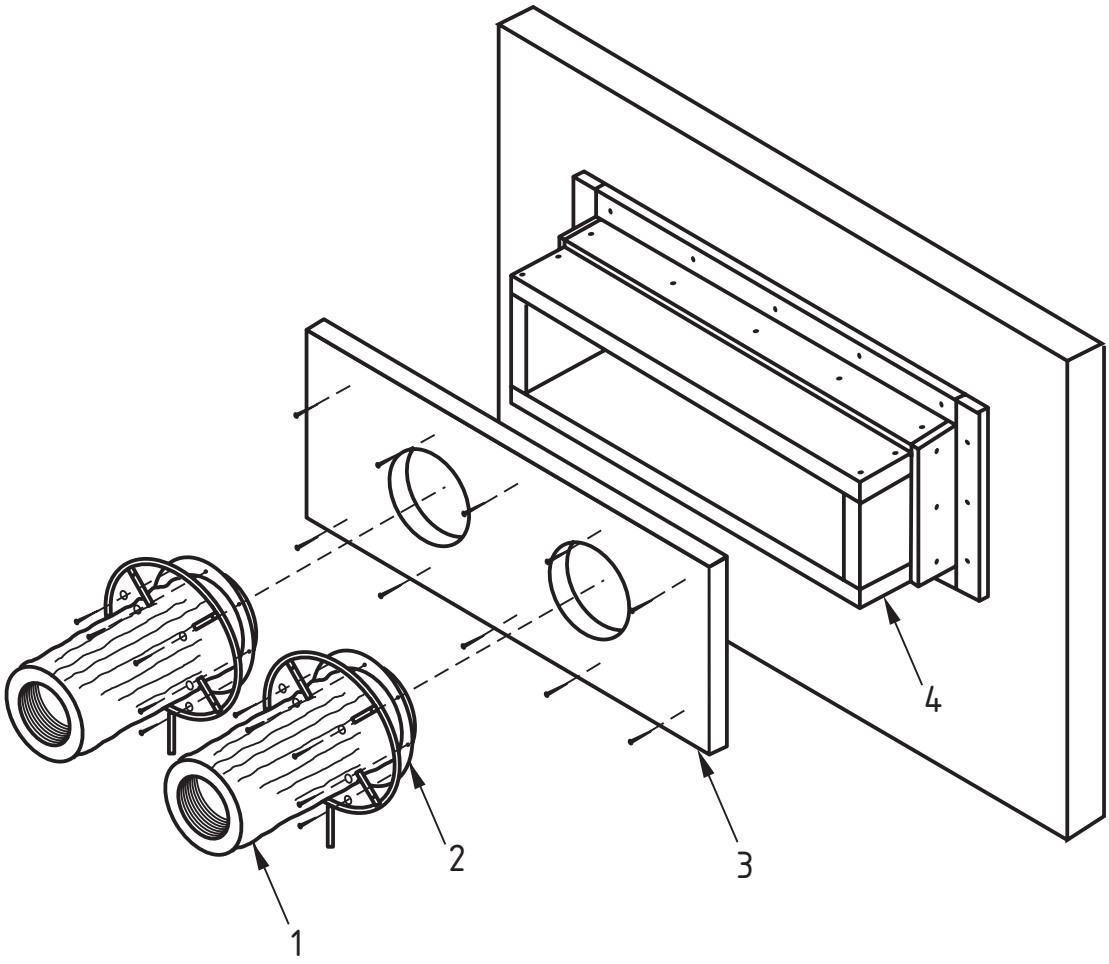


Figure 16 — Inlet nozzle

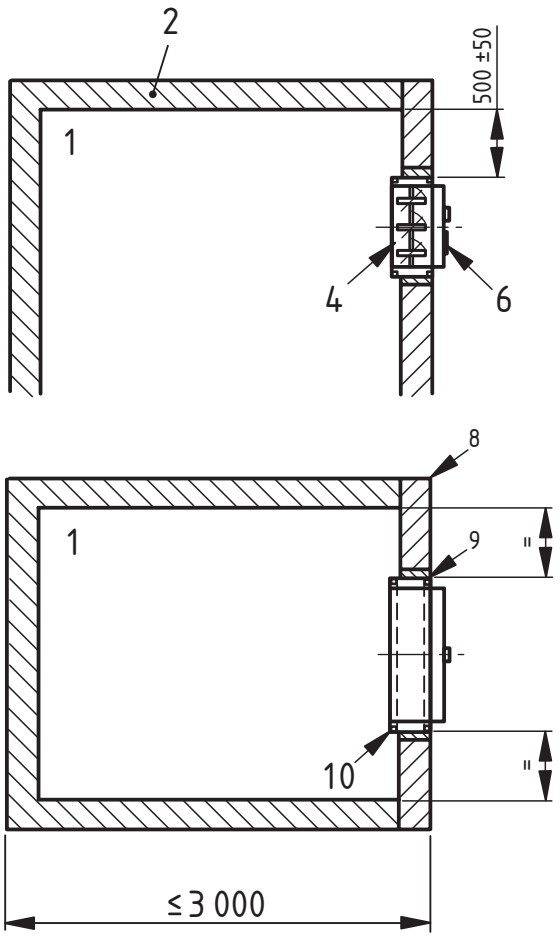


Key

1 insulation
2 inlet nozzle
3 duct end plate
4 test duct

Figure 17 — Method of mounting nozzles to the duct end

Dimensions in millimetres



Key

1 furnace chamber
2 furnace roof
4 test damper
6 observation window/hole
8 supporting construction (wall)
9 fire stopping as used in practice
10 actuator inside

NOTE For test according to 6.6.2, the damper is in open position by the start of the test.

Figure 18 — Test arrangement for smoke control damper to be mounted in a compartment boundary for HOT 400/30 test – cycling and maintenance of opening test

Annex A
(normative)

Cycling test

A.1 General

Three different requirements are placed on smoke control dampers as described in 6.3.

The results of the tests shall record that the cycles from the closed position to the open position and from the open position to the closed position (where required) were fully completed and that each travel took not longer than 60 s.

A.2 Purpose of the test

For smoke control or fire dampers, which have the closed position as safety position, any torque supports the closing process, so no test is required in the case of flow.

Due to their nature, smoke control dampers have to open against pressure and flow. Their ability to do this shall be confirmed by test with a load.

To do this economically without the use of actual flow the smoke control damper shall be subjected to a resistive force.

A.3 Method of Application

A.3.1 General

For each smoke control damper the following torque shall be applied to each blade.

$$T = 34{,}4 \times (BW/1\,000) \times (BH/1\,000)^2$$

where 34,4 is the constant base value, BW = the smoke control damper blade width in mm and BH = smoke control damper blade height in mm.

See A.4 for background with regard to the constant base value.

A.3.2 Smoke Control Damper with single blade

As an example, the torque on a smoke control damper with a large single blade area may be determined.

Blade size = 1 500 mm wide $\times$ 800 high

$$T = 34{,}4 \times (1\,500/1\,000) \times (800/1\,000)^2 = \underline{33\ Nm}$$

The test arrangement is shown in Figure A.1 and the load is determined as follows:

