BS EN 13216-1:2004

Chimneys — Test methods for system chimneys —

Part 1: General test methods

The European Standard EN 13216-1:2004 has the status of a British Standard

ICS 91.060.40

British Standards

National foreword

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The UK participation in its preparation was entrusted to Technical Committee B/506, Chimneys, which has the responsibility to:

— aid enquirers to understand the text;

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 8 September 2004

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 66, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 44423 6

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13216-1

September 2004

ICS 91.060.40

English version

Chimneys - Test methods for system chimneys - Part 1: General test methods

Conduits de fumée - Méthodes d'essai pour les systèmes de conduits de fumée - Partie 1: Méthodes d'essai générales

Abgasanlagen - Prüfverfahren für System-Abgasanlagen - Teil 1: Allgemeine Prüfverfahren

This European Standard was approved by CEN on 1 April 2004.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13216-1:2004: E

Contents

Foreword

This document (EN 13216-1:2004) has been prepared by Technical Committee CEN/TC 166 "Chimneys", the secretariat of which is held by UNI.

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

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of an identical text or by endorsement, at the latest by March 2005, and conflicting national standards shall be withdrawn at the latest by March 2005.

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

Introduction

CEN/TC 166 intends to publish the test methods for system chimneys as separate parts of a series of standards.

The first part of the series of EN 13216 includes material-independent test methods for system chimneys.

For the purpose of this document, system chimneys are considered as kits in the meaning of Guidance Paper C (see Bibliography).

Further parts of the multi-part standard include material-specific test methods, each material used for the inner wall being decisive. The material-specific test methods are based on the general material-independent test methods. Considering the various characteristics, the material tests can be carried out on deviating specimens or can include other test procedures which however have correlation to those given in this standard.

It is intended to prepare further parts if further material-specific standards are published.

1 Scope

This document specifies material-independent general test methods for system chimneys.

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 1443:2003, *Chimneys – General requirements.*

EN 10088-1, *Stainless steels – Part 1: List of stainless steels.*

EN 13384-1, *Chimneys – Thermal and fluid dynamic calculation methods – Part 1: Chimneys serving one appliance.*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989).*

BS 1042-2.1, *Measurement of fluid flow in closed conduits – Velocity area method – Method using Pitot static tubes.*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 1443:2003 and the following apply.

3.1
test chimney
assembly of representative chimney components necessary to enable the system chimney to be assessed for the performance criteria

3.2
test assembly
complete assembly of all parts necessary to enable the specific performance criteria (thermal performance and others) to be assessed, comprising test chimney, test structures, and measuring equipment

3.3
test sample
assembly of chimney components necessary to enable the system chimney to be assessed as defined for specific performance criteria

3.4
test structure
assembly of the additional materials (non-chimney components) to enable the test sample to be assessed for the specific performance criteria

3.5
thermal shock test
method to assess the sootfire resistance characteristics of the system chimney (internal to external)

3.6
thermal test
method to assess the temperature characteristics of the system chimney

3.7
vapour and condensate resistance test
method to assess the system chimney's resistance to vapour and condensate

3.8
condensate resistance test
method to assess the components or sub assemblies of system chimney's resistance to condensate

3.9
thermocouple rake
assembly of thermocouples used to measure the temperature distribution across a flue

3.10
accuracy
ability of the measuring instruments to give response in the specified range from the true value

3.11
uncertainty of measurement
combination of all parameters (i.e. accuracy, human parameter, environmental parameters) to give response in the specified range from the true result

3.12
tolerance
range in which a parameter has to be met without respects to accuracy an uncertainty of measurement

4 Test environment and measurement parameters

4.1 Location of test chimneys (see Figure 1)

The minimum distance between the test chimneys and building structures (i.e. walls etc.) shall be 1,0 m.

4.2 Test environment

The ambient air temperature in the test room shall not vary during tests by more than 5 °C and shall remain in the temperature range of 15 °C up to 30 °C.

The test room shall consist of a ventilated space not subject to air movement greater than 0,5 m/s measured at the ambient thermocouple positions.

4.3 Location for the measurement of ambient air condition (see Figure 1)

The ambient air temperature and velocity shall be measured at a position:

— 1,5 m ± 0,1 m above the test rig floor;

— 1,5 m ± 0,5 m from any walls of test chimneys;

— at least 1,0 m from any other structures.

The ambient air temperature shall be measured for a test chimney, corner installation, enclosed, see 5.7.3.1.3 additional 0,3 m ± 0,1 m below the ceiling of zone B.

4.4 Accuracy of measurement

The ambient air temperature shall be measured with an accuracy of ± 0,5 °C.

The velocity of the ambient air shall be measured with an accuracy of ± 0,1 m/s.

5 Performance tests for system chimneys, material independent

5.1 General

NOTE Annex A gives a recommended test sequence.

5.2 Abrasion resistance test

5.2.1 Test apparatus

A tight fitting metal sleeve attached to a guide funnel shall be fitted into the top opening of the flue of the test chimney (see Figure 2). The alternative test sample from components may be tested as shown in Figure 3. A tight fitting metal sleeve attached to a plate which has an opening matching the area of the opening to the flue shall be fitted into the bottom opening of this test sample.

A bottom plate supported directly over a collection box is positioned to collect any material which is dislodged during the test, and which is sufficiently deep to allow the brush to pass through the complete length of the test sample.

The brush shall be attached either to a rod or to a sweeping equipment as shown in Figure 4.

Use a sweeping brush having flat spring-steel bristles of stainless steel in accordance with EN 10088-1, grade X 10 Cr Ni 18-8, steel number 1.4310, with a cross section of (2,0 ± 0,2) mm x (0,25 ± 0,05) mm with the ends cut square. The bristles shall be arranged so that there are 5 per 10 mm length of the perimeter of the plan area of the brush. The brush may be a combination of single brushes.

The over-all dimension of the brush shall be (25 ± 5) mm greater than the internal dimension of a round flue or the corresponding dimension of a flue with square or rectangular cross section (see Figure 4). The brush shall be held securely between plates having a plan dimension (100 ± 5) mm less than the internal dimension of the flue.

The balance to weigh the deposit shall have an accuracy of 1,0 g.

5.2.2 Test sample

The test sample shall be the test chimney used for the thermal performance tests, see Figure 2 or the alternative test sample, see Figure 3, thermally conditioned to the test temperature according to the designation given in EN 1443. The test sample shall be assembled as specified in the product standards.

5.2.3 Measuring parameters

Measure the weight of material dislodged from the inner surface of the test assembly after 100 cycles with an accuracy of 1,0 g.

The area for the inner surface of the test sample, exposed to abrasion shall be calculated.

5.2.4 Test procedure

The brush shall be pushed down and up through the total length of the test sample with a maximum speed of 2 m/s and this represents one cycle.

A test number of 100 cycles shall be completed.

Record the weight of material dislodged and the dimensions of the inner surface.

5.2.5 Test results

The recorded mass of material abraded from the inner surface of the test sample over 100 sweeping cycles shall be expressed in terms of kilograms per square meter of the total exposed area of the inner surface of the flue.

5.3 Relative movement of the flue liner in multi-wall system chimneys

5.3.1 Test apparatus

A test apparatus which allows the measurement of deviations in the differential movement between the flue liner and the outer wall of multi-wall-system chimneys.

The accuracy shall be ± 0,001 m.

5.3.2 Test sample

The test sample shall be the test chimney used for the thermal performance tests, thermally conditioned according to the designation given in EN 1443. The test sample shall be assembled as specified in product standards. When the manufacturer claims for an opening, it shall be installed in Zone C (see Figure 1).

5.3.3 Measuring parameters

Measure the surface temperature of the test chimney according to 5.7.
Measure the change in position of the flue liner relative to the outer wall at the top of the test sample before and after the thermal performance tests.

5.3.4 Test procedure

All measurements shall be made before and after the thermal performance test appropriate to the designation.

Record the difference in length between the flue liner and the outer wall when all thermocouples have reached ambient air temperature within 5 °C.

5.3.5 Test results

The results are expressed by the change in position of the flue liner relative to the outer wall after the test sample has cooled down to room temperature.

5.4 Gas tightness test

5.4.1 Test apparatus

Provide an air supply capable of delivering air at a rate sufficient to achieve and maintain the required test pressure at the leakage rate appropriate to the designation.

Seal the flue inlet and the flue outlet of the test chimney with an air tight seal in a typical manner (see Figure 5).

For measurement of pressure use:

— for chimneys designated N a device with the pressure to an accuracy of ± 1 Pa;

— for chimneys designated P a device with the pressure to an accuracy of ± 5 Pa;

— for chimneys designated H a device with the pressure to an accuracy of ± 50 Pa.

For measurement of the gas leakage for negative and for positive pressure chimneys in accordance with EN 1443 use a device with an accuracy of ± 5 %.

5.4.2 Test sample

The test sample shall be the test chimney used for the thermal performance tests, thermally conditioned according to the designation given in EN 1443. The test sample shall be assembled as specified in system chimney standards, (i.e. with an opening where appropriate) (see Figure 5).

Where the products are not required to be thermally conditioned, the test sample (i.e. with an opening where appropriate) shall consist of at least two chimney sections or fittings with one joint where applicable.

5.4.3 Measuring parameters

Measure and record:

— gas leakage and the pressure maintained during the test in accordance with EN 1443;

— inner dimensions of the test sample.

Calculate the inner surface area.

Record the air flow rate, the pressure and the inner dimensions of the test sample.

5.4.4 Test procedure

Deliver air from the air supply to the flue at a rate necessary to achieve and maintain the required test pressure given in EN 1443. Measure the gas leakage at ambient temperature.

Subject the test sample to thermal conditions appropriate to the designation or as stated in the product standards.

Measure the gas leakage again at ambient temperature.

5.4.5 Test results

The results are expressed by the leakage rate related to the inner surface area of the test sample.

5.5 Condensate resistance test

5.5.1 Test apparatus

A test apparatus which allows to spray (coloured) water into the flue, in accordance with Figure 6. The test apparatus shall consist of a tank, a water heater, a gate valve, an air supply where required for the apparatus, a peristaltic pump and a spray equipment capable of giving even distribution of the spray.

The balance to weigh components of the test sample shall have an accuracy of ± 1 g up to 10 kg and ± 2 g for more than 10 kg. The balance shall be capable of weighing at least two flue liners or two chimney sections.

5.5.2 Test sample

The test sample shall consist of minimum two sections or fittings with at least one joint. If the test chimney of the thermal performance test is to be used as a test sample, take only the two top sections for weighing.

5.5.3 Measuring parameters

Measure:

— spray temperature and the spray volume;

— appearance of water on the outside the test sample of fittings or chimney sections of the test chimney;

— change in weight of the test sample.

5.5.4 Test procedure

Dry and weigh the test sample used before spraying water.

Spray (coloured) water on the inner surface at the outlet of the flue liner:

- with a temperature of 50 °C ± 5 °C;
- with a pressure of a maximum of 3 bar;
- with a water volume related to the diameter (at $0{,}040 \cdot m^3 \cdot h^{-1} \cdot m^{-1} \pm 0{,}008\ m^3 \cdot h^{-1} \cdot m^{-1}$)

during 4 h or until water appears on the outside of the test sample.

Dry and weigh the test samples. When components of the test chimney are weighed, they have to be dried and then re-weighed.

Record:

- spray temperature and the spray volume;
- detection of (coloured) water outside of fittings or chimney sections;
- change in weight of the test sample after spraying water in comparison to the dried sample.

5.5.5 Test results

Record:

- location of any appearance of water on the outside of any fitting or chimney section of the test samples, and
- any change in weight of the test sample or components.

5.6 Vapour and condensate resistance test

5.6.1 Test apparatus

A test apparatus which allows to deliver water vapour saturated air at a temperature of 52 °C ± 2 °C and a velocity of 1 m/s ± 0,2 m/s, consisting of a fan, a heater, a vapour steam vessel, and a flow rectifier (see Figure 7).

Use a measurement equipment:

- for flue gas temperature with an accuracy of ± 1,5 °C,
- for layer temperature with an accuracy of ± 0,5 °C and
- for humidity with an accuracy of ± 2 % in the range of 0 % to 80 % and of ± 3 % in the range of 80 % to 100 %.

The balance to weigh components of the test sample shall have an accuracy of ± 1 g up to 10 kg and ± 2 g for more than 10 kg. The balance shall be capable of weighing at least two flue liners or two chimney sections.

For measurement of chimney draught use a device with an accuracy of ± 1 Pa.

For measurement of flue gas velocity use a device with an accuracy of ± 0,1 m/s.

5.6.2 Test sample

The test sample shall be the test chimney used for the thermal performance tests, thermally conditioned according to the test temperature given in EN 1443. The sample shall be assembled as specified in Figure 7. When the manufacturer claims for an opening it has to be installed in Zone C (see Figure 7).

Zone B shall have no enclosure.

5.6.3 Measuring parameters

5.6.3.1 General

Measure and record the temperatures and relative humidity of:

— flue gas;

— specified layers of the test sample; and

— ambient air.

Measure and record any change in weight.

5.6.3.2 Ambient air temperature and humidity

Ambient air temperature, see 4.3. Ambient humidity shall be measured at the same position.

5.6.3.3 Flue gas temperature and humidity

Measure the flue gas temperature with an accuracy of ± 1,5 K at a position (50 ± 2) mm before the inlet to the test chimney and at a position 500 mm below the exit at the top of the test sample. Measure the flue gas humidity at the same positions.

5.6.3.4 Layer temperatures

Where a change in weight in components of the test sample is the assessment criteria specified in the specific product standard, measure the specified outer surface temperatures (see 5.7.4.5).

Where a change in humidity in components of the test sample is the assessment criteria specified in the specific product standard, measure:

- specified temperatures in the insulation layer and the outer surface temperature at the heights given in 5.6.3.6, (see Figure 8);

- temperatures of the ventilating air at the inlet and outlet of the test chimney, where appropriate.

Measure the temperatures to an accuracy of ± 0,3 K.

5.6.3.5 Layer humidity

Where a change in humidity in components of the test sample is the assessment criteria specified in the specific product standard, measure the relative humidity at the same relevant positions as the temperatures to an accuracy of ± 2 % RH in the range 0 % to 80 % RH and ± 3 % RH in the range 80 % to 100 % RH (see Figure 8).

5.6.3.6 Change in weight

Where a change in weight in components of the test sample is the assessment criteria specified in the specific product standard, measure the increase in weight before and after exposing to the water vapour saturated air.

5.6.3.7 Location for surface temperature and humidity / temperature measurements

Locations for surface temperatures and humidity / temperature measurements, at heights of 1 m, 2 m and 3 m are given in Figure 9.

5.6.3.8 Chimney draught measurement

Measure and record the chimney draught for a negative pressure chimney to an accuracy of ± 1 Pa.

5.6.3.9 Flue gas velocity

Measure the flue gas velocity to an accuracy of ± 0,1 m/s at a distance of (150 ± 10) mm from the entry to the inlet and downstream of a flow rectifier.

5.6.3.10 Test environment, test room

The ambient temperature within the test building shall be maintained between 20 °C and 25 °C, measured at the designated ambient air point (see Figure 1).

5.6.4 Test procedure

Install the test chimney into the test structure without enclosure of zone B, corner installation, in accordance with the manufacturer’s installation instructions (see Figure 9).

Subject the test chimney to a drying phase at its designated temperature until all thermocouples register steady state conditions. Steady state conditions are reached when the outer wall temperature of the test sample after a drying phase of at least 2 h changes not more than 1 K in 1 h.

Record all relevant temperatures and humidities.

Generate water vapour saturated air at a temperature of (52 ± 2) °C and a rate necessary to give a velocity of (1 ± 0,2) m/s in the test chimney. Maintain these conditions until:

- condensate appears on the external wall of the test sample; or
- steady state conditions in the boundary layers between insulation and outer wall are reached. In any case, terminate the test after no longer than 3 weeks (see Figure 10).

For chimneys designated as N, monitor the chimney draught. Terminate the test when the chimney does not remain under negative pressure.

Record all the test parameters during the heating period and at steady state conditions. Steady state conditions are reached when the humidity in the boundary layer of the test sample after a test phase of at least 2 days changes not more than 2 % relative humidity in 4 h.

5.6.5 Test results

Record any change in humidity and temperature within the boundary layer between insulation and outer wall.

Record the location of any appearance of water on the outside of any fitting or chimney section of the test chimney.

Calculate the temperatures and humidity in the walls of multi-wall chimneys for ambient conditions specified for the region where the chimney is to be installed. For this specified ambient conditions, no condensation shall occur within the walls (see Annex B).

