

Chimneys — Metal chimneys — Test methods

The European Standard EN 1859:2000, with the incorporation of amendment A1:2006, has the status of a British Standard

ICS 91.060.40

National foreword

This British Standard is the official English language version of EN 1859:2000, including amendment A1:2006. It supersedes BS 4543-1:1990 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated in the text by **A1** **A1**.

The UK participation in its preparation was entrusted by Technical Committee B/506, Chimneys, to Subcommittee B/506/5, Chimneys and their connecting flue pipes made of metal, which has the responsibility to:

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 60, an inside back cover and a back cover.

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This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 April 2000

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ISBN 0 580 32653 5

Amendments issued since publication

Amd. No.	Date	Comments
16448	31 August 2006	See national foreword

English version

Chimneys - Metal Chimneys - Test Methods

Conduits de fumée - Conduits de fumée métalliques -
Méthodes d'essais

Abgasanlagen - Metall-Abgasanlagen - Prüfverfahren

This European Standard was approved by CEN on 16 April 1999.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 166, Chimneys, the secretariat of which is held by UNI.

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 July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

This European Standard should be read in conjunction with the general requirements defined in EN 1443, the products requirements defined in prEN 1856-1 and prEN 1856-2 and the general test methods defined in WI 166005 which may offer a suitable alternative to those in this document. Attention is also drawn to other material related European Standards developed by CEN/TC 166.

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

Foreword to amendment A1

This document (EN 1859:2000/A1:2006) has been prepared by Technical Committee CEN/TC166 "Chimneys", the secretariat of which is held by UNI.

This Amendment to the European Standard EN 1859:2000 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2006, and conflicting national standards shall be withdrawn at the latest by December 2006.

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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard describes test methods for metal chimney products.

2 Normative references

This European Standard incorporates by dated or undated reference provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 1443, Chimneys - General requirements.

EN 60529, Degrees of protection provided by enclosures (IP Code).

prEN 1856-1, Chimneys - Requirements for metal chimneys - Part 1: System chimney products.

prEN 1856-2, Chimneys - Requirements for metal chimneys - Part 2: Metal liners and connecting flue pipe products.

EN 60068-2-59, Environmental testing. Test methods. Test Fe and guidance. Vibration. (Sine-beat method)

ISO 3966, Measurement of fluid flow in closed conduits. Velocity area method using Pitot static tubes.

3 Definitions

For the purposes of this standard, the definitions given in EN 1443 and prEN 1856-1 apply.

4 Test methods for metal chimney products

4.1 Compressive strength

4.1.1 Fitting

4.1.1.1 Test assembly

Assemble the fitting according to the manufacturer's installation instructions between two adaptors including one chimney section (see Figure 1a). The adaptors shall be supplied by the chimney manufacturer and shall transfer the test load in the usual way to the load bearing wall of the test components as it is done in the installation. The test load shall be transferred to the test components by means of a pivoted plate.

4.1.1.2 Procedure and results

Increase the test load on the components without shock up to four times the design load where the flue liner is load bearing or three times the design load where the flue liner is non load bearing. The load shall be measured to an accuracy of 2 % of the design load. Record the result.

Where the design load is unknown, increase the test load uniformly and record the results to allow the point of failure to be detected. Failure is deemed to have occurred when the fitting cannot sustain a further increase in load.

Use the minimum value from three failure loads to determine the design load.

4.1.2 Chimney support

4.1.2.1 Test assembly

Install the chimney support according to the manufacturer's installation instructions. Apply the test load to the chimney support through a chimney section and an adaptor (see Figure 1b). The adaptor shall be supplied by the chimney manufacturer and shall transfer the test load in the usual way to the load bearing wall of the chimney sections. The test load shall be transferred to the test component by means of a pivoted plate.

4.1.2.2 Procedure and results

Increase the test load up to the design load without shock. Record the maximum displacement of the chimney. Measure the displacement to an accuracy of 0,1 mm.

Further increase the load up to three times the design load. Record the results.

Measure the load to an accuracy of 2 % of the design load.

Where the design load is unknown, increase the load uniformly and record the results to allow the point of failure to be detected. Failure is deemed to have occurred when the support cannot sustain a further increase in load.