$$L = \frac{torque}{a \times 9{,}81}$$

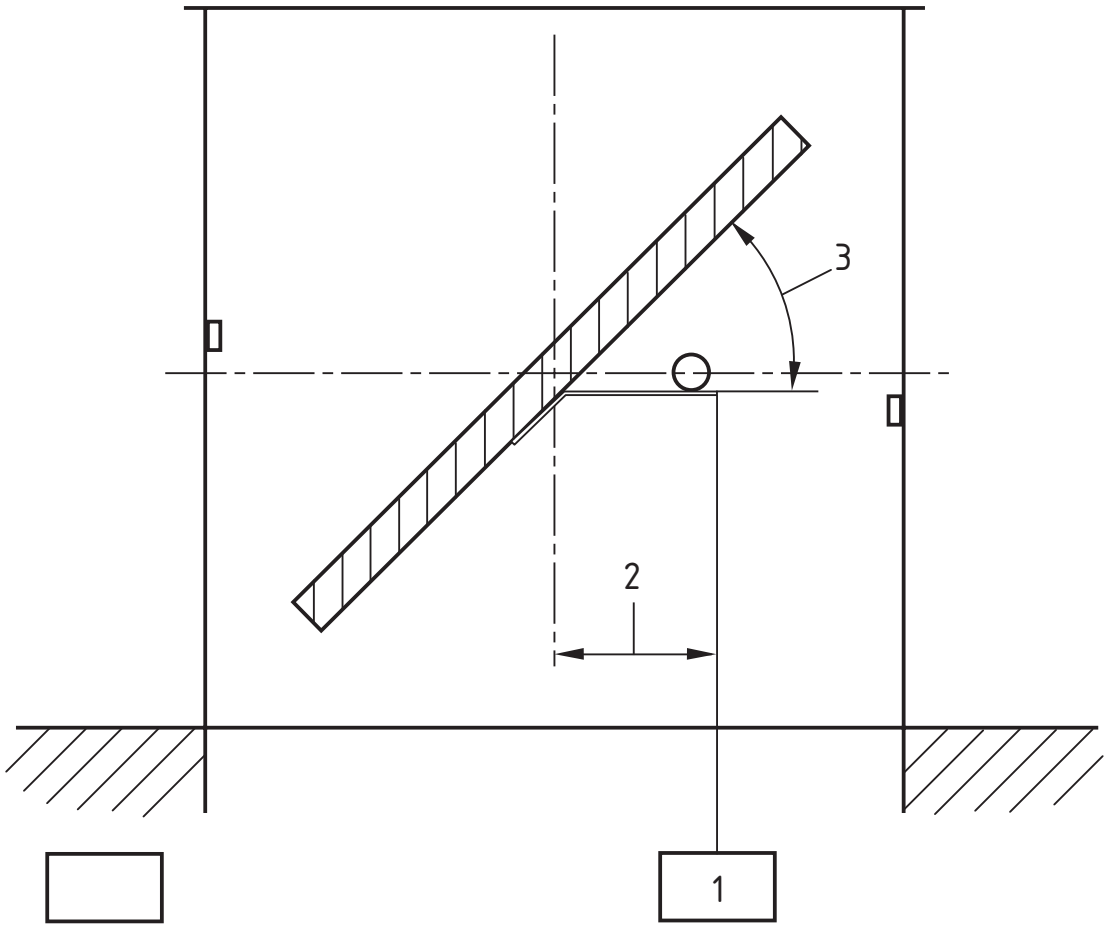
a = lever arm length (m)

L = load (kg)

Torque = (Nm)

The number of cycles shall then be made as per the requirements stated in 6.3.

The surface of the blade shall be made good only if necessary, without compromising or increasing the smoke control damper's ability to perform in the fire test.



Key

1 load

2 lever arm length – a

3 angle α – angle at which maximum torque has been determined – normally 45°

Figure A.1 — Testing method large single blade dampers

A.3.3 Smoke control damper with multi blades of smaller area

As an example, the torque on a smoke control damper with a large single blade area may be determined.

Blade size = 1 000 mm wide $\times$ 75 high

$T = 34{,}4 \times (1\,000/1\,000) \times (75/1\,000)^2 =$ 0.19 Nm

The load shall be applied to each individual blade to give the prescribed torque.

