BRITISH STANDARD

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13069:2005

Chimneys — Clay/ceramic outer walls for system chimneys — Requirements and test methods

The European Standard EN 13069:2005 has the status of a British Standard

ICS 91.060.40

BSI
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National foreword

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Summary of pages

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EN 13069

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English Version

Chimneys - Clay/ceramic outer walls for system chimneys - Requirements and test methods

Conduits de fumée - Enveloppes extérieures en terre cuite/céramique pour systèmes de conduits de fumée - Prescriptions et méthodes d'essai

Abgasanlagen - Keramik-Außenschalen für System-Abgasanlagen - Anforderungen und Prüfungen

This European Standard was approved by CEN on 27 October 2004.

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Contents

Foreword

This document (EN 13069:2005) 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of an identical text or by endorsement, at the latest by January 2006, and conflicting national standards shall be withdrawn at the latest by April 2007.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 89/106/EEC.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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1 Scope

This European Standard specifies the performance requirements for factory-made clay/ceramic chimney outer wall elements used to form the outer walls of chimneys and which are used in combination with flue liners in site. It applies to clay/ceramic chimney outer wall elements with solid walls or walls with vertical perforations (see Figure 1) which have square, rectangular or circular passages. Testing, making and inspection requirements are covered by this standard.

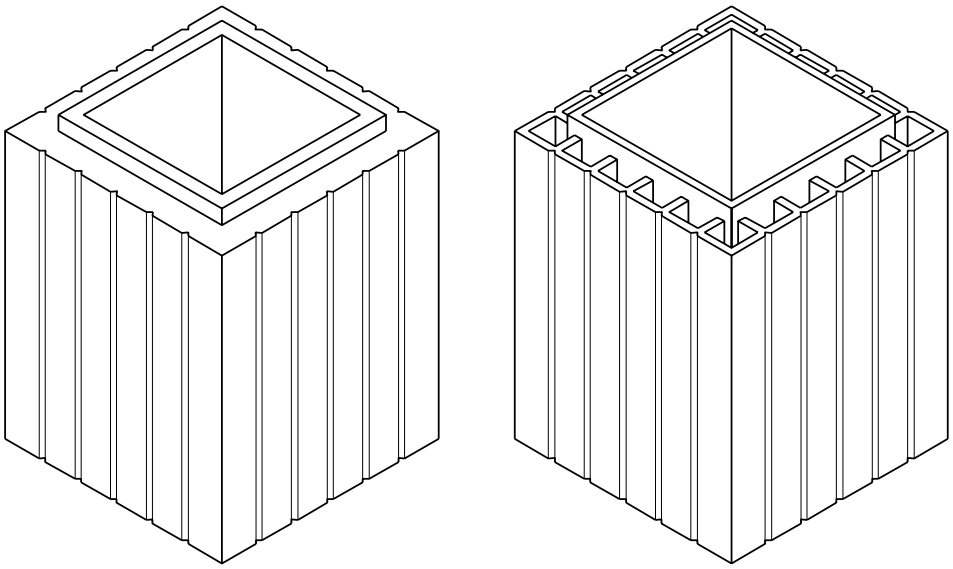


Figure 1 - Examples of clay/ceramic chimney outer wall elements with and without vertical perforations

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 312*, Particleboards - Specifications.*

EN 1443:2003, *Chimneys - General requirements.*

EN 14297: 2004, *Chimneys – Freeze-thaw resistance test method for chimney products.*

EN ISO 7500-1, *Metallic materials - Verification of static uniaxial testing machines - Part 1: Tension/compression testing machines -- Verification and calibration of the force-measuring system (ISO 7500-1:2004).*

ISO 2859-1, *Sampling procedures for inspection by attributes - Part 1: Sampling schemes indexed by acceptable quality limit (AQL) for lot-by-lot inspection.*

3 Terms and definitions

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

3.1
Nominal size
numerical designation of size which is a convenient round number equal to or approximately equal to either:

— the internal diameter in millimetres of the circular flue passage, or

— the internal width in millimetres of blocks with square section flues, or

— the internal width and breadth in millimetres of the internal transverse dimensions of outer walls with rectangular flueways

3.2
Nominal height
numerical designation of the height in millimetres of a standard outer wall excluding any projecting spigot, which is a convenient round number.

4 Materials

4.1 Outer walls

Clay/ceramic outer walls elements shall be manufactured from suitable clay/ceramic materials which, when fired, meet the performance requirements given in this standard.

5 Tolerances on dimensions

5.1 Internal transverse dimensions

When tested in accordance with 14.1, the internal diameter of outer walls with circular flues measured on any diameter shall not deviate more than ± 3 % of the manufacturer's stated nominal internal diameter. For outer walls with square and rectangular passages, the tolerances on the internal widths and breadths shall not deviate more than ± 3 % of the manufacturer's stated nominal internal dimension of the side.