Record the displacement during the load increase. Use the minimum value from three failure loads to determine the design load.

4.2 Tensile strength

4.2.1 Test assembly

Install the chimney sections according to the manufacturer's installation instructions. Apply the test load through an adaptor (see Figure 1c). The adaptor shall be supplied by the chimney manufacturer and shall transfer the test load in the usual way to the load bearing wall of the chimney sections.

4.2.2 Test procedure and results

Increase the test load on the components without shock up to 1,5 times the design load. The load shall be measured to an accuracy of 2 % of the design load. Record the result.

Where the design load is unknown, increase the test load uniformly and record the results to allow the point of failure to be detected. Failure is deemed to have occurred when the fitting cannot sustain a further increase in load.

Use the minimum value from three failure loads to determine the design load.

4.3 Lateral strength

4.3.1 Fittings in non-vertical orientation

4.3.1.1 Test assembly

Install the chimney fittings and supports at the maximum angle from vertical according to the manufacturer's installation instructions using additional vertical supports to install the sections without deflection (see Figure 2).

4.3.1.2 Procedure and results

Remove the additional vertical supports. Record the maximum deflection to an accuracy of 0,1 mm.

4.3.2 Wind load

4.3.2.1 Test assembly

Install the chimney components according to the manufacturer's installation instructions. Use the test assembly consisting of the manufacturer's declared freestanding components and further chimney sections up to the manufacturer's maximum declared lateral support separation distance between the supports, and once again the same distance up to an anchor point (see Figure 3).

4.3.2.2 Procedure and results

Apply an evenly distributed test load increased uniformly up to $1,5 \text{ kN/m}^2 \pm 2,5 \%$.

NOTE: A method for applying an evenly distributed load is described in informative Annex H. Other methods using a vertical assembly may also be used.

Apply the test load to those components declared by the manufacturer for external use, except 50 % of the last laterally supported section of the test assembly.

Apply the test load by a number of individual evenly distributed loads equally spaced from the freestanding end at not more than $(0,2 \pm 0,01) \text{ m}$ intervals. The individual loads shall not vary by more than 1 %. Record the results.

4.4 Gas tightness

4.4.1 Test assembly

Construct the test assembly as described in 4.5. Seal the test assembly chimney flue outlet with an air tight seal. Use adaptors supplied by the manufacturer in order to ensure that the chimney inlet and outlet are closed in a typical manner. Connect a positive pressure air supply and flow meter to the test chimney flue inlet with appropriate air tight seals. Connect a manometer to the flue of the test assembly (see Figure 4).

4.4.2 Procedure and results

The test shall be carried out at ambient temperature.

Deliver air from the air supply to the flue at a rate necessary to achieve and maintain the required test pressure given in Table 1 of prEN 1856-1.

Measure the test pressure and the air flow rate, both to an accuracy of $\pm 2,0$ %.

Record the air flow rate.

4.5 Thermal performance test

4.5.1 Apparatus

The test assembly shall comprise a test structure (see 4.5.1.2), a test chimney (see 4.5.1.3), a hot gas connecting pipe (see 4.5.1.4), and measuring equipment (see 4.5.1.5).

4.5.1.1 Test assembly

A1 Construct

- an open room outlet test assembly consisting of the test chimney in the test structure.

The chimney shall be tested according to Figure 5.

NOTE Figure 6 shows the arrangement for testing off-sets.

Alternatively,

- a recirculating hot gas test assembly (see Figure 7) containing the test chimney in the test structure in one arm of the assembly and having interconnecting tubes so that heated air can pass around the test assembly. **A1**

4.5.1.2 Test structure

4.5.1.2.1 General

Construct a test structure consisting of two walls at right angles and two floors through which the test chimney passes, of construction as described in 4.5.1.2.2 and 4.5.1.2.3 or of equivalent thermal characteristics and dimensions, 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 5. The wall/floor interface shall be fitted with nominally 20 mm x 100 mm skirting board. The vertical distance between the floor and ceiling in Zone B shall be $(2\,400 \pm 25)$ mm. The height of the chimney protruding into Zone C shall not be less than 900 mm. Timbers shall have a dimensional tolerance of ± 1 mm.