5.7 Thermal performance test

5.7.1 General

The test chimney outlet shall be positioned within the test room. The chimney draught generated in the chimney by extract provisions shall not be more than 1 Pa. The velocity of flue gas through the chimney shall not be influenced by combustion air supply provisions by more then 0,2 m/s. Methods for determining the effects of extract and air supply provisions are given in Annex C.

5.7.2 Test apparatus and test structure for thermal and thermal shock tests

5.7.2.1 General

The test assembly shall comprise a test structure (see 5.7.2.2), a hot gas connecting pipe (see 5.7.2.3), a hot gas generator (see 5.7.2.4) and a test chimney (see 5.7.2.2).

5.7.2.2 Test structure

5.7.2.2.1 General

Construct the test assembly consisting of the test chimney, the test structure and the measuring equipment.

NOTE Figure 9 illustrates arrangements for testing chimney sections away from the test structure, at the test structure in a corner with and without enclosure.

5.7.2.2.2 General requirements for test structures

Construct a test structure consisting of two walls at right angles and two floors through which the test chimney passes (see Figure 11). The construction shall have thermal characteristics as described in 5.7.2.2.3 and 5.7.2.2.4, with the area below the first floor designated as zone A, the area between the first floor and second floor as zone B, and the area above the second floor as zone C, as shown in Figure 1. The wall/floor interface shall be fitted with nominal 20 mm x 100 mm skirting board. The vertical distance between the floor and ceiling in zone B shall be (2 400 ± 25) mm. The height of the chimney protruding into zone C shall not be less than 500 mm. Timbers shall have a dimensional tolerance of ± 1 mm.

5.7.2.2.3 Walls

Construct walls consisting of nominal dimension 38 mm x 89 mm thick timbers in a framework (see Figure 12) faced on each side with one layer of nominally 12 mm thick plywood to give a total thickness of 114 mm ± 1,0 mm insulated in the voids with mineral wool insulation having a thermal conductivity of 0,035 W/mK ± 0,002 W/mK at 20 °C, with a minimum density of 70 kg/m^3. The walls shall extend 1 200 mm ± 12 mm.

5.7.2.2.4 Floors

Construct flooring framework of nominal dimension 50 mm x 200 mm timbers at the first floor level and nominal dimension 50 mm x 100 mm timbers at the second floor level forming an opening that enables the test chimney to be erected so that all parts of the test structure are at the manufacturer's specified clearance x mm from the chimney components (see Figure 12e) covered with one thickness of nominal dimension 20 mm boarding for the floors and one thickness of nominal dimension 12 mm plywood for the ceilings, except for the second floor ceiling (exposed top), and the spaces between the timbers filled with nominal 100 mm thick mineral wool insulation with a thermal conductivity of 0,035 W/mK ± 0,002 W/mK at 20 °C, with a minimum density of 70 kg/m^3.

5.7.2.3 Hot gas connecting pipe

Construct a purpose-made insulated straight flue pipe having an nominal diameter equal to that of the flue of the test chimney of a length of approximately seven diameters measured from the centre line of the flue gas generator to the entry to the test chimney, insulated to provide a thermal resistance value of not less than that equivalent to 50 mm thickness of material having a thermal conductivity of (0,125 ± 0,005) W/mK at 750 °C ± 5 °C (see Figure 1).

5.7.2.4 Hot gas generator

The test apparatus shall consist of a hot gas generator, producing the hot gas as given in Table 1 at the rate and temperature according to the designation and flue diameter. The overall temperature distribution factor (OTDF), see Annex D, shall not be greater than 1,05 at the measuring point at the entry of the chimney, see Annex D.

When the hot gas is generated by the combustion of fuel, no flame shall enter the test sample. This is fulfilled when the hot gas has a CO/CO_2 ratio not greater than 0,01.

Alternatively, a test apparatus consisting of a fan and an electric heater, producing the hot gas as given in Table 1 at the rate and temperature according to the designation and flue diameter may be used up to a designated temperature of 250 °C.

5.7.3 Test sample

5.7.3.1 Test chimney for thermal test and for thermal shock test

5.7.3.1.1 General

The test sample is the test chimney which shall be installed according to the manufacturer's instructions.

The size of the test chimney shall be the largest size produced up to 200 mm flue diameter.

The test chimney shall have a minimum of 4,50 m height, from the heat gas input up to the gas exit. The size shall be the nearest to 200 mm flue diameter for a production range starting with diameters more than 200 mm.

The height of the test sample above the second floor shall be not less than 0,5 m. This part shall not be enclosed (see Figure 1).

When cleaning doors, terminals or inspection openings are installed in the test sample, they shall be located in the part over the second floor.

When a device for condensate removal is installed in the test sample, it shall be located in the lowest part, under the T-piece.

The maximum distance between measuring points of the hot gas temperature and the inlet of the test sample shall be not more than 50 mm.

Where the manufacturer provides measurement points access and inspection openings, they shall be tested for positive pressure chimneys in the horizontal part while the horizontal part shall be as short as possible.

5.7.3.1.2 Free standing test chimney (see Figure 9)

When the test chimney shall be tested in a free standing arrangement, it may be fixed to the test structure or other walls. The distance between the test sample outer surfaces to the walls of the test structure shall be not less than 1,1 m.

5.7.3.1.3 Test chimney, corner installation (see Figures 9 and 13)

When the test chimney shall be tested, positioned in the corner formed by the insulated walls of the test structure, the distance between the test sample outer surface to the walls of the test structure shall be as declared by the manufacturer. Where no declaration is made, it shall be installed touching the walls. Unless otherwise specified the space where the chimney passes through the floor shall be closed according to the manufacturer's instructions, (see Figure 13). The space between the test chimney and the test structure shall be closed in Zone B with a 12 mm thick sealed panel of non combustible material and of a thermal conductivity class of 0,035 W/mK ± 0,002 W/mK at 20 °C unless otherwise specified by the manufacturer.

When an enclosure is necessary to achieve outer surface temperature and to give safety distances to combustibles, the chimney and the enclosure shall be considered as the test sample.

5.7.3.1.4 Test chimney, corner installation, enclosed (see Figures 9, 12 and 14)

When the test chimney shall be tested fully enclosed, the test sample shall be encased by the addition of 2 further walls, defined in the relevant product standards. The distance between the test sample outer surfaces shall be as declared by the manufacturer. Where no declaration is made, the test sample shall be installed touching the walls. Unless otherwise specified, the space in the floor shall be closed according to the manufacturer’s instructions, or completely closed with an insulation material of a thermal conductivity class of 0,035 W/mK ± 0,002 W/mK at 20 °C.

5.7.3.1.5 Thermal conditioning of the test sample

Incorporate a drying conditioning phase into the thermal test if required by the manufacturers instructions.

NOTE Information on conditioning may be contained in relevant product standards.

5.7.3.2 Hot gas adapter for thermal shock test

Where the chimney manufacturer requires it, an adapter may be used to guide the flue gas into the vertical part of the chimney. This adapter shall not reduce the flow area by more than 5 % and shall not protrude into the vertical chimney by more than 25 mm.

5.7.4 Measuring parameters

5.7.4.1 Test environment - Test room

The test room shall consist of a ventilated space not subject to air movement greater than 0,5 m/s measured at the ambient thermocouple positions (see 4.2 and 4.3).

Ambient air shall be able to circulate freely between all parts of the test room.

5.7.4.2 Hot gas temperature

For measuring the hot gas temperature use a device with an accuracy of ± 2 °C for hot gas temperatures less than or equal to 250 °C, of ± 5 °C for hot gas temperatures less than or equal to 600 °C and ± 0,75 % for hot gas temperatures greater than 600 °C at a position (50 ± 2) mm before the inlet to the test chimney and at a point in the cross section coincident with the highest temperature position.

The method is described in Annex D.

NOTE In order to prove the integrity of measurements the hot gas temperature may be measured by one thermocouple located in the centre of the flue, at each level. The temperature of flue gases within the sample may be measured at each level by means of a thermocouple rake inserted vertically into the centre of the flue.

5.7.4.3 Hot gas velocity

Determine the hot gas velocity to an accuracy of - 5 % to + 10 %.

Determine the hot gas velocity by the use of a Pitot tube in accordance with BS 1042-2.1 or by calculation from measured values for fuel flow and CO_2 level.

5.7.4.4 Test structure, surface temperatures

For measuring the surface temperature at the test structure use a device with an accuracy of ± 1 °C.

The thermocouples shall be located on the test structure as follows, see Figure 11:

a) Wood joists on surfaces adjacent to the chimney:

   First floor and second floor: one row of five thermocouples at least sufficient to go beyond the centre line located on both walls spaced at a regular distance of 50 mm ± 2,0 mm beginning 100 mm ± 2,0 mm from the corner.

b) Wall panels between floors:

   300 mm below the ceiling of the second floor located on both walls one row of five thermocouples spaced at a regular distance of 50 mm ± 2,0 mm beginning 100 mm ± 2,0 mm from the corner.

5.7.4.5 Test chimneys, surface temperatures

5.7.4.5.1 General

For measuring the surface temperature at the test chimney where appropriate use a device with an accuracy of ± 1 °C.

The measuring point for accidental human contact is the outer surface temperature in Zone A, see Figures 9 and 13, in a height of 0,5 m ± 0,1 m.

5.7.4.5.2 Test chimney, freestanding

The thermocouples on external surfaces shall be located at levels of 0,5 m ± 10 mm, 1,5 m ± 10 mm and 2,5 m ± 10 mm above the gas inlet, see Figure 9.

The temperature of flue gases within the sample may be measured at each level by means of a rake inserted vertically into the centre of the flue.

5.7.4.5.3 Test chimney, corner installation

The thermocouples on external surfaces shall be located as follows:
500 mm above the flue gas inlet of the test sample opposite to the walls of the test rig.

The temperature of flue gases within the sample may be measured at each level by means of a rake inserted vertically into the centre of the flue.

5.7.4.5.4 Test chimney, corner installation, enclosed

The thermocouples on external surfaces shall be located as follows:
300 mm below the ceiling of the second floor on the additional walls of the enclosure.

The temperature of flue gases within the sample may be measured at each level by means of a rake inserted vertically into the centre of the flue.

NOTE The measuring points of the thermal resistance test fulfil this requirement.

Measure the ambient air temperature with an accuracy of ± 0,5 K, additionally in Zone B (see Figure 1) at a position (300 ± 5) mm below the ceiling of the second floor with a distance to the test structure according 4.3, using the following method:

Shield a calibrated thermocouple by placing it centrally within a length of aluminium painted metal tube, (150 ± 2) mm long and 50 mm nominal diameter, open at each end. Two tubes shall be located (600 ± 5) mm away from the test chimney surface on diametrically opposite sides of the test assembly. The shielded thermocouple shall be placed vertically to avoid direct radiation to the thermocouple.

5.7.5 Test procedure

5.7.5.1 General

Erect the test sample according to the manufacturer's instructions.
Condition the test sample according to the manufacturer's (commissioning) instructions. In the absence of manufacturer's instructions, the test shall be carried out without conditioning.

NOTE Information on conditioning may be in the relevant product standards.

5.7.5.2 Test procedure for thermal test

Generate hot gas with a velocity in a test chimney and a test temperature specified in Table 1 appropriate to the hot gas velocity for negative and positive pressure chimneys, product designation and diameter.

Regulate the rate of rise of the hot gas temperature to achieve the test temperature defined in EN 1443, with an average increase of 50 K per min.

Table 1 — Hot gas velocity as a function of test temperature *T* and diameter of the test chimney

		Hot gas velocity in m/s at a test temperature *T* of											
	D mm	100 °C	120 °C	150 °C	170 °C	190 °C	250 °C	300 °C	350 °C	500 °C	550 °C	700 °C	1 000 °C
Negative pressure chimney	100	1,5	1,7	1,9	2,1	2,3	2,6	2,9	3,2	4,0	4,2	4,8	5,9
	120	1,6	1,8	2,1	2,3	2,5	2,9	3,2	3,5	4,3	4,5	5,1	6,3
	160	1,8	2,0	2,3	2,5	2,7	3,1	3,4	3,8	4,6	4,8	5,5	6,6
	200	1,9	2,1	2,4	2,6	2,8	3,3	3,6	3,9	4,8	5,0	5,7	6,9
Positive pressure chimney	100	2,2	2,4	2,6	2,8	3,0	3,3	3,6	3,9	4,7	5,0	5,6	6,7
	120	2,4	2,6	2,8	3,0	3,2	3,6	3,9	4,2	5,0	5,3	59	7,1
	160	2,6	2,8	3,1	3,3	3,5	3,9	4,2	4,5	5,4	5,6	6,3	7,6
	200	2,8	3,0	3,2	3,4	3,6	4,1	4,4	4,7	5,6	5,9	6,6	7,9
High positive pressure chimney	100	5,4	5,6	5,9	6,1	6,4	6,8	7,2	7,6	8,7	9,1	9,9	11,6
	120	5,8	6,0	6,3	6,5	6,8	7,3	7,7	8,1	9,2	9,6	10,6	12,3
	160	6,2	6,5	6,8	7,0	7,3	7,8	8,3	8,7	9,9	10,3	11,3	13,1
	200	6,6	6,8	7,1	7,3	7,7	8,2	8,6	9,1	10,3	10,7	11,8	13,6

NOTE Normal production sizes are limited to a diameter of 200 mm. Hot gas velocities for other sizes are possible by calculating according to EN 13384-1 (see Annex E).

Maintain the hot gas temperature at ${}^{+5}_{0}$ % of the test temperature, and the flow rate at ${}^{+10}_{0}$ % of the value but not less than 0,2 m/s given in Table 1, until equilibrium or 6 h. Equilibrium is deemed to exist when the rate of rise of the temperature at the hottest point on the test assembly or structure does not exceed 1 K per 30 min up to hot gas temperatures of 250 °C and 2 K per 30 min for higher hot gas temperatures. During the test phase, the ambient temperature shall not vary by more than 5 K.

Record the temperatures after firing the test assembly until the temperatures have reached their maximum.

5.7.5.3 Test procedure for thermal shock test

With the test assembly temperatures within 10 °C of the test room ambient conditions, generate hot gas with the volume flow and test temperature specified in Table 1 appropriate to the diameter. Regulate the rate of rise of the hot gas temperature to achieve 1 000 °C in (10 ± 1) min. The ambient air temperature may vary during test more than 5 °C.

Maintain the hot gas temperature at 1 000 °C ${}^{+50,0}_{-2\,0,0}$ °C for a period of 30 min, then turn off the hot gas generator.

Continue to record the temperatures on the test assembly until the temperatures have reached their maximum.

Measure and record flue regularity and measure gas tightness according to 4.4.

NOTE The relevant product standard may require to run the test with positive pressure chimney and high positive pressure chimney for soot fire condition.

5.7.6 Test results

Record all temperature values as specified in 5.7.4. Record any instance where the maximum temperature exceeds the allowed values.

For the purpose of determining temperature rises on chimney accessory parts and on enclosures and structures, such temperatures shall be related to the ambient air temperature as follows:

— temperatures of joists shall be related to the ambient temperatures of the average of the ambient temperature above and below the joist area;

— temperatures of floor and roof material shall be related to the ambient temperature in the highest position;

— temperatures of ceiling material shall be related to the ambient temperature in the highest position;

— temperatures of chimney surfaces or accessories shall be related to the nearest ambient temperature.

Continue to record the temperatures on the test assembly until the temperatures have reached their maximum.

Record the hottest touchable external surface temperature in Zone A of Figure 1 of the test chimney.

5.8 Thermal resistance test

5.8.1 Test apparatus (see Figures 15 and 16)

Use a test assembly consisting of two fans, two electric heaters, and interconnecting tubes so that heated air can pass around the test assembly. Install in each arm of the test assembly approximately 2 m of the already thermally tested chimney sections including at least two joints (see Figure 15).

Alternatively, connect the chimney sections of 5.7 in zone B to a re-circulating hot gas test assembly (see Figure 16).

5.8.2 Test sample

The test sample is a chimney straight section without enclosure installed according to the manufacturers instructions. When the manufacturer additionally wants to know the thermal resistance in enclosed conditions, this resistance is determined with its specified enclosure, with or without free ventilation. The test samples shall be thermally conditioned according to the system designation for temperature.

Install in each arm of the test assembly approximately 2 m of chimney sections including at least two joints. The size of the test chimney shall be the largest size produced up to 200 mm flue diameter. If the system chimney shall be tested with an enclosure, the enclosure has to be specified by the manufacturer.

Alternatively, the test sample may be the test chimney used for the thermal performance tests. The test sample shall be assembled as specified in product standards. When an opening is installed in the test sample, it has to be removed.