NOTE Corners of the passages may be rounded.

5.2 Height

When tested in accordance with 14.2, the height of an outer wall shall not deviate more than ± 3 % of the manufacturer's stated nominal height subject to a maximum value of 10 mm.

5.3 Straightness

When tested in accordance with 14.3, the permissible deviation from straightness of straight outer walls shall be ± 1 % of the test length.

5.4 Squareness of ends

When tested in accordance with 14.4, the permissible deviation from square of the ends of straight clay/ceramic outer wall elements shall be not greater than an angle of slope 30 mm/m.

5.5 Squareness of corners and flatness of walls

When tested in accordance with 14.5, the permissible deviation from square of the corners and flatness of walls for square or rectangular shape straight clay/ceramic outer wall elements, shall be not greater than 5 % of the manufacturer's stated nominal internal width or breadth.

5.6 Joints

The design and dimensions of the joints shall be as specified by the manufacturer to provide an adequate joint.

6 Compressive strength

6.1 Straight outer walls

When tested in accordance with 14.6 and 14.7.3.2.2, straight outer walls shall withstand an intensity of loading of 10 MN/m^2.

6.2 Minimum load for outer wall elements with inspection opening sections

When tested in accordance with 14.6, the minimum load shall be as given in Table 1.

Table 1 — Minimum load

Height of chimney (m)	Minimum load (kN)
$H \leq 12,5$	25
$12,5 < H \leq 25$	50
$25 < H \leq 50$	100

For chimneys with area greater than 0,04 m^2 the following equation shall be used:

$$F = \chi \cdot H \cdot G / 100 \quad (1)$$

F = minimum load (kN)

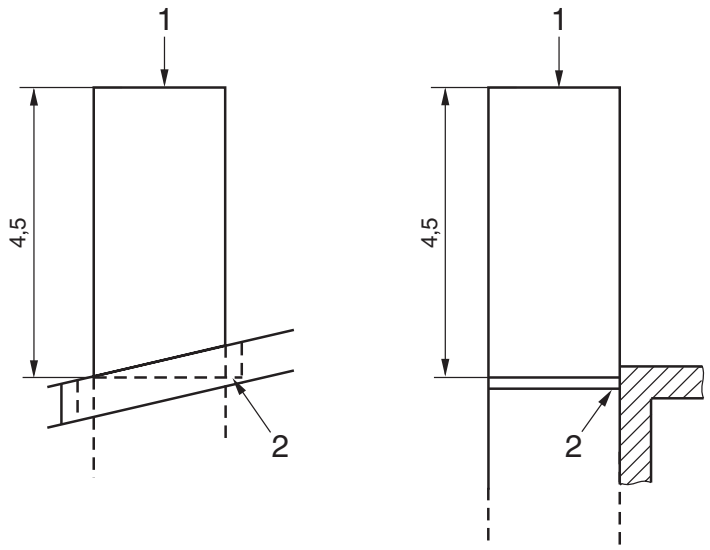
χ = safety factor = 5

H = height of chimney (m)

G = mass per metre (kg/m)

7 Flexural strength under wind loading

Outer wall elements to this standard are not tested for stability under wind loading. The maximum free standing height of outer wall elements to this standard shall be 4,5 times the least lateral overall external dimension of the outer wall element from the last point of lateral support (see Figure 2). The manufacturer shall declare the smallest lateral dimension.



Key

1 Top of chimney excluding any terminal or chimney pot

2 Last point of support

Figure 2 — Explanation of last point of support

8 Thermal shock

When tested in accordance with 14.7.3.2, clay/ceramic straight outer wall elements shall withstand an intensity of loading of 10 MN/m².

9 Resistance to fire

9.1 External to external

The performance criteria of integrity and insulation are declared as EI for the exposure outside to outside.

Examples are given in Table 2.

NOTE For fire classification see EN 13501-2 clause 7.5.11.

Table 2 — Fire resistance performance classes

Fire resistance performance classes	Duration in minutes
EI 000	0 ≤ EI 000 < 30
EI 030	30 ≤ EI 030 < 60
EI 060	60 ≤ EI 060 < 90
EI 090	90 ≤ EI 090 < 120
EI 120	120 ≤ EI 120

10 Thermal resistance

The values of thermal resistance of outer walls shall be declared by the manufacturer for a flue temperature of 200°C or calculated by the methods given in Annex A for the same temperature.

11 Water absorption and bulk density

11.1 General

The outer wall body shall be tested for either water absorption or bulk density for production control.

11.2 Water absorption

When tested in accordance with 14.8, the mean water absorption of five test specimens from new production of outer walls shall not vary more than ± 2,5 % from the mean value obtained for five test specimens taken from outer walls which have been subjected to the thermal type test.