4.5.1.2.2 Walls

Construct walls consisting of nominal dimension 38 mm x 89 mm thick timbers in a framework (see Figure 5) faced on each side with one layer of nominally 12 mm thick plywood to give a total thickness of 114 mm insulated in the voids with mineral fibre insulant having a thermal conductivity of 0,035 W/m K at 20 °C, with a density of 100 kg/m³. The walls shall extend 1 200 mm.

4.5.1.2.3 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 fittings (see Figure 5) 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 100 mm thick mineral wool slab with a thermal conductivity of 0,035 W/m K at 20 °C, with a density of 100 kg/m³.

4.5.1.3 Test chimney

Construct the test chimney using the components materials and construction representing the manufacturer's product range, including a termination, and, if incorporated, joints. Assemble the chimney in accordance with the manufacturer's installation instructions, including firestops or firestops and spacers to a height of not less than 4,5 m, including base support components, if used.

Include any finishing (e.g. non-combustible enclosures or claddings) specified in the manufacturer's instructions.

4.5.1.4 Hot gas connecting pipe

Construct a purpose-made insulated straight flue pipe having an internal diameter equal to that of the flue of the test chimney of a length of approximately seven diameters (7D) 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 W/m K $\pm$ 0,005 W/m K at 750 °C.

NOTE: This item should be supplied by the chimney manufacturer.

4.5.1.5 Measuring equipment and its location

4.5.1.5.1 Ambient temperature

Measure ambient air temperature with an accuracy of $\pm 1,5$ °C, in Zone A at a position 300 mm $\pm$ 5 mm below the ceiling and in all other zones 300 mm $\pm$ 5 mm above the floor.

When testing a non-enclosed chimney, place additional ambient measuring points at levels corresponding to the outer surface temperature measurements.

The method is described in normative Annex A.

4.5.1.5.2 Hot gas temperature

Measure the hot gas temperature with an accuracy of $\pm 3\text{ }^{\circ}\text{C}$ for hot gas temperatures less than or equal to $600\text{ }^{\circ}\text{C}$ and $\pm 0,75\%$ for hot gas temperatures greater than $600\text{ }^{\circ}\text{C}$ at a position $50\text{ mm} \pm 2\text{ mm}$ 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 normative Annex B.

4.5.1.5.3 Metal surface temperature

Measure the surface temperature of metal components with an accuracy of $\pm 1,5\text{ }^{\circ}\text{C}$.

The method is described in normative Annex C.

4.5.1.5.4 Combustible/wood surface temperature

Measure the surface temperature of the adjacent wood/combustible parts of the test structure with an accuracy of $\pm 1,5\text{ }^{\circ}\text{C}$.

The method is described in normative Annex D.

4.5.1.5.5 Locations for surface temperature measurements

Establish the maximum temperature of the surfaces of the test structure and the test chimney during the thermal cycle appropriate to the designation.

Locations for thermocouples are described in normative Annex E.

4.5.1.5.6 Chimney draught measurement

Measure the draught in the chimney with an accuracy of $\pm 2\%$, through a $150\text{ mm} \pm 2\text{ mm}$ length of stainless steel tubing, internal diameter $3\text{ }^{+1}_0\text{ mm}$ inserted through the flue pipe and flush with the flue surface and sealed by brazing, at a distance of $100\text{ mm} \pm 2\text{ mm}$ from the entry to the test chimney.

4.5.1.5.7 Hot gas volume flow

Measure the flue gas volume to an accuracy of $^{+10}_{-5}\%$.

Informative Annex J gives acceptable techniques.

4.5.2 Test environment and conditioning

4.5.2.1 Test room

The test room shall consist of a ventilated space not subject to draughts greater than $0,5\text{ m/s}$ measured at the ambient thermocouple positions (see 4.5.1.5).

Ambient temperature within the test building shall be maintained within the limit of $20\text{ }^{\circ}\text{C} \pm 15\text{ }^{\circ}\text{C}$, measured at the designated ambient temperature positions (see 4.5.1.5).

The humidity shall be controlled between 30% and 70% RH.

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

The distance between the test assembly and other structures (e.g. test room walls) shall be at least 1,0 m.

4.5.2.2 Vibration conditioning

Vibration conditioning shall be undertaken using vibration equipment and measuring techniques complying with EN 60068-2-59.