Methods to do this may include the addition of metal strips or similar to the surface of the blade by means of removable adhesives / magnets etc. or on large units a method similar to A.3.2 may be used.

$$L = \frac{torque}{a \times 9{,}81}$$

a = moment distance

L = load (kg)

Torque = (Nm)

The number of cycles shall then be made as per the requirements stated in 6.3.

The surface of the blade shall be made good only if necessary, without compromising or increasing the smoke control damper's ability to perform in the fire test.

A.3.4 Report

The test report shall include:

a) a drawing of the test specimen, so that it is possible to check the applied load;

b) details of any making good/ blade cleaning/fixing.

A.4 Background for the torque value (informative)

A.4.1 Threshold rates of the working condition of the system

In conformity with standard designed systems, a flow rate of 10 m/s (at ambient temperature) in the open position and a differential pressure of 1 500 Pa in the closed position were considered.

Considering the above the volumetric flow rate passing through a smoke control damper with largest dimensions of 1 500 mm $\times$ 800 mm in the open position would be

$V = 1{,}5 \times 0{,}8 \times 10$

$= 12\ m^3/s$ or $43\,200\ m^3/h$

A.4.2 Previous experience

Several tests with smoke control dampers, designed like fire dampers (single blade dampers) with closing elements in the form of only one approximately 50 mm thick damper blade, have shown that the greatest torque working against the opening process was in case of damper blades for smoke control dampers at an aperture angle of 40° and 65°. It could also be established that for the lifting of the smoke control damper blade from the closed position only minor torques are necessary, if the housing is not deformed by the prevailing pressure.

In the laboratory, the torques of smoke control dampers of sizes (Height × Width) 800 mm × 500 mm and 400 mm × 100 mm have been tested at a flow rate of 10 m/s. It can be deduced from the test results that following torques act on 50 mm thick damper blades:

For H = 800 mm 22 Nm per 1 m width

For H = 400 mm 10,5 Nm per 1 m width

Using the above figures the base value of 34,4 Nm, for use in the equation, was determined.

Annex B
(normative)

Leakage calculation from oxygen measurement

B.1 General

Using the values recorded, calculate the leakage from the O_2 measurements as follows:

First determine m_L the leakage mass flow (kg/s)

$$m_L = \frac{C_f \times m_{G2} \times (c_{G2} - c_{G1})}{21 - c_{G1}} - m_{LD}$$

where

m_{G2} is the mass flow at point G_2 near inlet nozzles (kg/s);

c_{G1} is the oxygen content of first sensor (vol-%);

c_{G2} is the oxygen content of second sensor (vol-%);

m_{LD} is the leakage mass flow of the supporting duct previously tested in accordance with EN 1366-8 or EN 1366-9: i.e. values for m_{LD} come from the initial type test report for the duct, calculated for the surface area of the duct installed after the perforated plate.

and C_f the correction factor is determined as follows:

$$C_f = \frac{0,79 \times L_{min} + 1,85 \times C}{0,79 \times L_{min} + 1,85 \times C + (21 - c_{G2}) \times 0,529 \times H}$$

where

C is the carbon content in fuel (kg/kg fuel);

H is the hydrogen content in fuel (kg/kg fuel);

S is the sulphur content in fuel (kg/kg fuel)

and L_{min} the minimum stoichometrical air needed (m^3/kg fuel) at standard temperature and pressure is determined as follows:

$$L_{min} = 8,88 \times C + 26,44 \times H + 3,33 \times S$$

Then determine V_L, the leakage volume flow (m^3/s):

$$V_L = \frac{m_L}{\rho}$$

where

ρ is the density of dry air at 20 °C/1 013 hPa (= 1,2 kg/m^3)

Annex C
(normative)

Maintenance of opening calculation

C.1 Calculation of the theoretical total mass M_{max} of hot gases during the fire test

C.1.1 Basis

The extract fan provides a static pressure which changes proportionally to the square of the rotation speed of the wheel. The static pressure changes proportionally to the change of the gases density. The gases density changes proportionally to the absolute temperature. The volume flow changes proportionally to the speed.