5.8.3 Measuring parameters

For measuring use devices (see Figures 15 and 16):

- for the hot gas temperature at the entry of the test sample with an accuracy of ± 2 °C for temperatures less than or equal 250 °C, with ± 5 °C for temperatures less than or equal 600 °C and ± 0,75 % for temperatures greater than 600 °C,
- for the inner surface temperature with an accuracy of ± 1 °C,
- for the outer surface temperature with an accuracy of ± 1 °C,
- for the ambient temperature with an accuracy of ± 1 °C,
- for the pressure of the hot gas at the entry of the test sample with an accuracy of ± 1 Pa,
- for the velocity of the hot air in the joint pipe with an accuracy of - 5 % to + 10 %
- for the total heat input with an accuracy of ± 2 %, and
- for the inner dimensions with an accuracy of ± 1 mm for length and ± 0,5 mm for the diameter of the test sample.

5.8.4 Test procedure

5.8.4.1 Heat input with the test sample

Circulate hot air around the test assembly. The velocity of the hot air shall be of 4 m/s ± 0,2 m/s at the specified flue gas temperature at the inlet of the test sample. Measure the internal and external surface temperature of the test samples.

The flue gas temperature shall be that specified in the product standards for the thermal resistance.

Adjust the temperature and heat content of the hot air until equilibrium conditions exist. Equilibrium is deemed to be reached when the difference between the outer surface temperature of the chimney sections and the ambient temperature does not change by more than 1 % in 60 min.

Perform the test twice with one temperature rise from a lower temperature level and one temperature drop from a higher level (see Figure 17).

Check that the equilibrium conditions have again been achieved with the following tolerances on the individually determined thermal resistance values.

A difference of less than 4 % of both values is required. If the tolerances are of a greater value, repeat the tests until a difference of less than 4% is achieved between the two values.

Record all the measuring parameters (see 5.8.3).

5.8.4.2 Heat input without the test sample

Reassemble the test assembly without the test sample or replace them by a calibrated section. Repeat the test as described before until the flue gas temperature is the same as during the tests with the chimney sections in place, and until equilibrium. Equilibrium is reached when the difference in the hot air temperature and ambient temperature does not change by more than 1 % in 3 h (see Figure 17).

Maintain the test environment as specified in 4.2.

Circulate hot gas around the test assembly. The velocity of the hot air shall be not less than 4 m/s and the hot gas temperature at the ends of the test sections shall not differ by more than 10 K. For negative pressure chimneys maintain the pressure in the test chimney between 0 Pa and + 5 Pa.

Perform the test twice with one temperature rise from a lower temperature level and one temperature drop from a higher level (see Figure 17).

Check that the equilibrium conditions have again been achieved with the following tolerances on the individually determined thermal resistance values.

A difference of less than 4 % of both values is required. If the tolerances are of a greater value, repeat the tests until a difference of less than 4 % is achieved between the two values.

Record the hot gas temperature, the ambient temperature, the pressure of the hot gas at the entry of the test sample and the velocity of the hot air in the joint pipe as specified in 5.8.4.1.

5.8.5 Test results

Calculate the thermal resistance ($1/\Lambda$) from:

$$1/\Lambda = A_j \, x \, (t_j - t_0) / (Q_1 - Q_2) \qquad (1)$$

where

Q_1 is the total heat input with the chimney section, in Watts;

Q_2 is the total heat input without the chimney sections, in Watts;

t_j is the inner surface temperature, in degree Celsius;

t_0 is the outer surface temperature, in degree Celsius;

A_j is the total inner surface area of the test chimney, in square metres.

5.9 Terminal flow resistance

5.9.1 Test apparatus

The test apparatus shall comprise a fan capable of delivering enough flue flow and an appropriate measurement device.

5.9.2 Test sample

The test sample is the terminal representing the manufacturer's product range. The size shall be the largest size produced up to 200 mm flue diameter. The size shall be the nearest to 200 mm flue diameter for a production range starting with diameters more than 200 mm. The test sample shall be thermally conditioned in a test chimney (see 5.7), or in an oven for 4,0 h ± 10 min, according to the designation for temperature given in the relevant product standard.

5.9.3 Measuring parameters

For measuring parameters use a device with an accuracy of:

— for the pressure difference, ± 0,5 Pa;

— for the air velocity, ± 5 %;

— for the ambient air, ± 1,0 °C; and

— for the static ambient pressure, ± 5 %.

5.9.4 Test procedure

Connect the flue terminal to a flue duct with the same nominal diameter. The flue duct shall have a straight length of at least six times the nominal diameter. Place pressure measurement points in the flue duct at a distance of approximately three times the nominal diameter from the terminal. For this purpose, at least three openings, with a 1 mm diameter, shall be distributed evenly around the circumference of the duct, in a plane perpendicular to the duct axis. The openings shall be free of burrs on the inside of the duct. These openings shall be used to determine the average static pressure within the duct.

Deliver air by means of a fan at three velocities in the flue of 2 m/s ± 10 %, 4 m/s ± 10 % and 6 m/s ± 10 %, and take the average ζ- value. Measure the pressure difference between static pressure in the flue duct and the pressure in the test room. The pressure difference is measured at equilibrium.

$$\zeta = \frac{2 \bullet \Delta p}{\rho \bullet w^2} \qquad (2)$$

where

Δp pressure difference, in Pascal;

ρ density of air, in kilograms per cubic metre;

w velocity, in metres per record;

ς coefficient of flow resistance.

5.9.5 Test results

Record the pressure difference between static pressure in the flue duct and the pressure in the test room the velocity and the calculated value of the coefficient of flow resistance.

5.10 Aerodynamic behaviour of terminal under wind conditions

5.10.1 Test apparatus

The test apparatus shall comprise:

a) a wind generator capable of delivering a minimum wind front of five times the projected cross section of the terminal to be tested but not less than 1 m^2. The overall wind velocity distribution shall be within 0,25 m/s in the wind front at velocities up to 10 m/s at the terminal test position.

b) a fan capable of delivering enough flue flow. A suitable means of measurement is by an appropriate orifice plate arrangement (see EN 483).

The test apparatus shall be capable of rotating the flue terminal in front of the wind system in such a way that wind pressure angles relative to the flue terminal range from downward wind (to a maximum of + 90°) to an upward wind (to a maximum of - 45°) in maximum steps of 7,5°.

5.10.2 Test sample

The test sample is the terminal representing the manufacturer's product range. The size shall be the largest size produced up to 200 mm flue diameter. The size shall be the nearest to 200 mm flue diameter for a production range starting with diameters more than 200 mm. The test sample shall be thermally conditioned in a test chimney, see 5.7, or in an oven for 4,0 h ± 10 min, according to the test temperature appropriate to the designation given in EN 1443.

5.10.3 Measuring parameters

The static pressure within the duct and the static pressure in the test room shall be measured at equilibrium.

5.10.4 Test procedure

Connect the flue terminal to a flue duct with the same nominal diameter. The flue duct shall have a straight length of at least six times the nominal diameter. Place pressure measurement points in the flue duct at a distance of approximately three times the nominal diameter from the terminal. For this purpose, at least three openings, with a 1 mm diameter, shall be distributed evenly around the circumference of the duct, in a plane perpendicular to the duct axis. The openings shall be free of burrs on the inside of the duct. These openings shall be used to determine the average static pressure within the duct.

Deliver air by means of a fan at a nominal velocity in the flue of 2 m/s ± 10 %. Measure the pressure difference between static pressure in the flue duct and the pressure in the test room. The pressure difference is measured at equilibrium.

Determine the pressure characteristics through wind influences of the flue terminal under the following conditions:

— a nominal velocity of 2 m/s in the flue duct;

— wind speeds of 3 m/s ± 0,3 m/s, 6 m/s ± 0,3 m/s, 9 m/s ± 0,3 m/s, 12 m/s ± 0,3 m/s in combination with wind direction angles ranging from - 45° ± 2° either to 45 ° ± 2° or to + 90° ± 2° depending on the type of the terminal.

5.10.5 Test results

Record the pressure characteristics.

5.11 Flow resistance of the test chimney, of fittings or liners

5.11.1 Test apparatus

The test apparatus shall comprise (see Figure 18):

- a fan capable of delivering enough flue flow;
- a measuring duct through which test air is supplied and discharged. These measuring ducts shall have a straight length of at least 2 000 mm ± 10 mm and, except for testing adapters, the same diameter.

Pressure measuring points are placed in the measuring ducts. For this purpose, at least three measurement openings with a 1 mm diameter are distributed evenly around the circumference of each duct, in a plane in line with the central line. These openings shall be free of burrs on the inside of the duct. The average static pressure in the duct is measured via these openings.

For testing adapters, measuring ducts of varying diameter are necessary. These measuring ducts of varying diameter, reducing or enlarging, shall be made of stainless steel with the smoothest possible finish and have a transition angle α = 10° (2 × 5°).

5.11.2 Test sample

For chimney sections the test sample shall be a test chimney which contains only straight elements. For fittings provide a test sample consisting of chimney sections with a length of minimum 7d, followed by the fitting and a further straight chimney section with a length of minimum 3d. The test sample shall be assessed as specified in the product standards. Alternatively, the test sample shall consist of at least a liner, a fitting and another liner. The test chimney for thermal performance test can be used provided it meets the parameters.

5.11.3 Measuring parameter

For measuring parameters use a device with an accuracy for:

- air velocity, of ± 5 %;
- pressure difference in the duct, of ± 0,5 Pa;
- inner dimensions, of ± 1,0 mm for the length and ± 0,5 mm for the diameter;
- ambient air temperature, of ± 1,0 °C;
- static ambient pressure, of ± 5 %.

5.11.4 Test procedure

An intake guide is installed on the top of the test chimney or on the top of the alternative test sample. The measuring duct shall be installed on the bottom of the test chimney at the inlet.

The length of the measuring ducts, the position of the pressure measuring points in the measuring ducts and the position of the pressure measuring points relative to the connected pipe or fitting to be tested and the position of the pressure measuring points relative to the other supply and flue ducts to which the measuring ducts are, in turn, connected shall be such as to permit an undisturbed flow at all times, over a distance of 5 times the length on each side of the pressure measuring points.

The velocity through the ducts is set to an accuracy of ± 2,5 %. The pressure differential between the supply and the flue duct is measured to an accuracy of ± 0,2 Pa.

All tests shall be carried out at ambient air temperature.

The air velocity in the components tested shall be set in such a way that the air flow rate equals the nominal flow rate, with a tolerance of ± 5 % depending on the actual inside diameter of the fittings.

The nominal flow rate is a function of the nominal diameter and the nominal velocity, where:

$$V_{nom} = \frac{\pi}{4} D_{nom}^2 \, w_{nom} \, 3\,600 \qquad (3)$$

where

V_{nom} is the nominal air flow rate in square metres per hour;

D_{nom} is the nominal diameter in metres;

w_{nom} is the nominal velocity in metres per second.

For non-circular cross - sections use the cross – section calculated with the nominal diameter instead of $\pi / 4 \times D_{nom}^2$.

The static pressure loss over a certain length is measured.

The friction of a section or fitting is determined as the difference between the static pressures in the two measuring ducts.

The test shall be carried out at nominal flow rate equivalent to a nominal velocity of 4 m/s ± 0,1 m/s, 6 m/s ± 0,1 m/s and 8 m/s ± 0,1 m/s in the pipe section or fitting to be tested.

First determine the friction of the measuring duct between the pressure measuring points without the pipe section or fitting to be tested. There are two possible situations:

— there are two measuring ducts of the same diameter;

— there are two measuring ducts of different diameter because a reducing or enlarging adapter shall be tested.

In the latter case, a reducing or enlarging measuring duct (see 5.11.3) shall be placed between the two measuring ducts referred to above.

Mount the section or fitting to be tested in the rig (after removing the reducing or enlarging measuring duct if fitted). Determine the friction of the measuring ducts between the pressure measuring points again. The friction of the section or fitting is then given by the difference between the two test results.

NOTE The friction of the reducing or enlarging measuring ducts is thus ignored.

5.11.5 Test results

The friction value is calculated following the equation:

$$\psi = \frac{2 \times D_h \times \Delta\rho}{\rho \times w^2 \times L} \qquad (4)$$

where

ψ is the coefficient of friction;

D_h is the hydraulic diameter, in metres;

Δ_ρ is the pressure loss, in Pascals;

ρ is the density of air, in kilograms per cubic metre;

w is the velocity of air, in metres per second;

L is the length of the test chimney in metres.

The mean roughness of the inner wall r may be obtained by using the following equation:

$$\frac{1}{\sqrt{\psi}} = -2\log\left(\frac{2{,}51}{\mathrm{Re}\sqrt{\psi}} + \frac{r}{3{,}71 D_h}\right) \quad (5)$$

where

D_h is the hydraulic diameter, in metres;

r is the mean value of roughness of the inner wall, in metres;

Re is the Reynolds number;

ψ is the coefficient of friction of the flue.

The ζ - Value may be obtained by the following equation:

$$\zeta = 2\,\Delta p / \rho \text{ x } w^2 \quad (6)$$

where

Δp is the pressure loss, in Pascals;

ρ is the density of air, in kilograms per cubic metre;

w is the velocity of air, in metres per second.

5.12 Rainwater resistance for chimney sections

5.12.1 Test apparatus

The test structure shall consist of a rotating free draining plinth. The spray tube shall be perforated to direct jets of water towards the centre of the circle. Install the sections onto the centre of the plinth of the test structure so that the centre of the spray arc is approximately at the centre of the flue below or level with the joint (see Figure 19). Seal the joint where the sections stand on the plinth to prevent ingress of water into open end of sections.

The spray tube shall be constructed and dimensioned to allow the flow conditions of EN 60529 to be achieved and maintained.

5.12.2 Test sample

The test sample shall be chimney sections with at least one joint and a minimum height of 1,0 m representing the manufacturer's product range. The test sample shall be assembled as specified in product standards. The size shall be the largest size near to 200 mm.

5.12.3 Test procedure

Assemble the sample and than carry out conditioning:
Condition for at least 48 h in the test environment of 4.2 those chimney sections.

Weigh the test section before spraying water.

Spray water for (60 ± 5) min while oscillating spray arc through an angle of 120° ± 5° (60° either side of the vertical) and rotating the plinth. The time for one complete traverse (two traverses of 120°) shall be (6 ± 1) min and the time for one revolution of the plinth shall be (5 + 1) min. Remove any surface moisture from the surface of the chimney sections and condition the section for at least 12 h ± 10 min, and not more than 24 h ± 10 min, in the test environment of 4.2. The sections may be separated to facilitate removal of surface moisture. Reweigh the test section.

5.12.4 Measuring parameters

For measuring parameters use a balance with an accuracy for weight with ± 1,0 g.

5.12.5 Test results

Record the increase in weight of the test section.

5.13 Rainwater resistance for terminals

5.13.1 Test apparatus

See 5.12.1 and Figure 20.

5.13.2 Test sample

The test sample is the terminal representing the manufacturer’s product range. The size shall be the largest size produced up to 200 mm flue diameter.

5.13.3 Test procedure

Thermally condition the rainwater terminal to its test temperature either on the thermal test assembly, or in an oven for minimum 4 h.

Install the rainwater terminal fitted to a chimney section according to the manufacturer’s instructions, onto the centre of the plinth of the test structure of 5.13.1. Adjust the position so that the spray covers the entire rainwater terminal, see Figure 20. Collect and weigh any water entering the flue.

Spray water for (60 ± 1) min while oscillating spray arc through an angle of 120° + 5° (60° either side of the vertical) and rotating the plinth. The time for one complete traverse (two traverses of 120°) shall be (6 ± 1) min and the time for one revolution of the plinth shall be (5 + 1) min.

5.13.4 Measuring parameters

For measuring the weight of water collected use a balance with an accuracy of ± 1,0 g.

5.13.5 Test results

Record the weight of water collected inside the flue.