11.3 Bulk density

When tested in accordance with 14.9, the mean bulk density of five test specimens from new production of outer walls shall not vary more than ± 100 kg/m³ from the mean value obtained for five test specimens taken from outer walls which have been subjected to the thermal type test.

12 Resistance to freeze-thaw

The manufacturer shall declare the freeze/thaw resistance in accordance with EN 14297. The product shall not present any damage of type 7, 8, 9 and 10 in accordance with EN 14297, Table 1.

13 Evaluation of conformity

13.1 General

The conformity of the outer wall elements to the requirements of this standard and with the stated values (including classes) shall be demonstrated by:

— initial type testing

— factory production control by the manufacturer, including product assessment.

For the purposes of testing, the outer wall element may be grouped into families, where it is considered that the selected property/properties is/are common to all the outer wall elements within that family.

13.2 Initial type testing

Type tests relating to material composition shall be performed initially together with factory production control tests as given in Table 3. One test shall be carried for each requirement.

All thermal testing shall be carried out on one size of outer walls for each geometrical configuration, e.g. circular, square, rectangular. For circular outer walls the size to be tested shall be 200mm ± 50mm internal diameter. For other geometric configurations the outer walls shall have an equivalent cross section area range.

13.3 Further type tests

Type tests shall be performed when a change is made either in material composition, processing technique or to the design or method of manufacture of the outer wall, but they may be performed more frequently by incorporation into a plant for monitoring the consistency of manufacture (see Table 3).

Table 3 — Factory production control, initial type testing and type tests

Item	Relevant requirements clauses	
	Factory production control 13.1 and 13.4	Initial type testing an type tests 13.1, 13.2 and 13.3
Straight Outer walls	5.1,5.2, 5.4, 5.5 and 11	6.1,7, 8, 9, 10 and 12

13.4 Factory production control

To achieve compliance with this standard the manufacturer shall establish and maintain an effective documented quality system.

Factory production control tests are carried out following manufacture to monitor the quality of product (see Table 3).

Sampling and testing of any batch shall be completed prior to removal from the works and shall be in accordance with ISO 2859-1 at an AQL of 10 % and inspection level S2. Isolated batches of units shall be assessed in accordance with tightened inspection procedures, with a maximum batch size of 1200 (see Annex B).

Batches rejected under the sampling procedure specified in 16.2 may be resubmitted once, after removal of units with previously undetected visible defects, under the tightened inspection procedures, in respect only of the defect that caused initial rejection.

NOTE A quality system assessed by a certification body which complies with the requirements of EN 45012 can be applied to ensure that the requirements of EN ISO 9001 and Clause 16 are complied with.

14 Test methods

14.1 Internal transverse dimensions

For square and rectangular outer walls the maximum and minimum width/breadth shall be those calculated from the tolerances given in 5.1.

For circular section outer walls, whether the maximum and minimum diameters shall be those calculated from the tolerances given in 5.1 or the test also may be carried out using two gauges whose diameters are set at the minimum and maximum diameters. The minimum gauge shall be able to be turned through 360° within the ends of the flue. The maximum gauge shall not be able to enter the flue when tested through a rotation of 360°.

Both ends of the outer walls shall be measured.

14.2 Height

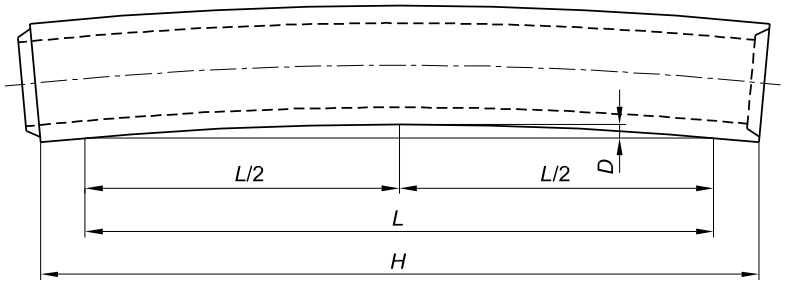
The maximum and minimum internal heights of a clay/ceramic outer wall shall be those calculated from the tolerances given in 5.2. If direct measurement is to be carried out, take two measurements at the maximum and minimum heights.

The test may also be carried out by using two gauges whose heights are set at the minimum and maximum internal heights. The minimum gauges shall not be able to fit over the internal height of the outer wall. The maximum gauge shall be able to fit over the internal height of the outer wall.

14.3 Straightness

The deviation from straightness of an outer wall is the maximum distance from the centre of a straight line equal to the test length spanning any concave curve on the outside of the outer wall to the outer wall surface (D) as shown in Figure 3. It is permissible to test for straightness using any suitable apparatus.