4.5.2.2.1 Procedure

Place each fitting intended for inclusion in the thermal test onto the vibrating table in its vertical orientation. Subject each fitting to a sinusoidal excitation at an acceleration equal to $9,81 \text{ m/sec}^2$, with a frequency of 10 Hz and an amplitude of 2,5 mm for 45 min.

4.5.2.3 Drying/conditioning phase

Incorporate a drying phase into the thermal cycle if required by the manufacturer's instructions.

Blow hot gases into the chimney in such a way that the hot gas temperature (see 4.5.1.5.2) rises to the nominated test temperature in $60 \text{ min} \pm 5 \text{ min}$, unless otherwise required.

4.5.3 Test procedure

Install the chimney components which have been subjected to the vibration conditioning criteria of 4.5.2.2 in the test assembly which is appropriate to the manufacturer's declared product location designation.

Encase a chimney designated for internal use and with combustible enclosure in Zone B on the remaining two sides with 12 mm nominal dimension plywood and positioned on the basis of the manufacturer's specified clearance to the enclosure and walls, measured between the outer surface of the chimney sections and the interior surface of the enclosing materials. Such clearance is designated by the dimension X (see Figure 5). Close the floor penetrations at each ceiling and floor level with a firestop, or firestop and spacer, arrangement supplied by the manufacturer.

Seal only joints and openings between spacers or supports and the test structure and all joints in the enclosure casing.

Install a chimney designated for use without an enclosure into the test structure, without enclosing the test chimney and without closing the floor penetrations (see Figure 8).

For a chimney designated for internal use and with non combustible enclosure, the sides of the enclosure shall be closed to the walls of the test assembly unless otherwise specified by the manufacturer (see Figure 9). Install the floor penetration assembly supplied by the manufacturer.

Maintain the test environment.

Generate hot gas with the volume flow and test temperature specified in Table 1 and Table 2 appropriate to the product designation and diameter.

Adjust the hot gas flow pattern so that the overall temperature distribution factor (OTDF) for the hot gas is not greater than 1,05.

Where:

$$OTDF = \frac{\text{peak hot gas temperature}}{\text{mean hot gas temperature}} \quad (1)$$

Ensure that the hot gas CO/CO₂ ratio does not exceed 0,01.

Maintain the ambient temperature of the test room so that it does not vary by more than 5 °C for the duration of the test.

4.5.3.1 Heat stress test

Generate hot gas with the volume flow and test temperature specified in Table 1 and Table 2 appropriate to the product designation and diameter. Regulate the rate of rise of the hot gas temperature to achieve the specified gas temperature (T_t) in time $T = (T_t \times 60/50) \text{ s} \pm 30 \text{ s}$.

Maintain the flue gas temperature at the specified test temperature until equilibrium is achieved. Equilibrium is deemed to exist when the average rate of rise of the temperature on the test chimney or structure does not exceed 2 °C per 30 min.

In addition, for positive pressure chimney systems only, introduce hot gas to achieve the volume flow and test temperature specified in Table 1 and Table 2 for the product designation and diameter. Maintain this condition for 5 min, then shut off the hot gas generator and allow to cool for 10 min. Repeat this cycle 50 times. Measure and record the gas tightness according to 4.4.

4.5.3.2 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 and Table 2 appropriate to the diameter. Regulate the rate of rise of the hot gas temperature to achieve 1 000 °C in 10 min $\pm$ 1 min.

Maintain the hot gas temperature at 1 000 $^{+20}_0$ °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 and are decreasing.

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

Repeat the heat stress test.

4.5.4 Results

Record all temperature values as specified in 4.5.1.5. Record any instance where the temperature exceeds the allowed values.

For the purposes 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.

The temperatures of joists shall be related to the average of the ambient temperatures above and below the joist area.

The temperatures of floor and roof material shall be related to the ambient temperatures above the floor or roof.

The temperatures of ceiling material shall be related to the ambient temperature below the ceiling.

The temperatures of chimney surfaces or accessories shall be related to the ambient temperature of the zone in which the chimney surface or accessory temperature is measured.

During the heat stress test the temperature rise shall be based on the ambient temperature recorded at the end of the relevant firing period.