5.14 Test report

The test report shall include the following:

a) name of the laboratory, the name of the sponsor, the nature and extent of test, the date and the index number;

b) structure of the chimney (description and drawing) with quality or trade-mark of the materials or units used. Data determined or checked by the laboratory shall be given separately from the data obtained from other sources;

c) ability to install the chimney according to the manufacturer's instructions;

d) conditioning procedure;

e) time necessary to achieve steady state in each phase;

f) indication of accuracy of measurement equipment use during the tests;

g) results;

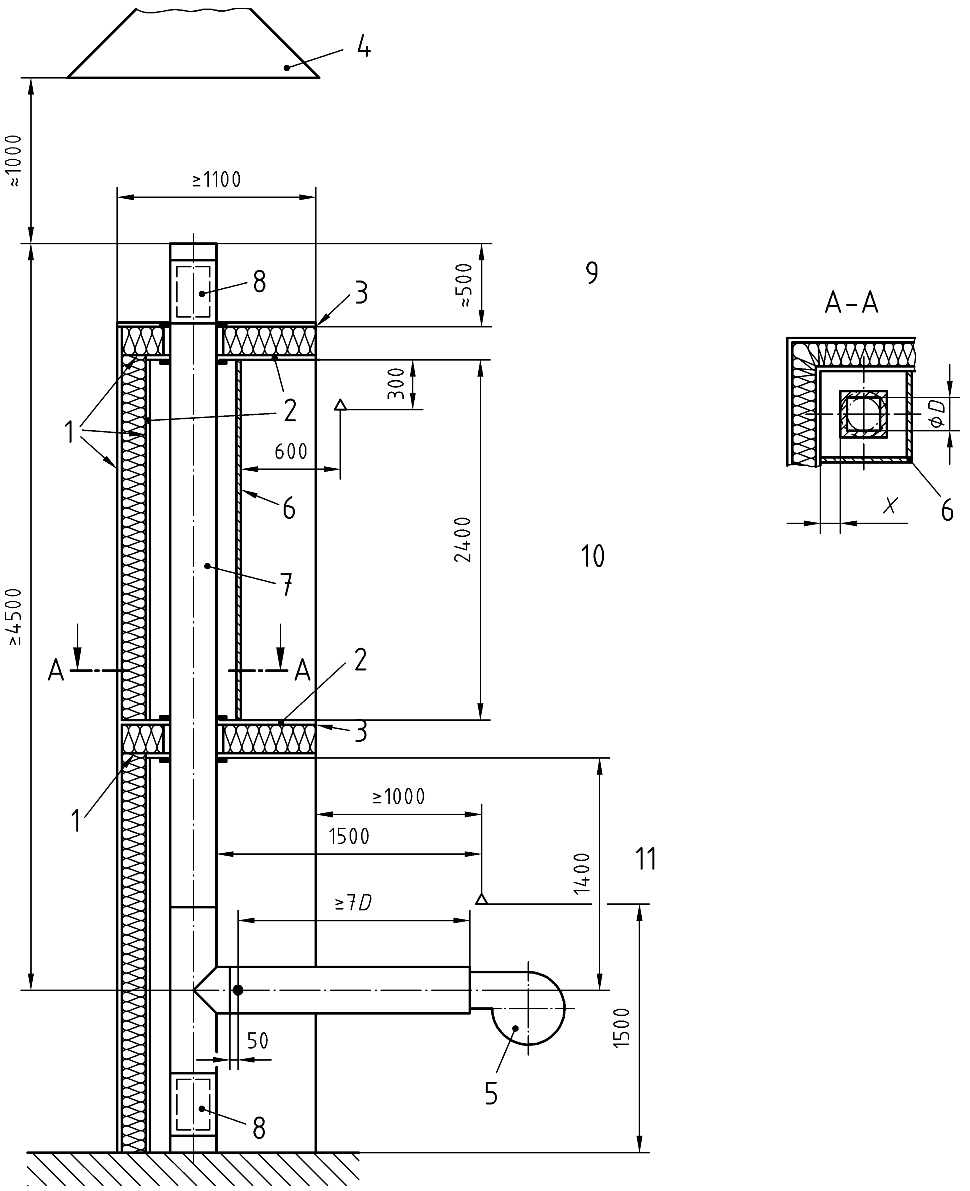
h) for thermal test description of installation, the measurements characterising the combustion and the heat supply to the chimney;

i) other phenomena.

The test results may be given using the form "Test report", see Annex F.

The test results shall be based on the mandated requirements. The mandated requirements are given in Annexes ZA of the system chimney product standards. These Annexes could be referenced. Besides that, all information important for the CE-marking and any voluntary characteristics claimed by the manufacturer should be included in the test report.
Besides that, it shall be stipulated that the test laboratory shall maintain all necessary information associated with accredited status followed by a list giving the former items d, e, f, h and i.

Dimensions in millimetres

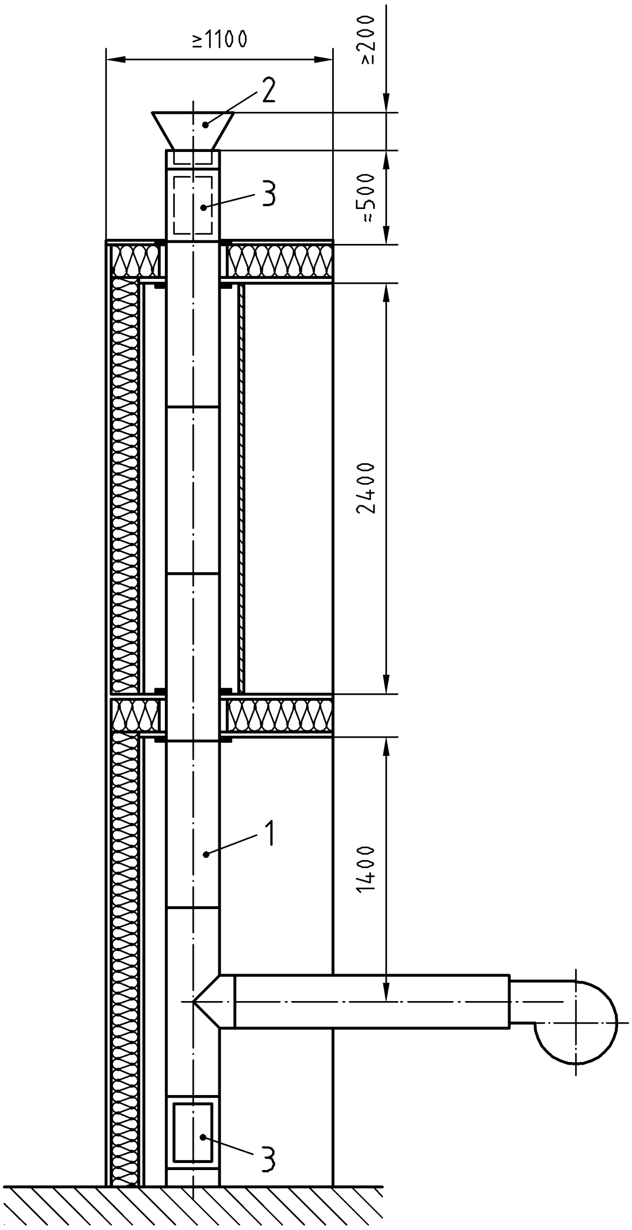


Key

1 Plywood thickness 12 mm	7 Test chimney	*X* manufacturers declared distance to combustibles
2 insulation	8 Opening	
3 Plywood thickness 20 mm	9 Zone C	
4 Roof outlet	10 Zone B	Measuring points
5 Hot gas generator	11 Zone A	• hot gas temperature
6 Enclosure		Δ ambient air temperature

Figure 1 — Example of a test chimney

Dimensions in millimetres

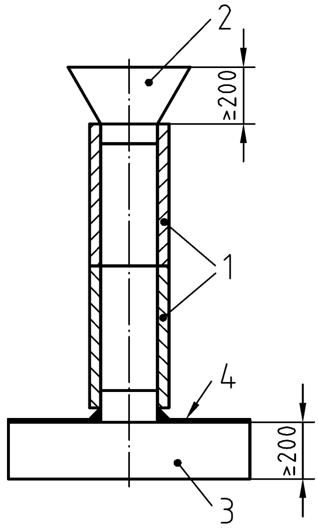


Key

1 Test chimney
2 Catchment funnel
3 Opening

Figure 2 – Abrasion resistance – test chimney

Dimensions in millimetres

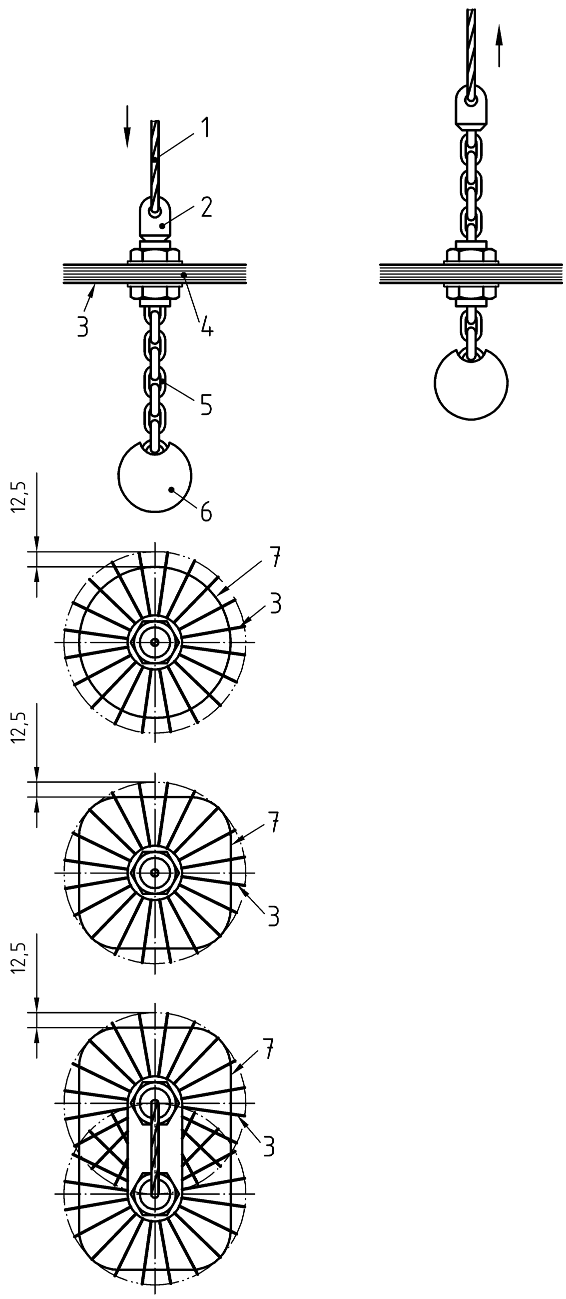


Key

1 Test chimney section
2 Catchment funnel
3 Collection box
4 Bottom plate

Figure 3 – Abrasion resistance – test chimney section

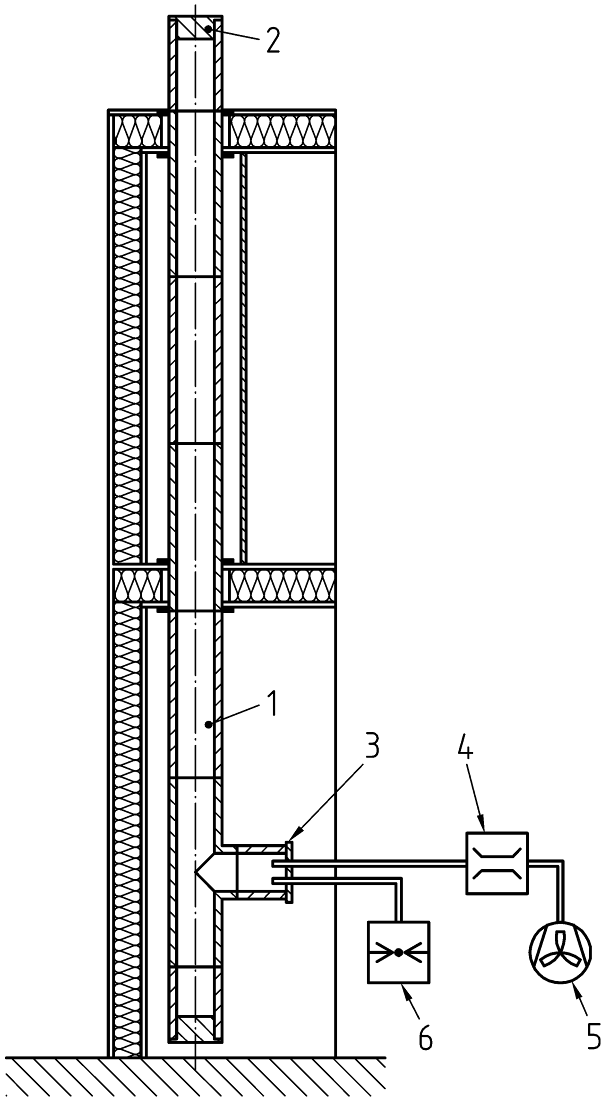
Dimensions in millimetres



Key

1 Rope
2 Striking element
3 Brush
4 Steel spring bristles
5 Chain
6 Weight
7 Flue liner cross section
(round)
(square)
(rectangular)

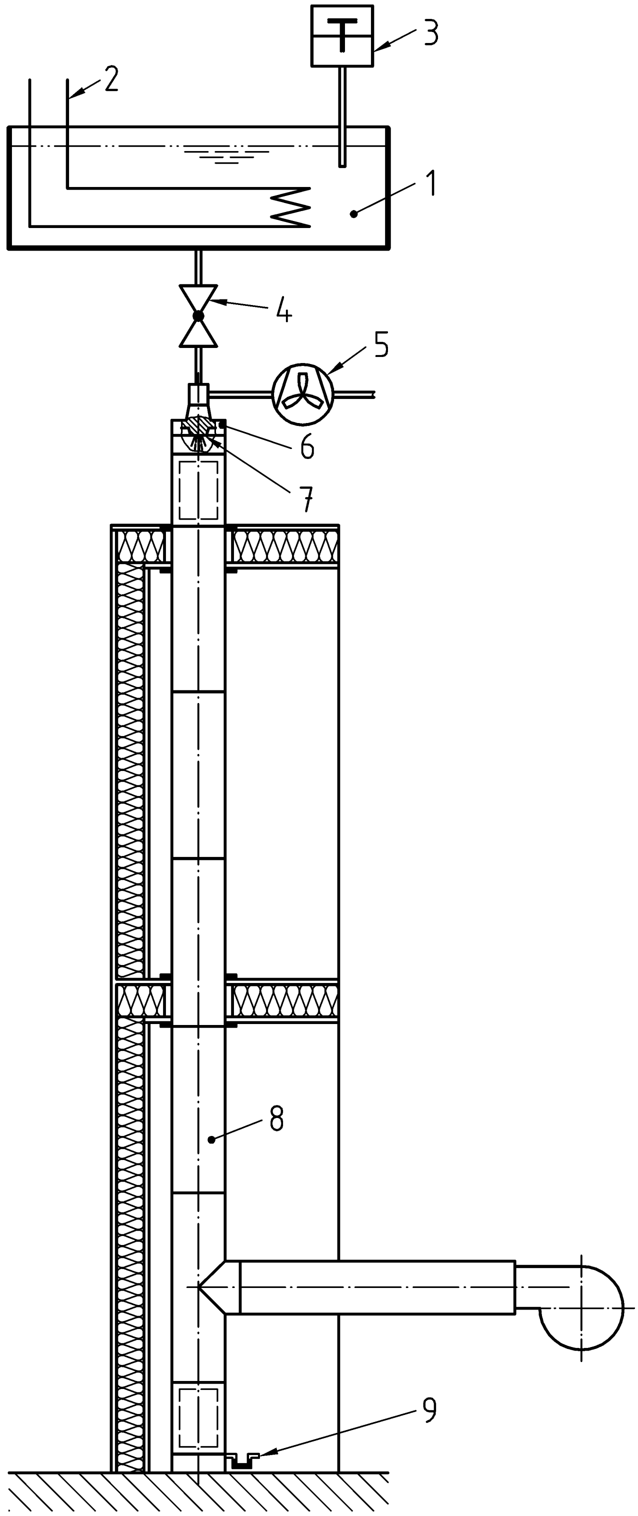
Figure 4 – Abrasion resistance – sweeping test equipment



Key

1 Test chimney
2 Equipment for closing the outlet (plate or bladder)
3 Sealing element
4 Flowmeter
5 Fan (air supply)
6 Manometer