The test length shall be 50 mm less than the nominal height of the outer wall to allow for clearance at the shoulder of any socket.



Key

H is the nominal height of the outer wall in millimetres

L is the test length in millimetres

D is the deviation from straightness, in millimetres

H-*L* = 50 mm

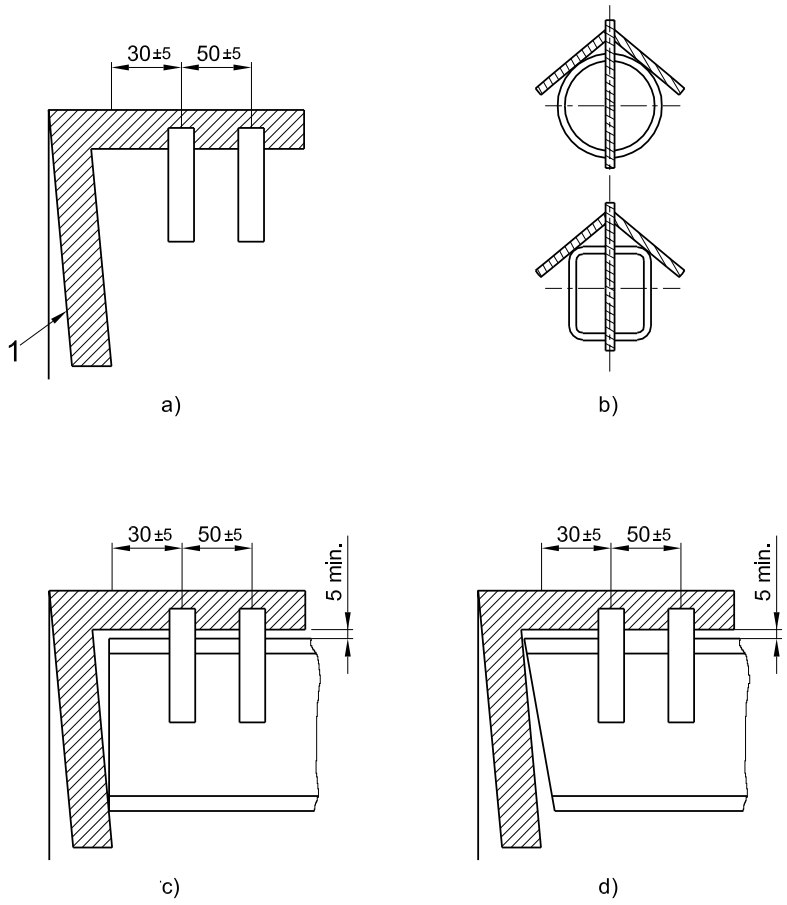
Figure 3 — Terms for deviation from straightness

14.4 Squareness of ends

14.4.1 Gauge test

The test gauge as shown in Figure 4 with one arm set at a slope of 30 mm/m to the other shall be provided with two pairs of supports at (50 ± 5) mm centres. The end support shall be positioned so that there is a recess of (30 ± 5) mm from the inside of the angled arm. The slope of the supports shall be such as to provide a clearance of at least 5 mm under the test gauge. The angled arm shall be of such a length as to span the outside diameter/width of the outer wall.

The gauge shall be placed on the end of the outer wall, at the line of the longest external measurement of the outer wall. The slope of the end shall be checked against that of the gauge.



Key

1 30 mm/m slope
a longitudinal section of gauge
b cross-section of gauge
c outer wall passing test
d outer wall failing test

Figure 4 — Squareness test for ends, gauge test

14.4.2 Direct measurement test

The outer wall shall be placed upright on the flat plate.

A set square shall be applied on the outside of the outer wall, at the inferior extremity (see Figure 5).

The horizontal distance (d) shall be measured at an accuracy of ± 0,5 mm.

The slope is given by the formula:

$$\text{slope} = 1000\ d/H \text{ (mm/m)} \quad (2)$$

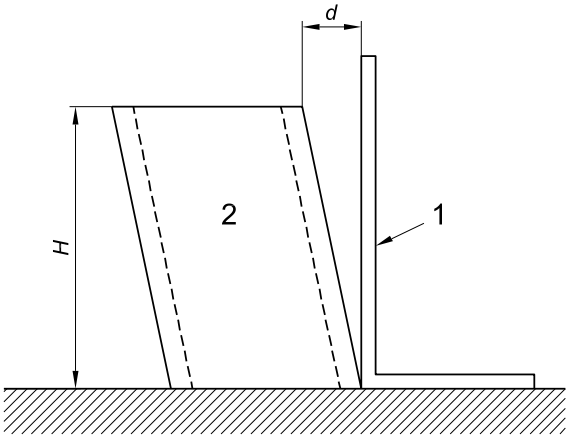
Where:

d: is the horizontal distance in millimetres.