C.1.2 Method

C.1.2.1 At the beginning of the fire test, we consider:

- the smoke control damper is fully open and shall remain fully open all through the test,
- air velocity in the test duct is V_o (m/s) (now $V_o = 2$ m/s),
- S (m²) is the cross-section of the test duct,
- volume flow Q_0 (m3/s) is $Q_0 = V_o \times S$
- air density ρ_o (kg/m^3) at ambient temperature T_o (K),
- initial speed of the fan wheel ω_o,
- static pressure in accordance with Table 1 (-150 Pa,-300 Pa or -500 Pa) is $p_{To, \omega o}$
- reference time is 0 s

C.1.2.2 During the fire test at t (s):

-the temperature goes from T_o to T (K) (for example T follows the standard temperature-time curve)

then $\rho / \rho_o = T_o / T$

-static pressure goes from $p_{To, \omega o}$ to $p_{T, \omega o}$

with $p_{T, \omega o} = p_{To, \omega o} \times \rho / \rho_o$

or

$$p_{T, \omega o} = p_{To, \omega o} \times T_o / T \qquad (C.1)$$

as $T > T_o$, $p_{T, \omega o} < p_{To, \omega o}$

It is necessary to increase the rotation speed ω of the fan to regulate the static pressure $p_{T,\omega}$ to get the initial value $p_{To,\omega o}$ This results in

$$p_{T,\omega} / p_{T,\omega o} = (\omega/ \omega_o)^2 \quad \text{(C.2)}$$

$$\text{with } p_{T,\omega} = p_{To,\omega o} \quad \text{(C.3)}$$

(C.1) and (C.3) in (C.2) give

$$T / T_o = (\omega/ \omega_o)^2 \quad \text{(C.4)}$$

From (C.4), as $Q / Q_o = \omega/ \omega_o$ this results in

$$Q = Q_o \times \sqrt{\frac{T}{T_0}} \quad \text{(C.5)}$$

From the start of the test

$$Q_o = V_o \times S \quad \text{(C.6)}$$

(C.5) and (C.6) give

$$Q(t) = V_0 \times S \times \sqrt{T(t)/T_0} \quad \text{(C.7)}$$

At time t, the theoretical mass flow exhausted from the furnace is

$$\dot{m}(t) = \rho(t) \times Q(t)$$

with $\rho(t) = \rho_0$ x T_o/ T (t) this gives

$$\dot{m}(t) = \rho_0 \times \frac{T_0}{T(t)} \times V_0 \times S \times \sqrt{\frac{T(t)}{T_0}} \quad \text{(C.8)}$$

C.1.3 Summary

C.1.3.1 Calculation

The theoretical maximum total mass M_{max} of hot gases exhausted during the fire test is:

$$M_{\max} = \int_{ts}^{t_f} \dot{m}(t)dt$$

from t = t_s (start time for recording the O_2 measurements) to t= t_f (end of the fire test):

with: t_s = (furnace ignition + 5 min) for smoke control dampers with an AA classification

or: t_s = (furnace temperature reaches 50 °C + 30 min) for smoke control dampers with an MA classification

Then using (C.8),

$$M_{\max} = \int_{ts}^{t_f} \rho_0 \times \frac{T_0}{T(t)} \times V_0 \times S \times \sqrt{\frac{T(t)}{T_0}} dt$$

or simplified:

$$M_{\max} = \rho_0 \times V_0 \times S \times \sqrt{T_0} \times \int_{ts}^{t_f} \frac{1}{\sqrt{T(t)}} dt \quad \text{(kg)}$$

with, for multi-compartment smoke control dampers

T (t) = 273,15 + 345 × log (8xt/60+1) + $\theta_{amb:}$ t in seconds, θ_{amb} in °C

or, for single compartment smoke control dampers

T (t) = 273,15 + 345 × log (8xt/60+1) + $\theta_{amb:}$ t in seconds, θ_{amb} in °C

Until T(t) reaches 600 °C, followed by T(t) = 600 °C for the remainder of the test.