Figure 5 – Gas tightness – test chimney

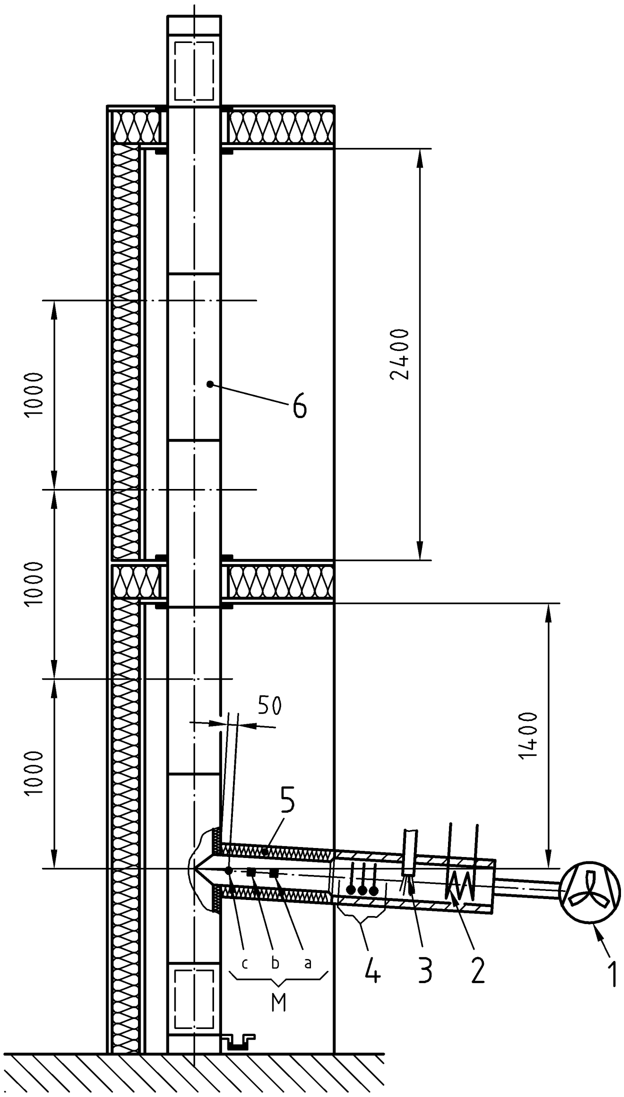


Key

1 Tank containing coloured water
2 Electric heating
3 Thermometer
4 Gate valve
5 Air supply
6 Air tight cap
7 Spray equipment
8 Test chimney
9 Water removal

Figure 6 – Condensate resistance – test chimney

Dimensions in millimetres



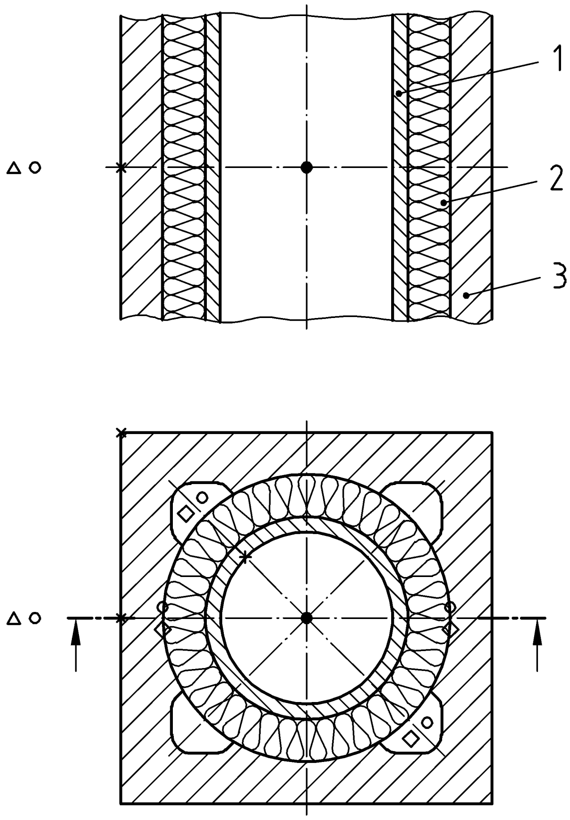
Key

1 Fan
2 Electric heating
3 Steam injection
4 Rectifier
5 Insulation
6 Test chimney

M Measuring points at cross sections

a Velocity
b Pressure
c Temperature

Figure 7 – Vapour and condensate resistance – test chimney



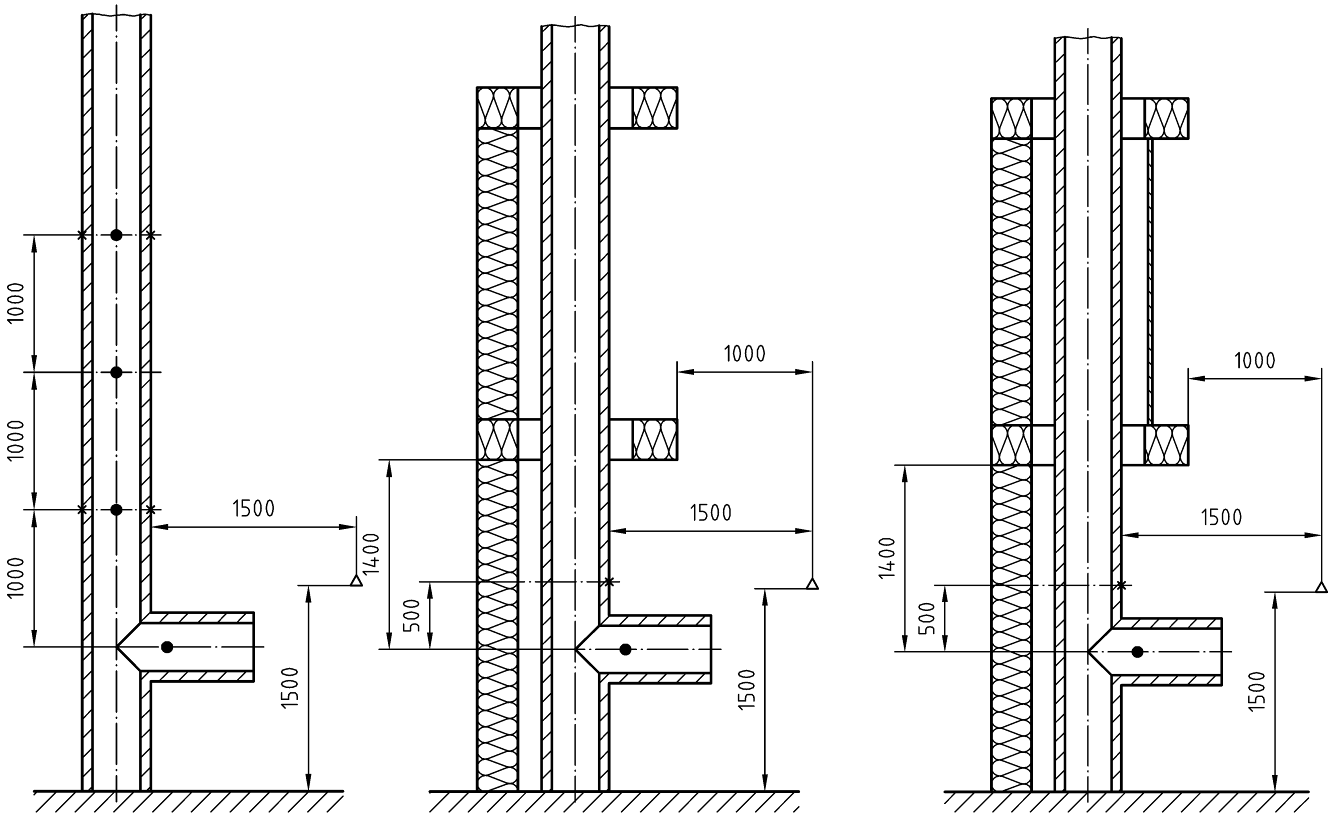
Key

Measuring points

1 Flue liner	•	hot gas temperature
2 Insulation	×	surface temperature
3 Outer wall	Δ	ambient air temperature
	◇	air temperature
	○	humidity

Figure 8 – Vapour and condensate resistance – test chimney, non-enclosed, measuring points in a multi-wall chimney

Dimensions in millimetres

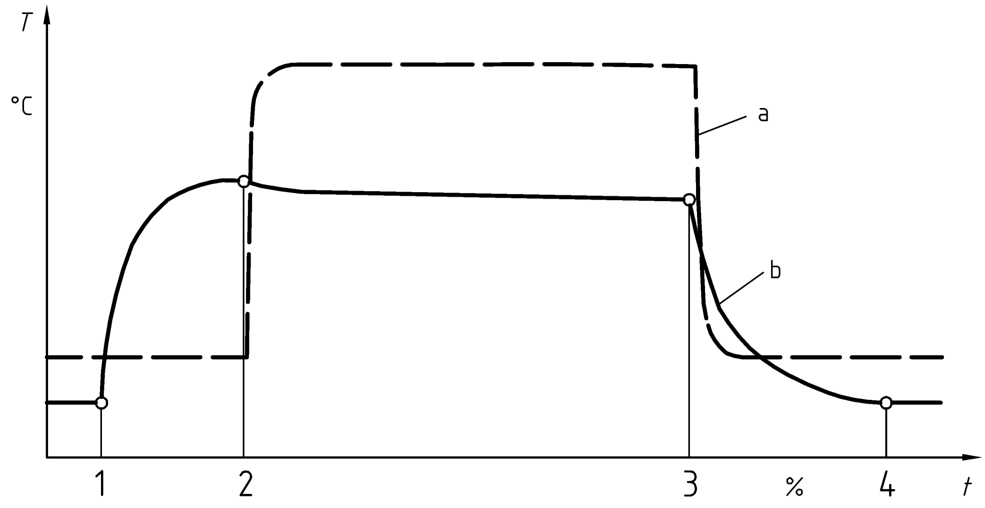


test chimney, free standing, non-enclosed	test chimney, corner installation	test chimney, corner installation, enclosed

KEY

Symbols	temperatures
•	flue gas temperature
×	surface temperature, test chimney
Δ	ambient air temperature

Figure 9 – Test chimneys – Location of measuring points and placement of the test chimneys



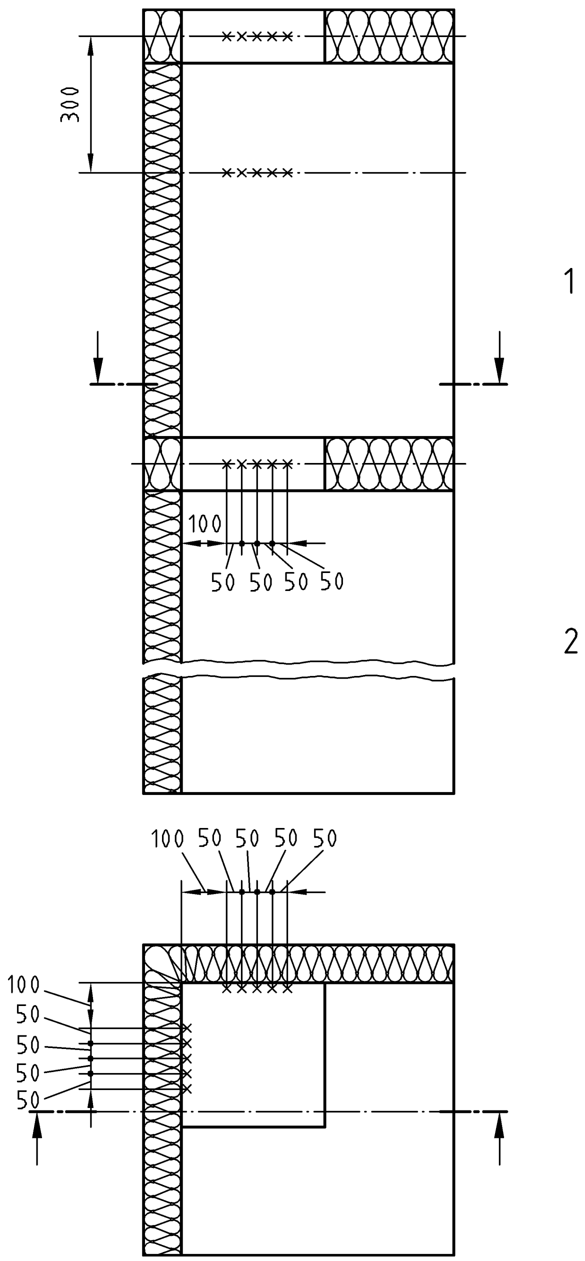
Key

a Relative humidity
b Temperature
T Temperature
t Time
φ Relative humidity

1 Temperature before test
2 Temperature, humidity, gas flow, pressure before heating period steady state condition
3 Temperature, humidity, gas flow, pressure at steady state conditions test period
4 Temperature after test

Figure 10 – Vapour and condensate resistance – Example of temperature/Time (in °C) and time/humidity (in % relative humidity) profiles

Dimensions in millimetres



Key

1 Zone A

2 Zone B

× surface temperature position

Figure 11 – Test structure – Location of surface temperature on the test structure

Dimensions in millimetres

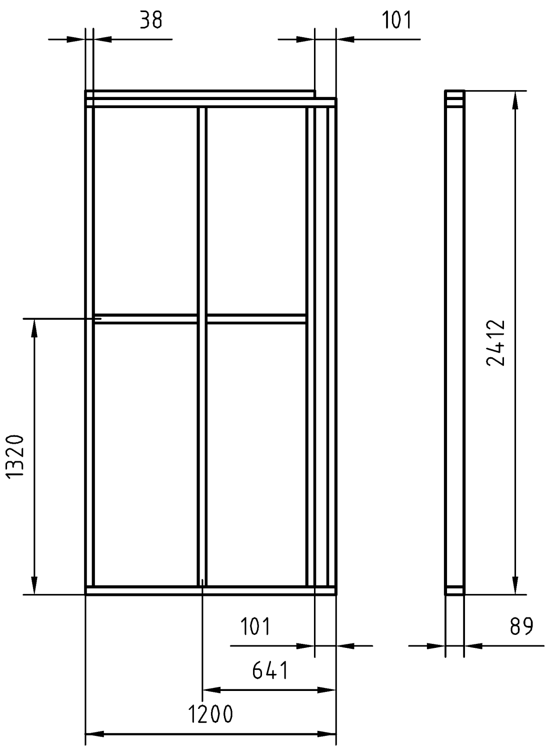


Figure 12a - Wall Frame A Side 1 Zone A

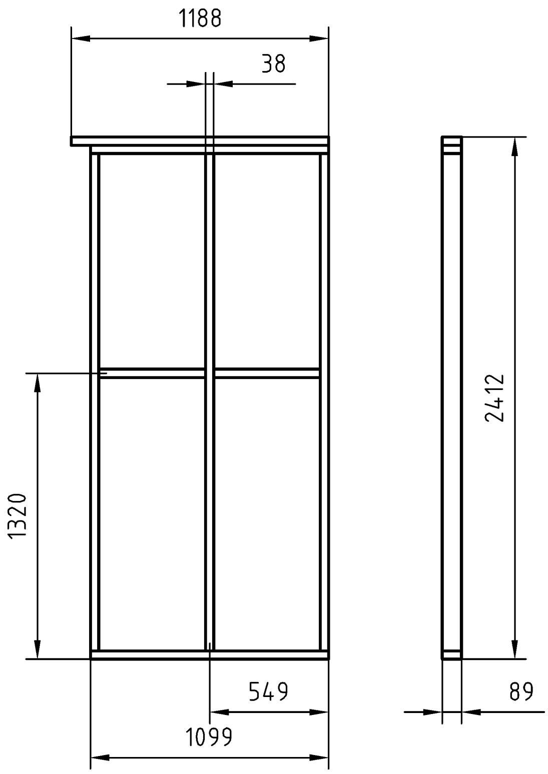


Figure 12b - Wall Frame B Side 2 Zone A

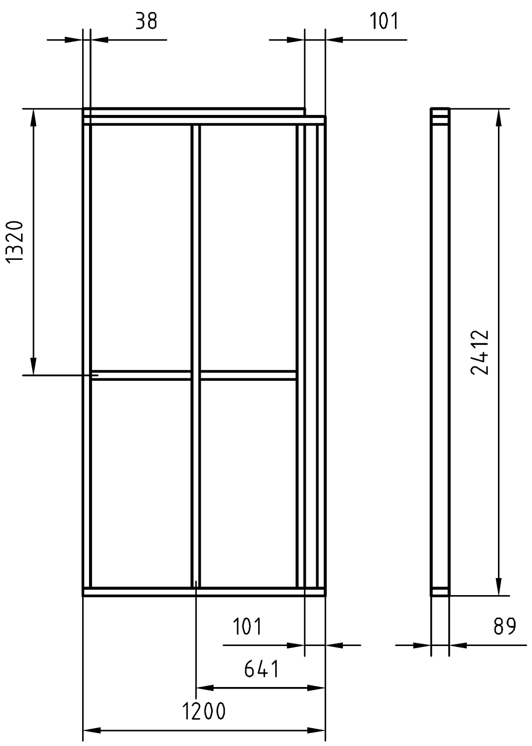


Figure 12c - Wall Frame C Side 1 Zone B

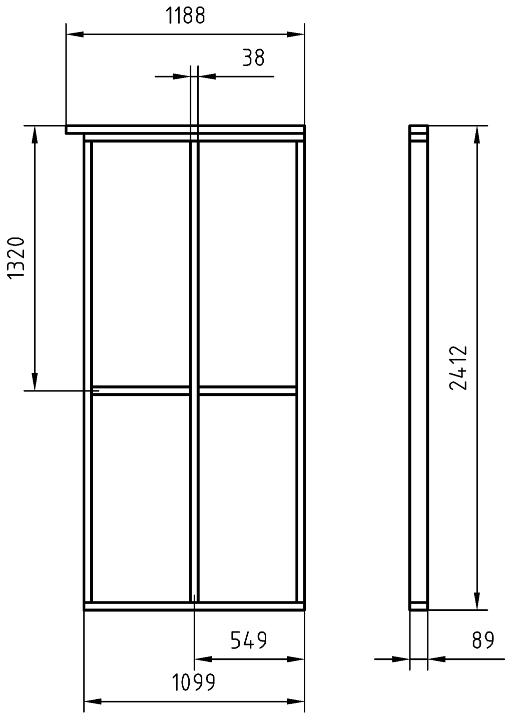
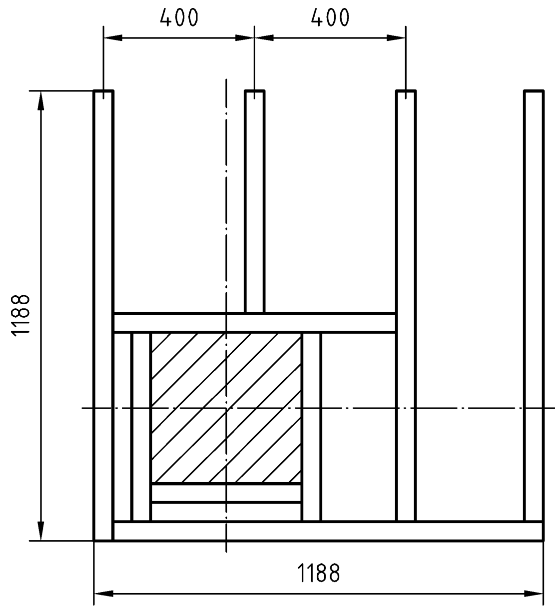