H: is the height of the outer wall in millimetres.

Repeat the measurement with the outer wall on the other side.

NOTE The joint section does not have to be taken into account.



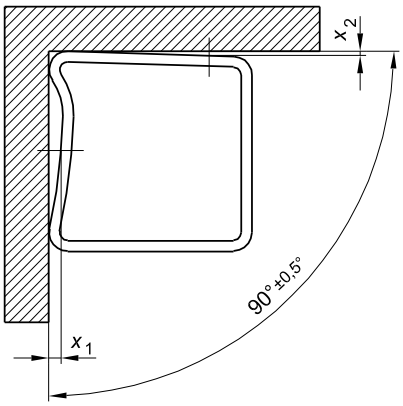
Key

1 Set square
2 Outer wall element
d horizontal distance in mm
H height of the outer wall in mm

Figure 5 — Squareness test for ends, direct measurement

14.5 Squareness of corners and flatness of walls

The test gauge shall be as shown in Figure 6 with one arm set at an angle of (90 ± 0,5)° to the other and both arms of the test gauge of such a length as to span the outside width of the outer wall under test.



Key

x_1 deviation from flatness of the wall, in millimetres.

x_2 deviation from squareness of the wall, in millimetres.

Figure 6 — Squareness test for angles and flatness of walls

The gauge shall be placed against two adjoining walls of square or rectangular straight outer walls and the distances x_1 and x_2 measured between the inner edge of the test gauge and the outside of the outer wall, excluding the rounded external corners, to an accuracy of ± 0,5 mm.

The percentage deviation from flatness shall be calculated as:

$$\frac{100.x_1}{L_{x1}} \tag{3}$$

The percentage deviation from squareness shall be calculated as:

$$\frac{100.x_2}{L_{x2}} \tag{4}$$

Where:

L_{x1} is the manufacturer's stated nominal internal length of the wall against which x_1 is measured, in mm.

L_{x2} is the manufacturer's stated nominal internal length of the wall against which x_2 is measured, in mm.

14.6 Compressive strength

14.6.1 Test sample

The test specimen shall be cut from an outer wall and shall not include any part of a joint. The test specimen shall not be less than 150 mm high with flat and parallel ends on the full cross section of the outer wall.

14.6.2 Testing equipment

The testing machine shall be substantial and rigid throughout so that the distribution of load will not be affected appreciably by the deformation or yielding of any part. The machine shall be capable of applying the load at the rate specified in 14.6.3 and its accuracy shall be verified by the means detailed in EN ISO 7500-1.

The bearing faces of both the thrust packers and the thrust plates shall be larger than the outside dimensions of the outer wall under test.

The thrust plates shall consist of metal, free from warping or twisting and be centrally located and of sufficient dimensions so as not to distort under load. One thrust plate shall be free to tilt in any direction so that it may align with the surface of its associated thrust packer.

The thrust packers shall consist of (18 ± 2) mm thick moisture resistant flooring grade chipboard according to EN 312 which shall be flat pressed with the surface as pressed and be concentric with the thrust plates. New thrust packers shall be used for each test.

The test specimen shall be placed in the machine so that the load is applied trough its longitudinal axis.

14.6.3 Procedure

Ensure that the bearing surfaces of the machine and test specimen are clean and free from any loose particles.

Place the test specimen, together with a thrust packer at each end, between the thrust plates. Place the test specimen in the machine so that the load is applied through its longitudinal axis.

Apply the load to the test specimen without shock and increase at a maximum rate of 14 MN/m^2 per minute until the required intensity of loading as specified in 7.1 is reached.

The proof load required to produce the specified intensity of loading shall be calculated by one of the following methods, as appropriate to the type of outer wall:

(i) For circular outer walls

$$\text{Proof load (N)} = \frac{10{,}0\pi(D_1^2 - D_2^2)}{4} \quad (5)$$

where

D_1 = mean external diameter of the test piece, in millimetres

D_2 = mean internal diameter of the test piece, in millimetres

(ii) For square outer walls

$$\text{Proof load (N)} = 10{,}0\ (W_1^2 - W_2^2) \quad (6)$$

where

W_1 = mean external width of the test piece (excluding rounded corners), in millimetres

W_2 = mean internal width of the test piece (excluding rounded corners), in millimetres

(iii) For rectangular outer walls

$$\text{Proof load (N)} = 10{,}0\ (L_1 \cdot B_1 - L_2 \cdot B_2) \quad (7)$$

where

L_1 = mean external width of the cross-section of the test piece (excluding rounded corners), in millimetres

B_1 = mean external breadth of the cross section of the test piece (excluding rounded corners), in millimetres

L_2 = mean internal width of the cross section of the test piece (excluding rounded corners), in millimetres