C.1.3.2 In practice

Based on $M_{\max} = \rho_0 \times V_0 \times S \times \sqrt{T_0} \times \int_{ts}^{t_f} \frac{1}{\sqrt{T(t)}} dt$

Calculate $M_{\max} = \rho_0 \times V_0 \times S \times \sqrt{T_0} \times \sum_{i=1}^{N} \frac{1}{\sqrt{Ti}} \times \Delta t$ with Δt (s) interval between two recordings of the temperature inside the furnace Ti (K) and Ti+1 (K) between t_s (i = 1) and t_f (i = N);

S (m²) is the cross sectional area of the test duct,

V_0 (m/s) is the air velocity in the duct before ignition of burners,

T_0 (K) = 273,15 + θ_{amb} with θ_{amb} ambient temperature (°C) inside the furnace before ignition of burners,

ρ_0 (kg/ m^3) the air density at ambient temperature T_0

C.2 Calculation of the actual total mass M_{actual} of hot gases during the fire test

C.2.1 Basis

The difference in the O_2 concentration measurements at points G_1 and G_2 form the basis of the calculation of the actual total mass M_{actual} of hot gases during the fire test.

The mass flow rate passing through the smoke control damper mounted inside the furnace is $\dot{m}_{G1}(t)$ with:

$$\dot{m}_{G2}(t) = \dot{m}_{G1}(t) + \dot{m}_{L}(t) \qquad \text{(C.9)}$$

where

$\dot{m}_{G2}(t)$ (kg/s) is the mass flow rate at point G_2, $\dot{m}_{L}(t)$ (kg/s) is the leakage mass flow rate and $\dot{m}_{G1}(t)$ (kg/s) is the mass flow rate at point G_1

With $\dot{m}_{L}(t) = C_f \times \dot{m}_{G2}(t) \times \dfrac{c_{G2} - c_{G1}}{21 - c_{G1}}$

C.2.2 Method

Mass flow at point G_2

$$\dot{m}_{G2}(t) = \sum_{nozj1}^{nozj2} A_{eff,\,nozj} \times \sqrt{2 \times \Delta p_{nozj} \times \frac{353}{273.15 + \theta_{nozj}(t)} \times \frac{p_{bar}}{1013.25}} \qquad \text{(C.10)}$$

Include both nozzles - p_{bar} is the is the atmospheric pressure (hPa)

Leakage mass flow

$$\dot{m}_{L}(t) = C_f \times \frac{c_{G2} - c_{G1}}{21 - c_{G1}} \times \left\{ \sum_{nozj1}^{nozj2} A_{eff,\,nozj} \times \sqrt{2 \times \Delta p_{nozj} \times \frac{353}{273.15 + \theta_{nozj}(t)} \times \frac{p_{bar}}{1013.25}} \right\} \qquad \text{(C.11)}$$

Thus ((C.10) and (C.11) in (C.9) give the mass flow rate passing through the smoke control damper mounted inside the furnace during the fire test

$$\dot{m}_{G1}(t) = \left[1 - C_f \times \frac{c_{G2} - c_{G1}}{21 - c_{G1}}\right] \times \left\{ \sum_{nozj1}^{nozj2} A_{eff,\,nozj} \times \sqrt{2 \times \Delta p_{nozj} \times \frac{353}{273.15 + \theta_{nozj}(t)} \times \frac{p_{bar}}{1013.25}} \right\} \qquad \text{(C.12)}$$

where C_f is the correction factor taken from Table C.1

Table C.1

Furnace temperature	Standard time temperature curve	600 °C
C_f for fluid fuels	0,903	0,940
C_f for natural gases (Hand L)	0,856	0,910

C.2.3 Summary

C.2.3.1 Calculation

The actual total mass of gases passing through the smoke control damper inside the furnace is

$$M_{actual} = \sum_{i=1}^{N1} \dot{m}_{G1}(ti) \times \Delta ti$$

where Δt_i is the interval between two recordings of c_{G1} and $c_{G2,}$and N1 is the total number of recordings.