Figure 12d - Wall Frame D Side 2 Zone B

Material: Kiln dried softwood sawn and planed 89X38 (Tolerance ± 1)

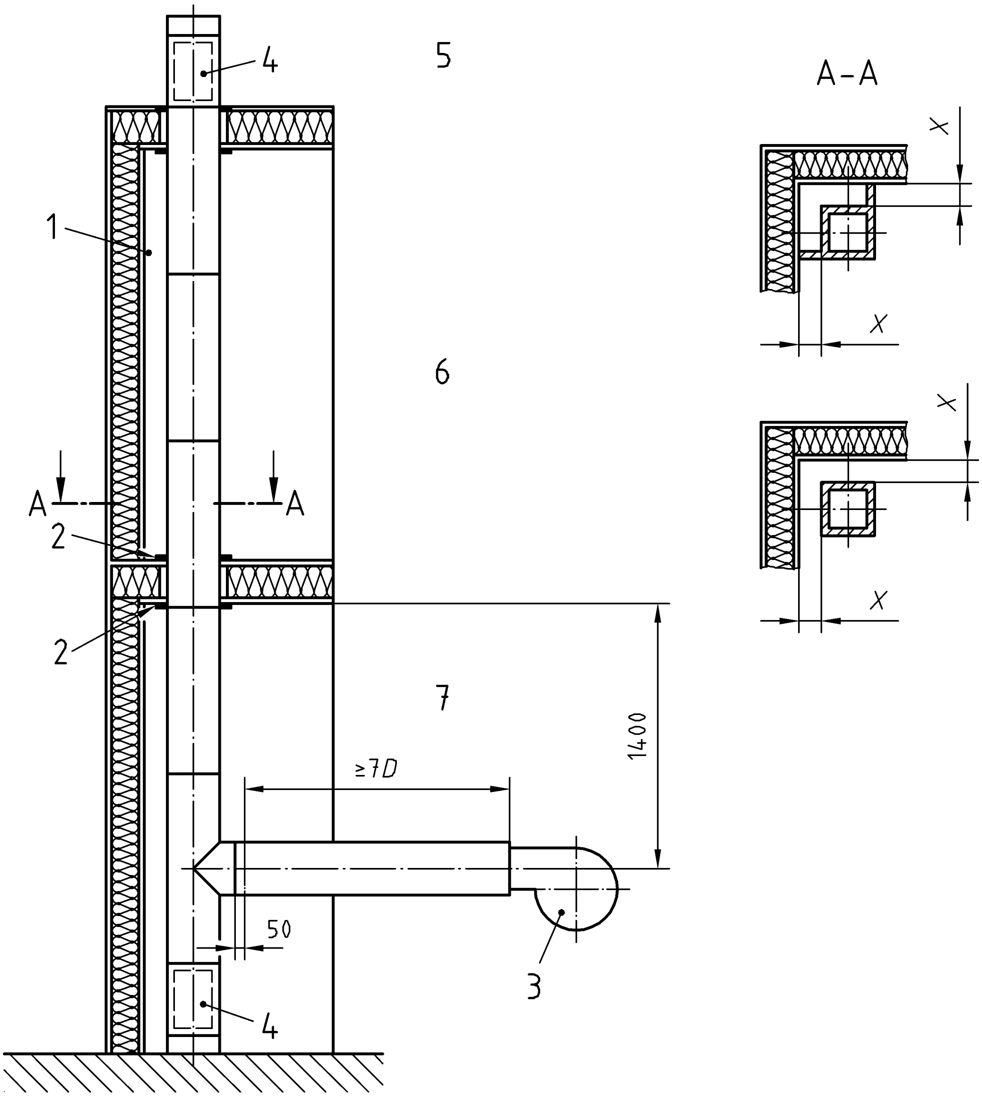
Dimensions in millimetres



First floor joists 200X50, 12 mm plywood floor. Second floor joist 100X50, 12 mm plywood ceiling

Figure 12e – Frame for floors

Dimensions in millimetres

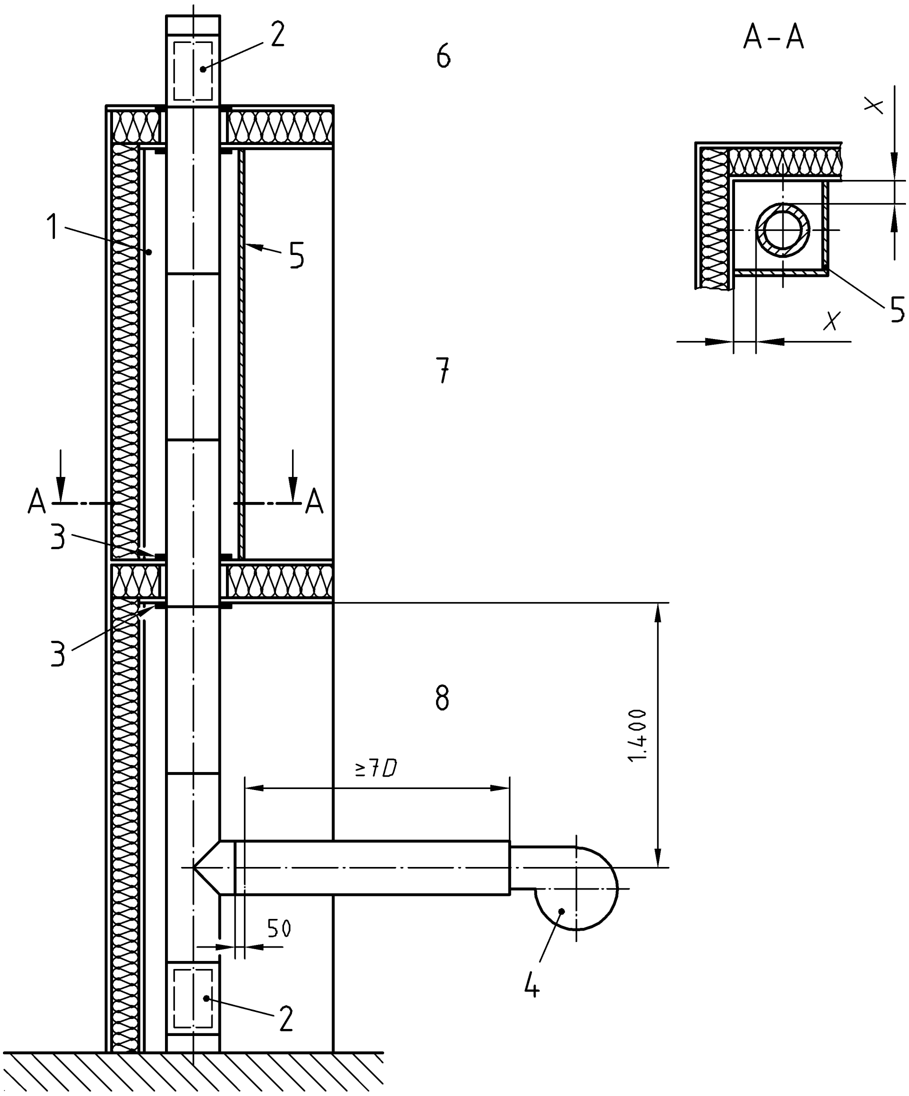


Key

1 Clearance
2 Fire stop
3 Hot gas generator
4 Opening
5 Zone C
6 Zone B
7 Zone A
X manufacturer's declared distance to combustibles

Figure 13 – Thermal performance, test chimney –partial enclosed

Dimensions in millimetres



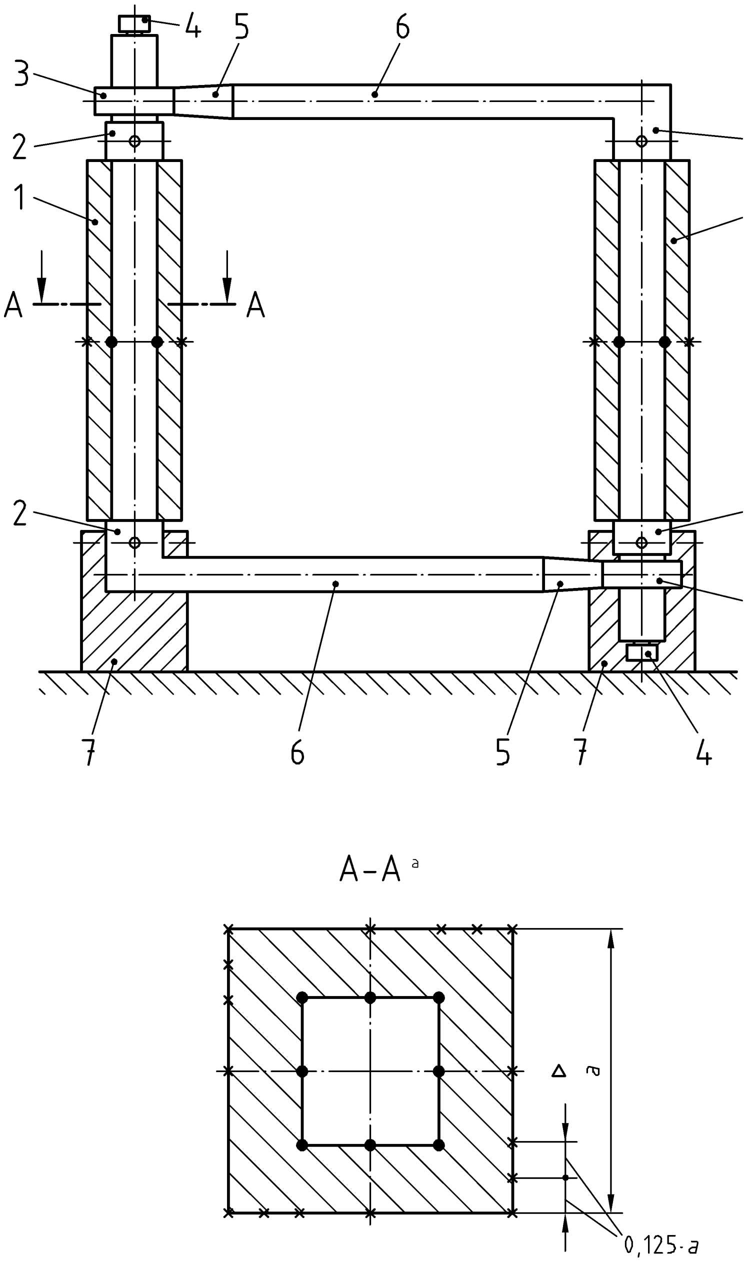
Key

1 Clearance
2 Opening
3 Fire stop
4 Hot gas generator
5 Enclosure

6 Zone C
7 Zone B
8 Zone A
X manufacturer's declared distance to combustibles

Figure 14 – Thermal performance, test chimney –enclosed

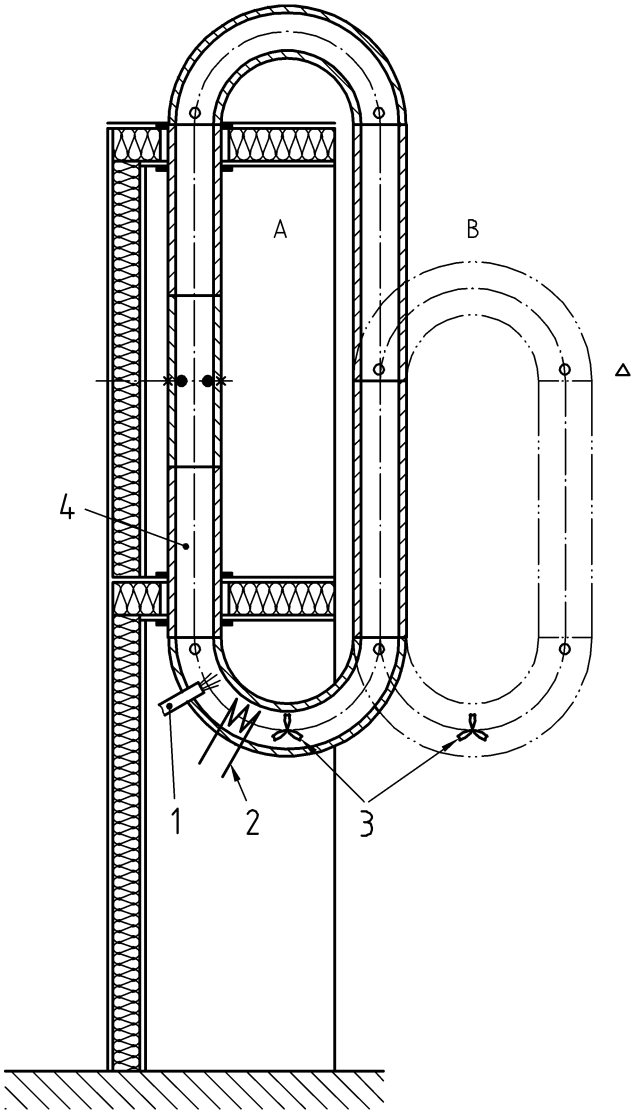
Dimensions in millimetres



Key

1 Test chimney	measuring points for	temperature, pressure and velocity of circulating air
2 Flow rectifier		
3 Radial ventilator		
4 Electric motor	•	internal surface temperatures
5 Electric heating unit	×	external surface temperatures
6 Joint pipe	Δ	ambient air temperature
7 Test stand	■	pressure and velocity

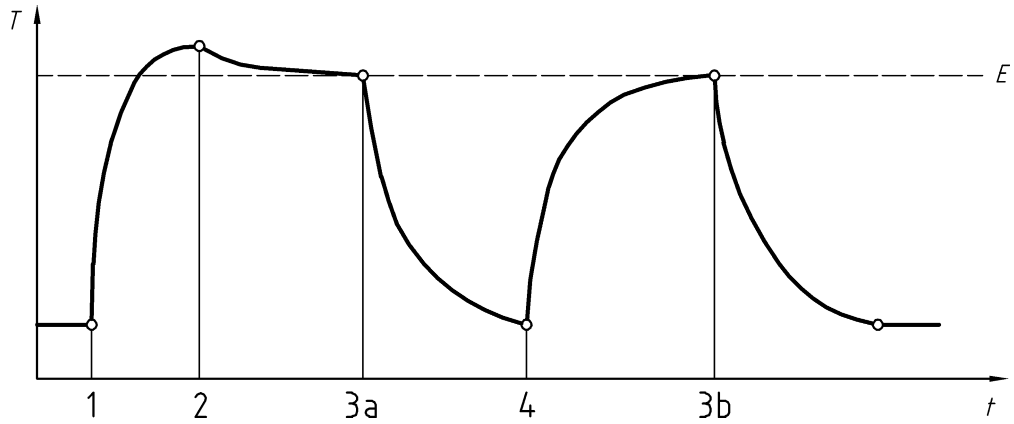
Figure 15 – Thermal resistance – two arm test rig – chimney section