B_2 = mean internal breadth of the cross section of the test piece (excluding rounded corners), in millimetres

(iv) For outer walls with vertical perforations

Proof load (N) = 10,0 A (8)

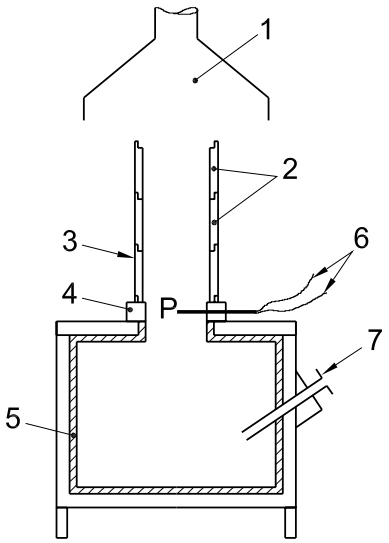
where

A= net cross-sectional area of outer walls in square millimetres (i.e. measured by hydrostatic weighing)

14.7 Thermal performance tests

14.7.1 Test equipment

An example of equipment suitable for heating the flue is shown in Figure 7.



Key

1 Exhaust gas canopy
2 Test flue
3 Outlet
4 Refractory collar
5 Ceramic fibre
6 Thermocouple
7 Gas burner

Figure 7 — Example of hot air generator

The box furnace should be heated by a high-velocity gas burner where combustion is essentially completed within the burner body. The burner should be angled downwards so that the hot gases do not impinge directly onto the exhaust port in the roof of the furnace. The burner should be fired by a gaseous fuel (natural gas, propane or butane). The maximum rated capacity of the burner shall not be less than 150 kW.

An alternative source of heat may be used provided the same heating conditions apply.

In order to obtain the required rate of heating, construct a light-weight furnace, i.e. low thermal mass. Typically, the internal dimensions of the box furnace are 700 mm long x 700 mm deep x 700 mm high and the box is lined with 100 mm of ceramic fibre. The burner shall be placed centrally on one side of the box furnace.

The exhaust port shall be fitted with a (300 ± 50) mm high outlet having the same internal cross-sectional dimensions as that of the test flue. This outlet shall be supported on a collar of cast refractory concrete with an opening of the same shape as the internal cross-section of the flue.

The temperature of the products of combustion shall be measured by a Type K (Nickel-Chromium / Nickel-Aluminium) thermocouple with an unsheathed junction located in the centre of the opening at the base of the flue. The gas and air supply to the burner shall be adjustable and a gauge shall be fitted to measure the volume flow rate of air supplied.

For permeability testing before and after subjecting the flue to a thermal test, a fan or other device capable of producing at least the required differential pressure, a flow meter and a manometer should be used.

The air supply for the test shall be measured by a flow meter with an accuracy of ± 5 % of full scale. The full scale reading shall be approximately the flow rate for the maximum air permeability rate for the appropriate class of flue liner.

14.7.2 Test assembly

14.7.2.1 General

Prior to assembly the test specimens shall be dried to constant mass at a temperature of (110 ± 5)ºC.

Construct a test sample of outer walls, without joint, to give a minimum overall height of 2 m.

If the manufacturer of the outer wall element specifies the type of liner for use with the outer wall element with or without insulation and/or an air gap include them in the test assembly, and construct the assembly in accordance with the manufacturers instructions. If the manufacturer does not specify the form of liner to be used with the outer wall install a single wall stainless steel liner (L316) having a wall thickness of 0,4 mm in the centre of the outer wall elements.

The liner shall have the same cross sectional profile as the opening in the outer wall elements and be positioned so that the gap between the outer wall elements is (25±5) mm. The gap between the liner and outer wall shall be sealed at the top and bottom of the assembly. If the outer wall has more than one passage, test the passage declared by the manufacturer. Passages can be used for ventilation or to contain a flue liner. The passage for which the highest temperature designation is given shall be tested. The remaining passages declared as being flue liner passages shall be sealed at top and bottom. The ventilation passage shall not be sealed.

14.7.2.2 Thermal shock

Install the test sample in a free standing manner.

14.7.3 Procedure

14.7.3.1 General

Deliver completely combusted gas, according to the flow rate in Table 4 into the test sample and raise the temperature of the gas uniformly to the appropriate test temperature (see Table 5) measured at the location determined as described in Figure 8.