Table 1: Hot gas volume flow vs. test temperature

THERMAL PERFORMANCE											
Diameter (mm)	Volume Flow (m ³ /h) Temperature (°C)										
	100	120	150	170	190	250	300	350	500	550	700
80	41,80	42,21	43,51	44,61	45,88	49,82	53,29	56,71	63,73	66,83	79,98
100	65,31	65,95	67,99	69,70	71,69	77,84	83,27	88,61	99,58	104,42	124,97
125	102,05	103,05	106,23	108,90	112,01	121,63	130,10	138,45	155,60	163,16	195,27
150	146,94	148,39	152,97	156,82	161,30	175,15	187,35	199,36	224,06	234,95	281,18
175	200,01	201,97	208,21	213,44	219,54	238,40	255,00	271,36	304,97	319,80	382,72
200	261,24	263,80	271,94	278,78	286,75	311,38	333,07	354,42	398,33	417,69	499,88

Table 2: Hot gas volume flow vs. flue diameter

THERMAL SHOCK						
Temperature (°C)	Volume flow (m ³ /h) Diameter (mm)					
	80	100	125	150	175	200
1000	108,00	144,00	252,00	360,00	468,00	612,00

4.6 Thermal resistance

4.6.1 Test assembly

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 10).

Alternatively, connect the chimney sections from the recirculating hot gas test assembly of 4.5.1.1 (see Figure 11).

4.6.2 Test procedure

Maintain the test environment specified in 4.5.2.1.

Circulate hot gas around the test assembly. The velocity of the hot air shall be minimum of 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 -10 Pa.

Measure the internal and external surface temperature of the chimney sections as specified in 4.5.1.5.5.

For chimneys designated suitable for dry operation, the hot gas shall have a heat content and temperature so that the inner surface of the chimney sections under test reaches a temperature 20 % below the designated temperature (nominal working temperature), but not more than 200 °C.

For chimneys designated suitable for wet applications, the hot gas shall be water vapour saturated and shall have a heat content and temperature such that the inner surface reaches a temperature of 70 °C. The gas is considered saturated if humidity is equal to or greater than 95 % measured at entry to the test sample.

Adjust the temperature, heat content and humidity of the hot air until equilibrium conditions exist. Equilibrium is 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. Record the heat input (Q_1), in Watts, the flue gas temperature t_g and the internal (t_i) and external (t_o) surface temperatures.

Reassemble the test assembly without the test chimney sections or replace by the calibrated section. Repeat the test as described before until the hot gas temperature is the same as during the tests with the chimney sections in place, and until equilibrium condition exists. Equilibrium is reached when the difference between the hot gas temperature and the ambient temperature does not change by more than 1 % in 3 h.

Record the heat input (Q_2).

4.6.3 Results

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

$$1/\Lambda = A_j (t_j - t_0) / (Q_1 - Q_2) \quad (2)$$

where:

Q_1 is the total heat input in watts with the chimney section

Q_2 is the total heat input in watts without the chimney sections

t_j is the inner surface temperature

t_0 is the outer surface temperature

A_j is the total inner surface area of the test chimney

4.7 Water vapour diffusion resistance

4.7.1 Conditioning

Condition the already thermally tested chimney fittings by standing in the test environment of 4.5.2 for at least 12 h. Weigh the fittings to an accuracy of $\pm 0,5$ g.

4.7.2 Test assembly

Install approximately 2 m of chimney fittings including two joints into each arm of the test assembly of 4.6.1. Alternatively, connect the recirculating hot gas generator of 4.6.1 to the part of the test chimney in Zone B (see Figure 11).

4.7.3 Test procedure

Pass water vapour saturated air at a temperature of 55 °C through the fittings at 4 m/s $\pm$ 0,1 m/s for 24 h.

For negative pressure chimneys maintain the pressure in the test chimney between 0 Pa and - 10 Pa.

4.7.4 Results

Record any evidence of moisture penetration. Reweigh the test fittings.

Record the increase in weight of the fittings.

4.8 Condensate resistance test

4.8.1 Test apparatus

Spray equipment according to Figure 12.

4.8.2 Test sample

The test sample is the test chimney, see 4.5.1.3, including T-piece and cleaning doors.

4.8.3 Measuring parameters

- Detection of coloured water outside of fittings.
- Spray volume.
- Spray temperature.
- Weight of fitting.