Key

1 Steam injector	measuring points for	temperature, pressure and velocity of circulating air
2 Electric heater		
3 Fan		
4 Test chimney	•	internal surface temperatures
Scheme A: heat loss with test chimney	×	external surface temperatures
Scheme B: heat loss without test chimney	Δ	ambient air temperature
	■	pressure and velocity

Figure 16 – Thermal resistance test – One arm test rig – Chimney section

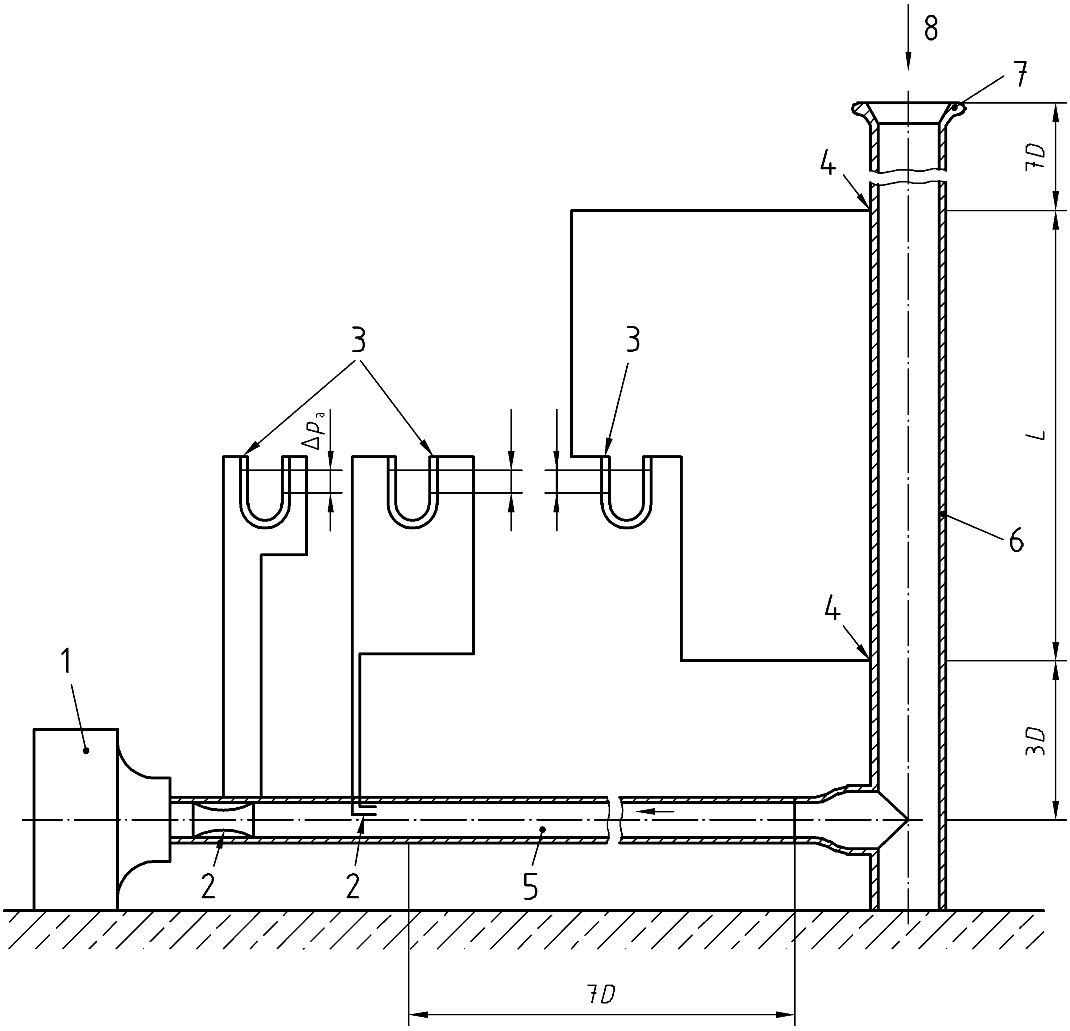


Key

Measuring points:
1 Before the test
2 During the test
3 During the test at steady state conditions
E Example: designated temperature

Record:
1 Ambient temperature during test
2 Maximum temperature during test
3 Relevant temperature at steady state conditions, velocity, pressure
x Time
y Temperature

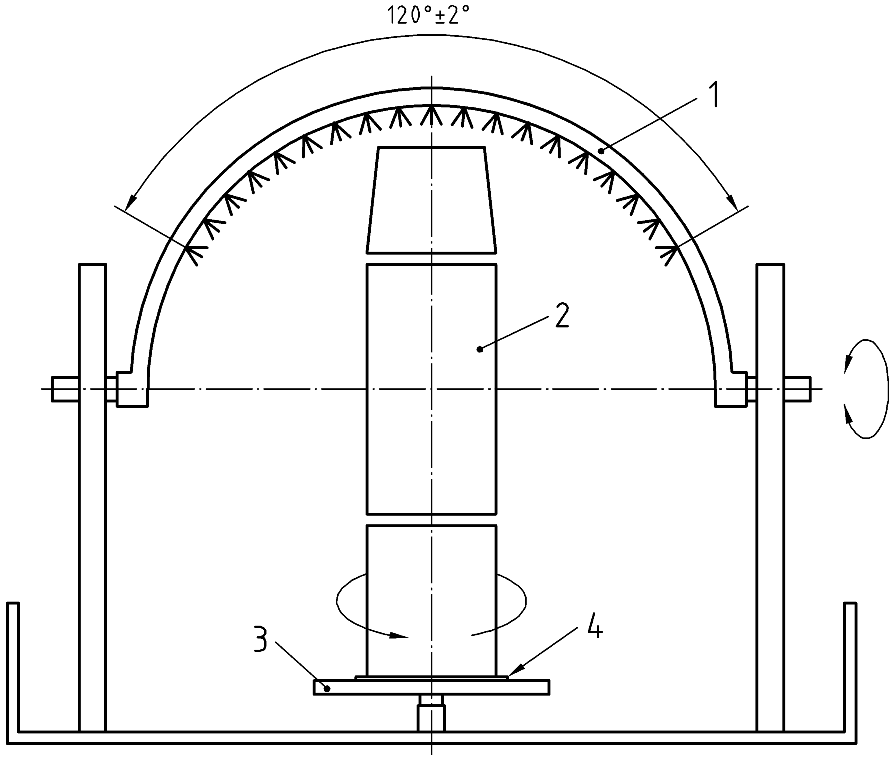
Figure 17 – Thermal resistance – Example for time temperature/ Time (T) profiles



Key

1 Fan
2 Measuring device
3 Pressure manometer
4 Static pressure manometer
5 Test tube
6 Test chimney
7 Intake guide
8 Flow direction
Δpa
L Length of the test chimney

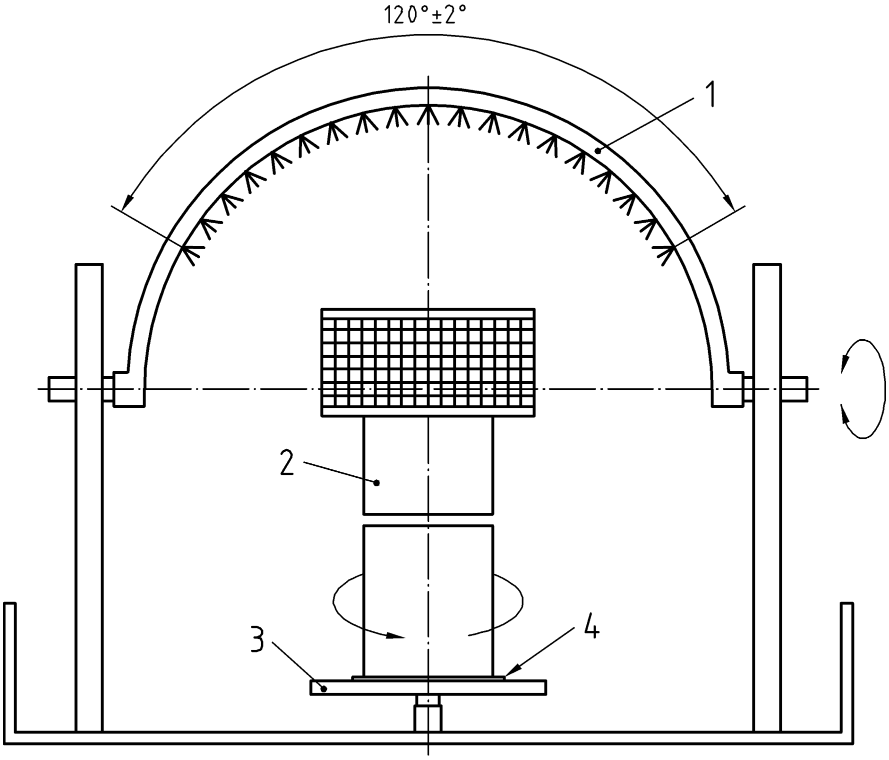
Figure 18 – Flow resistance, test rig – Test chimney



Key

1 Spray tube
2 Sample
3 Free draining plinth
4 Seal to prevent ingress of water into open end of section

Figure 19 – Rainwater resistance, spray apparatus – test chimney section



Key

1 Spray tube
2 Sample
3 Free draining plinth
4 Seal to prevent ingress of water into open end of section

Figure 20 – Rainwater resistance, spray apparatus –terminal

Annex A
(informative)

Recommended test sequence

The following list is a sequence for testing chimneys.

It has been compiled on the basis that failure to meet the specific requirements associated with the test could save further, possibly costly, tests being undertaken.

a) Check of manufacturer's literature

b) Confirmation of manufacturer‘s information and check of marking, labelling and packaging

c) Strength tests (compressive on sections, T-fittings and supports, tensile, where appropriate), lateral (where appropriate), and wind load, on appropriate sections

d) Assembly of the test chimney (see 5.7)

e) Gas tightness test (see 5.4)

f) Thermal test at nominal working temperature (see 5.7)

g) Gas tightness test (see 5.4)

h) Thermal shock test (see 5.7)

i) Relative movement of the flue liner of multi-wall chimneys (see 5.3)

j) Gas tightness (see 5.4)

k) Repetition of thermal test at nominal working temperature (where appropriate)

l) Gas tightness test (see 5.4)

m) Thermal resistance determination (see 5.8)

n) Abrasion resistance (see 5.2)

o) Water vapour diffusion resistance (see 5.6) or condensate resistance test (see 5.5), where appropriate

p) Rainwater resistance (see 5.12), where appropriate on the appropriate sections

q) Flow resistance (see 5.11), where appropriate

r) Terminal flow resistance (see 5.9), where appropriate

s) Aerodynamic behaviour of terminal under wind (see 5.10), where appropriate

t) Rainwater resistance of a chimney section (see 5.12), where appropriate

u) Rainwater resistance of a terminal (see 5.13), where appropriate

v) Freeze-thaw resistance, where appropriate

Annex B
(normative)

Calculation method to predict condensation in multi-wall chimneys for different ambient air temperatures others than the test ambient air temperature

B.1 Dimensions of the chimney structure type

The dimensions of the chimney structure type are given by the manufacturer. It shall be verified that they correspond with the test chimneys.

NOTE The principles of this calculation methods may be adopted also for single wall chimneys.

B.2 Calculation of the flue gas and inner wall temperatures

B.2.1 Calculation without taking account of condensation heat

The calculation of the flue gas and inner wall temperatures shall be carried out in accordance with EN 13384-1, but without taking account of condensation heat.

B.2.2 Calculation with taking account of condensation heat

The calculation of the flue gas and inner wall temperatures of chimneys with taking account of condensation heat can only be carried out iteratively and step-by-step dependent on the height. For the determination of the steps of height, the cooling of the flue gas over the height of the chimney shall be calculated first without taking account of condensation heat according to EN 13384-1.

On the basis of the calculated temperature decrease of the flue gas between the entry and the outlet, the chimney is divided into height elements within which the temperature decrease is no more than 1 K.

The thermal balance shall be satisfied at each of these defined height elements.

In addition, a linear relationship of the height elements is assumed in order to combine the equations. The heat transmission coefficient from the flue gas to the inner wall is assumed to be a hypothetical value which results from the value calculated according to EN 13384-1 without taking account of condensation heat and an additional value that takes account of condensation heat. The hypothetical value results from the heat flow and the temperature difference between the flue gas and the inner wall.

The mean temperatures of the flue gas and the inner wall of the chimney are determined by adding together the values of the particular height elements. The quantity of condensate is also determined by adding together the quantity of precipitated condensate in the different height elements.

B.3 Calculation of layer temperatures

The calculation of the layer temperatures is carried out two-dimensionally following the finite element method. To do so, the chimney is represented in a plane by elements according to the requirements of the calculation method. The temperature difference between two elements shall be not more than 10 % of the inner wall temperature.

The temperature field shall be determined as a function of the height by calculating the two-dimensional temperature field in one plane for several sections into which the chimney is divided over its whole height. The height of the individual sections for which a two-dimensional temperature field is calculated in one plane shall be not more than 0,5 m.

The heat transport by thermal conduction in the building heights within the chimney axis may be neglected.

The heat content of the flue gas within the chimney and thus the temperatures of flue gas and inner wall shall be calculated as a function of the height by using the equations given in Clause 1 or Clause 2.

B.4 Thermal resistance, test chimney

The values of thermal resistance, circulation air, inner and outer wall temperatures as well as the heat transmission coefficients α_i and α_a shall be determined according to 5.8 and recorded.

The value of thermal resistance determined under the action of moisture shall also be established and recorded. The calculation method shall be validated on the basis of these results. If the thermal transmittance coefficient of the inner and outer wall is known the thermal transmittance coefficient of the insulating wall shall be adjusted accordingly.

The thermal resistance of the weathering protection or an additional outer wall of the chimney in non-heated rooms and for outdoor sites shall not be taken into account.

B.5 Multi-wall chimney, back ventilated

B.5.1 General requirement

It is necessary to limit the height of chimneys with circulated thermal insulation layers in accordance with the performance of the ventilation air. The appropriate height is reached when the ventilation air can remove just enough moisture penetrating into the chimney structure without moisture damage occurring.

The heat content of the ventilation air and the resulting ventilation and inner wall temperatures of the ventilation ducts shall also be calculated as a function of the height. Irrespective of the flow rate, the heat transmission coefficient in the ventilation ducts shall be taken to be 8 W/m²K.

The flow rate of the ventilation air shall be calculated according to EN 13384-1 on the basis of the values determined at the test chimney in accordance with the given dimensions and densities of the ventilation air.

B.5.2 Removed moisture flow

The moisture is removed by additional loading of the ventilation. The moisture flow removed by increasing the dew point of the water vapour in the ventilation air shall be determined.

B.5.3 Penetrating moisture flow

The moisture flow penetrating through the inner wall of the top of the chimney structure shall be specified as a function of the partial pressure gradient between the inner surface of the inner wall and the environment.

The moisture flow diffusing through the outer wall shall be neglected.

B.5.4 Maximum moisture flow

The dew point of the water vapour in the ventilation air and the resulting maximum moisture flow to be removed is determined by the inner wall temperature of the ventilation ducts.

B.5.5 Layer temperatures

The layer temperatures of the test chimney calculated at the boundary conditions of measurement on the basis of the determined thermal transmittance coefficients of the wall materials shall be compared with the measured temperatures.

B.5.6 Calculation of the frictional and form resistance of the ventilation ducts, from a test chimney

The frictional and form resistance of the ventilation ducts shall be determined according to EN 13384-1. It is also determined from the data ascertained at steady temperature, moisture and flow conditions on the basis of the results obtained at the test chimney. For this, the room temperature at mean height shall be taken as the outside temperature and the temperature at the outlet of the ventilation ducts shall be taken as the ventilation temperature.

Generally, the frictional and form resistances calculated according to EN 13384-1 are more unfavourable; if not, the measured values shall be taken as an increased frictional value.

The calculated values of the flow rate and the ventilation temperatures shall be compared with the measured values by calculations at the boundary conditions of the measurements at the test chimney.

B.5.7 Moisture flow at test chimney

The moisture flow measured at the test chimney shall be converted into the specified boundary conditions for section 1 and 2 with and without additional outer thermal insulation.

B.5.8 Expression of results

The largest chimney height at which the conditions are satisfied is considered to be the maximum building height regarding the performance of the ventilation.

B.6 Multi-wall chimneys without back-ventilation, designated W

B.6.1 General requirement

At the specified boundary conditions no condensation water penetration is permitted at any point of the chimney structure. The inner surface of the outer wall is generally the most critical point for three-wall chimneys.

The temperatures and moistures are calculated step by step.

B.6.2 Partial pressures

The variations in partial pressure shall be determined from the temperatures in the chimney structure calculated according to Clause 1. Analogously to the calculation of the temperatures in the chimney structure, the variations in partial pressure in the chimney structure resulting from the moisture flow shall be determined using the moisture transport data.