Table 4 — Hot gas volume flow rates test temperature and flue diameter

A. Thermal performance – negative pressure chimneys (Volume flow in $m^3/h \pm 10\%$)												
Diameter mm	Test temperature °C											
	100	120	150	170	190	250	300	350	500	550	700	1000
80	42.1	42.9	43.9	45.1	46.3	50.2	53.7	57.2	67.4	68.2	80.6	108
100	65.8	66.9	68.5	70.4	72.3	78.5	83.9	89.3	105	110	126	144
125	102	104	107	110	113	123	132	140	164	172	197	252
150	148	150	154	159	163	177	189	201	237	238	283	360
175	201	205	210	216	221	240	257	274	322	338	386	468
200	263	266	274	282	289	314	337	357	421	439	504	612
B. Thermal performance – positive pressure chimneys (volume flow $m^3/h \pm 10\%$)												
Diameter mm	Test temperature °C											
	100	120	150	170	190	250	300	350	500	550	700	1000
50	22.0	22.8	24.0	25.0	26.0	28.0	30.0	32.0	37.0	38.8	44.1	-
80	64.0	66.0	69.0	72.0	74.0	80.0	85.5	91.0	107	112	126	108
100	105	109	115	119	122	133	142	151	177	185	209	144
125	174	180	189	196	202	220	235	249	292	305	345	252
150	262	271	285	295	304	331	353	375	440	460	520	360
175	370	383	404	417	430	468	500	531	622	651	736	468
200	500	518	545	564	580	632	675	717	840	879	994	612
NOTE: The flow rates are for heat generation from natural gas combustion.												

14.7.3.2 Thermal shock

14.7.3.2.1 Test

The temperature of the gas shall be raised in accordance with Table 5 then maintained for a period of 30 min.

After heating, the test flue shall be allowed to cool to room temperature without forced ventilation and with the thermal insulation retained in position.

Table 5 — Test temperature and time to test temperature

	Test temperature °C	Tolerance on test temperature °C	Time to test temperature from start of heating min
Soot fire resistant outer wall elements	1000	± 50	10
T600	700	± 25	7
T450	550	± 25	5,5
T400	500	± 25	5
T300	350	± 25	3,5
≤T250	250	± 25	2,5

14.7.3.2.2 Measurement of compressive strength

When the flue has cooled, after testing, determine the compressive strength of the last two outer wall elements in accordance with 14.6.1.

14.7.3.2.3 Expression of results

The compressive strength shall be expressed in terms of MN/m².

The test temperature shall be recorded.

Key
A and E Location of the hot gas thermocouple

Figure 8 — Example of test assembly

14.8 Water absorption

14.8.1 Test specimen

The test specimen shall be a test specimen of the outer wall having a dry mass of between 0,25 Kg and 0,4 Kg.

14.8.2 Test equipment

A ventilated oven capable of maintaining a temperature of 110°C ± 5°C.

A balance with an accuracy of ± 0,1 g.

A boiling tank with a capacity to immerse the whole test specimen in water. The tank shall be fitted with a grid on which to support the test specimen to ensure free circulation of water around all surfaces of the test specimen.

A desiccator containing silica gel or a more active desiccant.

14.8.3 Procedure

Dry the test specimen in a ventilated oven at a temperature of (110 ± 5)°C until no loss of mass (± 0,1 g) is noted on successive weightings at 24 h intervals. Determine the mass in grams (W_1) after cooling the test specimen to room temperature in a desiccator containing a desiccant.

Place the dry test specimen in water at ambient temperature. Bring the water to the boil and maintain at boiling point for one hour, immerse all of the test specimen during this period. After the end of boiling, leave the test specimen immersed in the water for a further four hours. Remove the test specimen from the tank, remove surface water by wiping with a damp cloth and weigh the test specimen in grams immediately (W_2).

14.8.4 Expression of results

The water absorption of the test specimen shall be determined as the ratio of the increase in mass of the saturated test specimen to the mass of the dry test specimen. The ratio shall be expressed in percentage terms to the nearest 0,1 %.

$$\frac{W_2 - W_1}{W_1} x100 \quad (9)$$

14.9 Bulk density

14.9.1 Test specimen

A test specimen shall be a test specimen of the outer wall having a dry mass of between 0,25 Kg and 0,4 Kg.

14.9.2 Test equipment

A ventilated oven capable of maintaining a temperature of (110 ± 5)°C.

A balance with an accuracy of ± 0,1 g.

A boiling tank with a capacity to immerse the whole test specimen in water. The tank shall be fitted with a grid on which to support the test specimen to ensure circulation of water around all surfaces of the test specimen.

A bridge to be placed over the load bearing scale pan of the balance.

A container with adequate capacity to freely suspend the whole test specimen submerged in water.

A suspension thread/wire not more than 0,3 mm in diameter.

A desiccator containing silica gel or a more active desiccant.

14.9.3 Procedure

Dry the test specimen to a constant mass in a ventilated oven at a temperature of (110 ± 5)°C (W_1). Determine the mass in grams (W_1) after cooling the test specimen to room temperature in a desiccator containing a desiccant.

Place the dry test specimen in water at ambient temperature.