C.2.3.2 In practice

For each recording of c_{G1} and c_{G2} calculate $\dot{m}_{G1}(ti)$ between t_s (i=1) and t_f (i=N);

and at the end of the test,

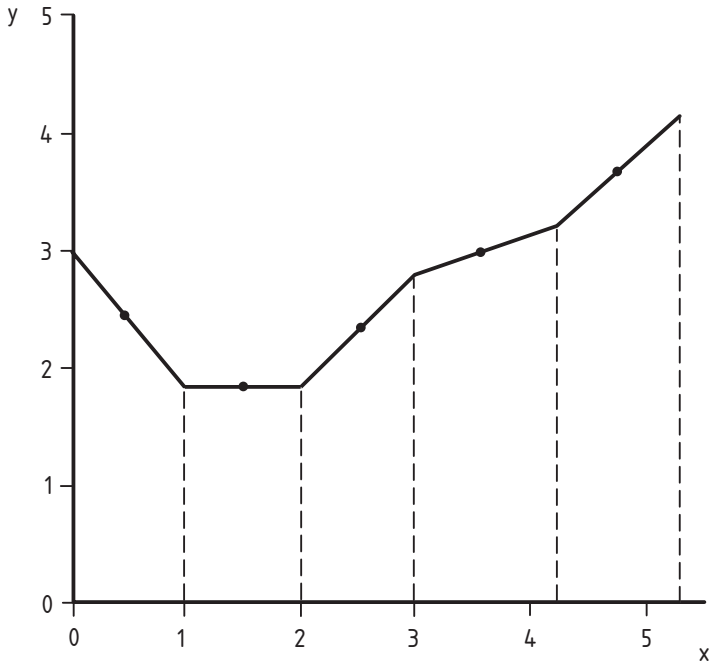
calculate $M_{actual} = \sum_{i=1}^{N1} \dot{m}_{G1}(ti) \times \Delta ti$

The first recording $\dot{m}_{G1}(1)$ corresponds to t_s (start time for recording the O2 measurements) with:

With: t_s = (furnace ignition + 5 min) for smoke control dampers with an AA classification

or: t_s = (furnace temperature reaches 50 °C + 30 min) for smoke control dampers with an MA classification

C.3 Graphical representation of typical integral calculation from data



Key
y – kg/sec
x - seconds

Figure C.1 — Typical curve

Table C.2 — Using the data from Figure C.1, calculate the total mass at each point in the test and keep a running total

MASS	0	=	0					RUNNING TOTAL
MASS	0 – 1	=	(3 + 2) / 2	×	(1 – 0)	=	2,5	2,5
MASS	1 – 2	=	(2 + 2) / 2	×	(2 – 1)	=	2	4,5
MASS	2 – 3	=	(2 + 3) / 2	×	(3 – 2)	=	2,5	7,0
MASS	3 – 4	=	(3 + 3,5) / 2	×	(4 – 3)	=	3,25	10,25
MASS	4 – 5	=	(3,5 + 4,5) / 2	×	(5 – 4)	=	4	14,25
	ETC							ETC

Bibliography

[1] EN 12101-3, *Smoke and heat control systems — Part 3: Specification for powered smoke and heat exhaust ventilators*

[2] CEN/TR 12101-4, *Smoke and heat control systems — Part 4: Installed SHEVS systems for smoke and heat ventilation*

[3] EN 12101-8, *Smoke and heat control systems — Part 8: Smoke control dampers*

[4] EN 12101-6, *Smoke and heat control systems — Part 6: Specification for pressure differential systems — Kits*

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