B.6.3 Variations in partial pressure in critical planes

The variations in partial pressure shall be calculated for one plane at the chimney entry, one plane at the chimney outlet of section 1 and one plane at the outlet of section 2 (= chimney outlet) the calculation being based on the calculated flue gas and inner wall temperatures.

B.6.4 Penetrating moisture flow

The moisture flow penetrating through the inner wall of the chimney structure shall be determined in accordance with the value of the partial pressure determined at the test chimney at the inner surface of the inner wall, the inner surface of the outer wall (= at the outer wall of the insulation wall) and in the ambient air. If the coefficients of vapour diffusion resistance of the thermal insulation and the outer wall are known, the coefficient of vapour diffusion resistance of the inner wall shall be adjusted.

B.6.5 Condensation water penetration

The calculated variations in partial pressure shall be compared with those of the saturated vapour pressure resulting from the temperatures. At no point shall the partial pressure be higher than the saturated vapour pressure.

B.6.6 Layer temperatures

The layer temperatures of the test chimney calculated at the boundary conditions of measurement on the basis of the determined thermal transmittance coefficients of the wall materials shall be compared with the measured temperatures.

B.6.7 Calculation of the variations in partial pressure in the chimney structure, height-dependent

According to B.6.3 the variations in partial pressure shall generally be calculated for the three critical planes stated above.

B.6.8 Expression of results

The determined partial and saturated vapour pressures shall be recorded for the maximum possible chimney heights.

Annex C
(informative)

Methods of determining the effects of extract and air supply provisions

Table C.1 — Effects, requirement and method to determine

effects	**effects of extract**	**air supply provision**
requirement	- influence by extract effects ≤ 1 Pa - Δp_1 ≤ 1 Pa	- influence by air supply ≤ 0,2 m/s - Δw ≤ 0,2 m/s
method to determine	- Δp_1 at ambient temperature without flow - Δp_1 during a test - Δp_1 at the end of a test at ambient temperature without flow	- Δw during a test

Annex D
(normative)

Method of measuring the hot gas temperature

Use a calibrated thermocouple. Its position is determined by a temperature traverse during the first thermal cycle as follows:

— Set the hot gas thermocouple in the centre of the flue pipe through one of two apertures provided at right angles to each other at a level (50 ± 2) mm from the entry to the test chimney.

— Fire the hot gas generator at the volume flow specified in Table 1 and regulate it to produce the nominated hot gas temperature.

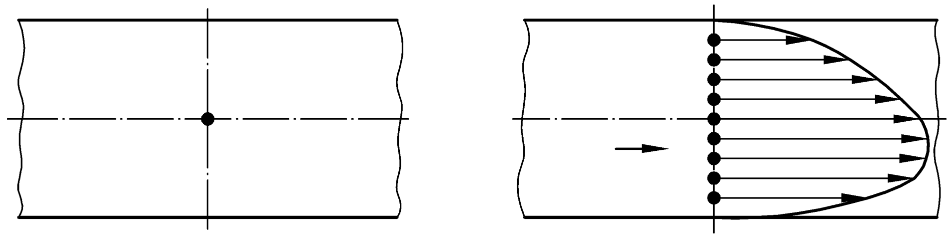
— After firing for not less than 10 min, take ten equally spaced temperature measurements along two traverses at right angles across the flue pipe cross section.

— Determine the location of the highest temperature of these two traverses and position the thermocouple there for the test.

— Seal the redundant aperture.

— Re-adjust the hot gas generator to obtain the nominated hot gas temperature.

— Alternatively, a thermocouple grid may be used to determine the OTDF (Overall Temperature Distribution Factor).



1st step   2nd step

Figure D.1 — Place for the measuring point for the hot gas

Annex E
(informative)

Hot gas mass flow, heat capacity of the flue gas, example of air velocity for natural gas combustion

Table E.1 — Hot gas mass flow as a function of test temperature *T* and diameter of the flue liner *D*

		Hot gas mass flow in g/s											
		T in °C											
	D in mm	100	120	150	170	190	250	300	350	500	550	700	1000
Negative pressure chimney	100	10,3	11,0	11,7	12,1	12,4	13,0	13,2	13,3	13,2	13,1	12,7	11,9
	120	16,1	17,1	18,2	18,8	19,2	20,0	20,3	20,4	20,2	20,0	19,3	19,0
	160	31,6	33,5	35,6	36,6	37,4	38,7	39,2	39,3	38,6	38,2	36,8	34,0
	200	52,4	55,5	58,8	60,3	61,5	63,6	64,4	64,3	63,0	62,2	59,9	55,3
Positive pressure chimney	50	2,7	2,7	2,8	2,8	2,9	2,9	2,9	2,9	2,9	2,9	2,8	2,6
	100	15,4	15,7	16,0	16,2	16,3	16,3	16,3	16,2	15,6	15,4	14,7	13,5
	120	23,8	24,2	24,6	24,8	24,9	25,0	24,9	24,7	23,7	23,4	22,3	20,5
	160	46,0	46,8	47,6	47,9	48,0	48,1	47,8	47,2	45,2	44,5	42,4	38,7
	200	75,6	76,8	78,0	78,5	78,7	78,7	78,1	77,1	73,7	72,5	69,0	62,9
High positive pressure chimney	50	6,8	6,7	6,6	6,5	6,5	6,3	6,1	5,9	5,5	5,4	5,1	4,6
	100	37,2	36,7	35,8	35,3	34,8	33,4	32,3	31,3	28,9	28,2	26,3	23,4
	120	56,9	56,0	54,7	53,8	53,0	50,8	49,2	47,6	43,8	42,7	39,8	35,4
	160	109,1	107,3	104,7	103,1	101,5	97,1	93,8	90,8	83,3	81,1	75,6	67,1
	200	178,5	175,5	171,1	168,4	168,7	158,5	153,0	148,1	135,6	132,0	122,9	109,0

Table E.2 — Heat capacity of the flue gas as a function of test temperature T and diameter of the flue liner D

		Heat capacity of the flue gas in kW											
		T in °C											
	D in mm	100	120	150	170	190	250	300	350	500	550	700	1000
Negative pressure chimney	100	0,9	1,2	1,7	2,0	2,3	3,3	4,1	4,8	7,0	7,6	9,5	12,8
	120	1,4	1,9	2,6	3,1	3,6	5,1	6,2	7,4	10,7	11,7	14,4	19,4
	160	2,8	3,7	5,1	6,0	7,0	9,8	12,1	14,3	20,4	22,5	27,5	36,6
	200	4,6	6,1	8,4	9,9	11,5	16,1	19,8	23,3	33,3	36,3	44,8	59,6
Positive pressure chimney	50	0,2	0,3	0,4	0,4	0,5	0,7	0,9	1,1	1,5	1,7	2,1	2,8
	100	1,3	1,7	2,3	2,7	3,0	4,1	5,0	5,9	8,2	9,0	11,0	14,6
	120	2,1	2,7	3,5	4,1	4,6	6,3	7,7	9,0	12,5	13,6	16,7	22,1
	160	4,0	5,1	6,8	7,9	9,0	12,2	14,5	17,1	23,9	25,9	31,7	41,7
	200	6,6	8,4	11,2	12,9	14,7	19,9	24,1	28,0	38,9	42,3	51,6	67,8
High positive pressure chimney	50	0,6	0,7	0,9	1,1	1,2	1,6	1,9	2,1	2,9	3,1	3,8	5,0
	100	3,3	4,0	5,1	5,8	6,5	8,4	9,9	11,4	15,3	16,4	19,7	25,2
	120	5,0	6,2	7,8	8,9	9,9	12,8	15,2	17,3	23,1	24,9	29,8	38,2
	160	9,6	11,8	15,0	17,0	19,0	24,6	28,9	33,0	44,0	47,3	56,5	72,3
	200	15,7	19,3	24,5	27,8	31,0	40,0	47,1	53,8	71,6	77,0	91,9	117,5

Table E.3 — Example of air velocity for natural gas combustion as a function of test temperature *T* and diameter of the flue liner *D*, ambient air temperature 20 °C, natural gas

		Combustion air velocity in m/s											
		T in °C											
	D in mm	100	120	150	170	190	250	300	350	500	550	700	1000
Negative pressure chimney	100	1,1	1,1	1,2	1,2	1,3	1,3	1,4	1,4	1,4	1,4	1,3	1,2
	120	1,2	1,2	1,3	1,4	1,4	1,4	1,5	1,5	1,4	1,4	1,4	1,3
	160	1,3	1,3	1,4	1,5	1,5	1,6	1,6	1,6	1,6	1,5	1,5	1,4
	200	1,4	1,4	1,5	1,6	1,6	1,6	1,7	1,7	1,6	1,6	1,6	1,4
Positive Pressure chimney	100	1,6	1,6	1,6	1,7	1,7	1,7	1,7	1,7	1,6	1,6	1,5	1,4
	120	1,7	1,7	1,8	1,8	1,8	1,8	1,8	1,8	1,7	1,7	1,6	1,5
	160	1,9	1,9	1,9	1,9	1,9	2,0	1,9	1,9	1,8	1,8	1,7	1,6
	200	2,0	2,0	2,0	2,0	2,0	2,0	2,0	2,0	1,9	1,9	1,8	1,6
High Positive pressure chimney	100	3,8	3,8	3,7	3,6	3,6	3,4	3,3	3,2	3,0	2,9	2,7	2,4
	120	4,1	4,0	3,9	3,9	3,8	3,7	3,5	3,4	3,2	3,1	2,9	2,6
	160	4,4	4,3	4,2	4,2	4,1	3,9	3,8	3,7	3,4	3,3	3,1	2,7
	200	4,6	4,6	4,4	4,4	4,3	4,1	4,0	3,8	3,5	3,4	3,2	2,8

Equations

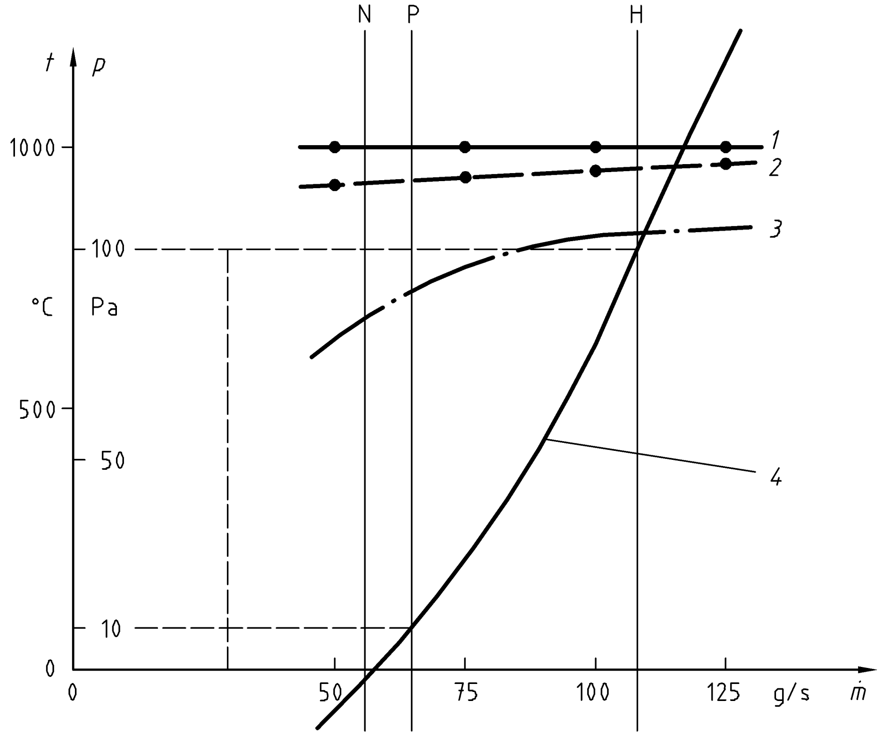
on the basis of EN 13384-1

— connecting flue pipe as required

— test sample = test chimney

— gas as fuel

formula	negative pressure chimney	positive pressure chimney	high positive pressure chimney
$Pz = P_H - P_E$ in Pa $P_H = g \times H \times (\rho_a - \rho_i)$ in Pa $P_E = S_E \times \rho_i / 2w^2 \times (\psi H/D + \Sigma\zeta)$ in Pa where Pz draught at the flue gas inlet into the chimney P_H theoretical draught available due to the chimney effect P_E pressure resistance due to friction and form resistance S_E flow safety coefficient g gravitation H effective height of the chimney ρ_a density of the air outside ρ_i density of the air inside w mean velocity within a cross section ψ coefficient of flow resistance due to friction of the flue D diameter $\Sigma\zeta$ sum of values of existing flow resistances	-1	+10	+100



Key

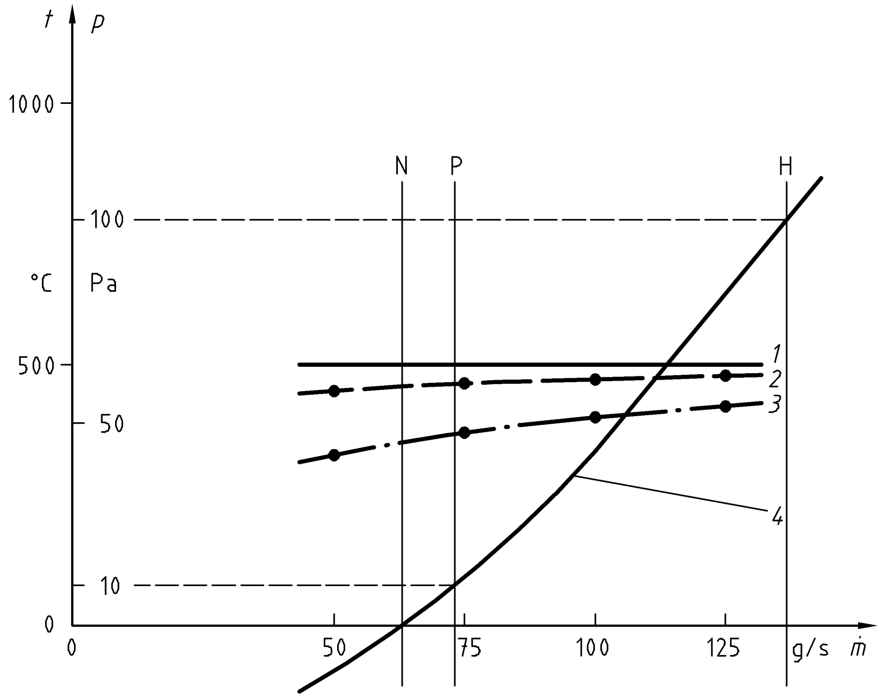
1 Flue gas temperature

2 Wall temperature

3 Wall temperature

4 Chimney draught

Figure E.1 — Pressure and wall temperatures in test chimneys operating with negative, positive and high positive pressure - sootfire conditions



Key

1 Flue gas temperature

2 Wall temperature

3 Wall temperature

4 Chimney draught

Figure E.2 – Pressure and wall temperatures in test chimneys operating with negative, positive and high positive pressure – normal operating conditions

Annex F
(informative)

Example of a test report

Table F.1 - Test results

No	Specific performance requirements	Requirement	Result	Comment
1	5.2 Abrasion resistance test – weight of material loss in kg			
2	5.3 Relative movement of the flue liner in multi-wall system chimneys – change in position of the flue liner			
3	5.4 Gas tightness test – air flow rate in l/(sm²) at pressure in Pa			
4	5.5 Condensate resistance test – appearance of water – location of appearance of water			
5	5.6 Vapour and condensate resistance test – humidity at boundary layer – appearance of condensate – thermal resistance in m²K/W – lowest possible ambient temperature in °C			
6	5.7 Thermal performance tests – max. outer wall temperature for thermal tests in °C – max. enclosure temperature for thermal tests in °C - max. outer wall temperature for thermal shock tests in °C - max. enclosure temperature for thermal shock tests in °C - max. outer wall temperature for touchable surfaces in °C			
7	5.8 Thermal resistance test - thermal resistance in m²K/W			
8	5.9 Terminal flow resistance			
9	5.10 Aerodynamic behaviour of terminal under wind conditions			
10	5.11 Flow resistance of fittings and flue liners			
11	5.12 Rainwater resistance for a chimney section			
12	5.13 Rainwater resistance for a terminal			

Bibliography

[1] EN 483, *Gas-fired central heating boilers – Type C boilers of nominal heat input not exceeding 70 kW.*

[2] EN 13501-1, *Fire classification of construction products and building elements - Part 1: Classification using test data from reaction to fire tests.*

[3] Guidance Paper C Treatment of kits and systems under CPD.

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