4.8.4 Test procedure

Precondition the test sample to the thermal designation parameters (thermal stress and thermal shock tests). Spray coloured water with a temperature of 50 °C, a pressure of 3 bar and a volume related to the diameter (e.g. 0,020 m³/h for 150 mm diameter) maintained during 4 h or until the water appears on the outside of any fitting.

4.8.5 Test results

Record the location of any appearance of water on the outside of any fitting.

4.9 Rainwater resistance

4.9.1 Chimney sections

4.9.1.1 Conditioning

Condition for at least 48 h in the test environment of 4.5.2.1, those chimney sections which have been subjected to the thermal performance test of 4.5 (located in Zone C) including at least one joint between the sections removed in their assembled state so that any joint between the sections shall have been left undisturbed following the thermal performance test. Weigh the section to an accuracy of 0,5 g.

4.9.1.2 Test assembly

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 13). Seal the joint where the sections stand on the plinth to prevent ingress of water into open end of section.

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

4.9.1.3 Spray procedure

Spray water for $60 \text{ min} \pm 1 \text{ min}$ while oscillating the spray arc through an angle of $120^\circ \pm 5^\circ$ (60° either side of the vertical) and rotating the plinth. The time for one complete traverse (two traverses of 120°) shall be $6 \text{ sec} \pm 1 \text{ sec}$ and the time for one revolution of the plinth shall be $5 \text{ min} \pm 1 \text{ min}$. Remove any surface moisture from the surfaces of the chimney sections and condition the sections for at least 12 h, and not more than 24 h, in the test environment of 4.5.2. The sections may be separated to facilitate removal of surface moisture. Reweigh the test sections.

4.9.1.4 Results

Record the increase in weight of the test sections.

4.9.2 Rainwater terminal

4.9.2.1 Conditioning

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

4.9.2.2 Test assembly

Install the rainwater terminal fitted to some chimney sections according to the manufacturer's instructions, onto the centre of the plinth of the test structure of 4.9.1.2. Adjust the position so that the spray covers the entire rainwater terminal (see Figure 14). Collect any water entering the flue.

4.9.2.3 Spray procedure

Spray water for $60 \text{ min} \pm 1 \text{ min}$ while oscillating the spray arc through an angle of $120^\circ \pm 5^\circ$ (60° either side of the vertical) and rotating the plinth. The time for one complete traverse (two traverses of 120°) shall be $6 \text{ sec} \pm 1 \text{ sec}$ and the time for one revolution of the plinth shall be $5 \text{ min} \pm 1 \text{ min}$. Collect and weigh any moisture entering the flue.

4.9.2.4 Results

Record the weight of water collected inside the flue.

4.10 Terminal flow resistance

4.10.1 Conditioning

Condition the flue terminal thermally to the test temperature corresponding to its designation either during the thermal performance test 4.5, or in an oven for 4 h.

4.10.2 Test assembly

The test assembly comprises a fan capable of delivering a flue flow between and including 15 m³/h and 120 m³/h, measured to an accuracy of $\pm 5\%$. A suitable means of measurement is by an appropriate orifice plate arrangement.

4.10.3 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 6 times the nominal diameter. Place pressure measurement points in the flue duct at a distance of approximately 3 times the nominal diameter from the terminal. For this purpose, at least 3 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 $\pm 2,5\%$. Measure the pressure difference between static pressure in the flue duct and the pressure in the test room. The pressure difference is measured with an accuracy of $\pm 0,2$ Pa.

4.10.4 Results

Record the pressure difference between static pressure in the flue duct and the pressure in the test room. Record the result.

4.11 Aerodynamic behaviour of terminal under wind conditions

4.11.1 Conditioning

Condition the terminal thermally to the test temperature corresponding to its designation either during the thermal performance test 4.5, or in an oven for 4 h, in the test assembly of 4.11.2.

4.11.2 Test assembly

a) A wind generator capable of delivering a minimum wind front of 5 times the projected cross-section of the terminal to be tested but not less than 1 m². 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 a flue flow between and including 15 m³/h and 120 m³/h, measured to an accuracy of $\pm 5\%$. A suitable means of measurement is by an appropriate orifice plate arrangement.