Bring the water to the boil and maintain at boiling point for one hour, keep all of the test specimen immersed during this period. After the end of boiling, leave the test specimen immersed in the water for a further four hours. Weigh the test specimen freely suspended in water at ambient temperature (20 ± 5)°C (W_2 grams).

Remove the test specimen from the water, remove surface water by wiping with a damp cloth and weigh the test specimen immediately (W_3). The difference in the two weights in grams (W_3-W_2) gives the volume of the test specimen in cm^3.

14.9.4 Expression of results

The dry density of the test specimen shall be determined by dividing the dry mass of the test specimen by the volume (obtained by subtracting the mass of the test specimen when weighed under water from that when weighed in air immediately after immersion). The dry density shall be expressed to the nearest 10 Kg/m^3.

$$\text{Bulk density} = \frac{W_1}{W_3 - W_2} x1000(kg/m^3) \quad (10)$$

15 Designation

The following shall be used for the designation of outer walls:

a) Denomination

b) Standard number

c) Nominal size

d) Temperature class (see Table 6)

Table 6 — Test Temperature

Temperature class	T 80	T 100	T 120	T 140	T 160	T 200	T 250	T 300	T 400	T 450	T 600
Test temperature °C	100	120	150	170	190	250	300	350	500	550	700

e) Thermal resistance *R* in m².K/W

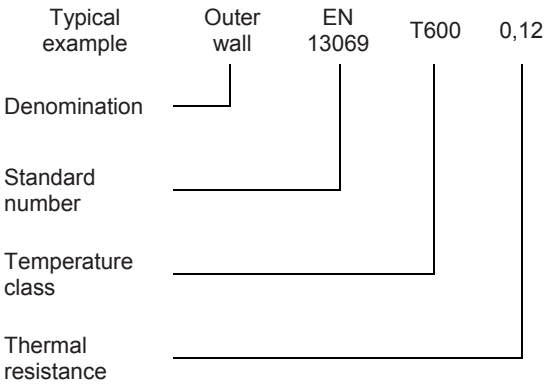


Figure 9 — Example of designation

16 Marking, labelling and packaging

Outer walls or packaging shall be marked with:

— EN 13069 (the number of this standard)

— Manufacturer's identification

— Date of manufacture or batch identification

— Type

NOTE For CE marking refer to annex ZA.

Annex A
(normative)

Thermal resistance

A.1 Method 1 – Simplified calculation

The thermal resistance may be determined approximately in accordance with the following equations if specific material properties and layer thicknesses are known:

a) With knowledge of the thermal resistances of the individual pipe shells

$$R = D_{h\,n}^{\Sigma}\left[R_h \frac{1}{D_{h,n}} \right] \text{ in m²·K/W} \qquad \text{(A.1)}$$

b) With knowledge of the coefficients of thermal conductivity of the layers

$$R = y \cdot \sum_{n} \frac{D_h}{2.\lambda_n} \cdot \ln\left(\frac{D_{h,n+1}}{D_{h,n}} \right) \text{ in m²·K/W} \qquad \text{(A.2)}$$

Where in

R thermal resistance of a pipe shell, referring to its internal surface in $m^2 \cdot K/W$

y coefficient of form

= 1,0 for round and oval cross-sections

= 1,10 for square and rectangular cross-sections up to a ratio of a side of 1:1.5

D_h Internal hydraulic diameter in m

$D_{h,n}$ Hydraulic diameter of the inside of each layer in m

λ_n Coefficient of thermal conductivity of the material of the layer at operating temperature in Watt per metre Kelvin

A.2 Method 2 Thermal resistance of outer walls with or without cavities

A.2.1 General

This clause deals with the calculation of the thermal resistance of a chimney outer wall made of one or several materials using a computer program.

This calculation is based on the transformation of the heat equation in a finite difference equation.

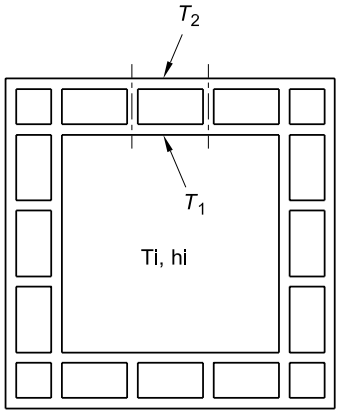
The "finite difference" form is developed for a network in the block where the dimensions are chosen according to each type of outer wall. This network is in two co-ordinated directions (x,y).

A.2.2 Data

A.2.2.1 Thermal properties of the material

Thermal conductivity of the clay in two directions (x, y).

A.2.2.2 Boundary conditions



Key

T_i	internal temperature
h_i	internal heat transfer coefficient
T_1, T_2	internal surface temperature of the cavity

Figure A.1 - Boundary conditions

- internal conditions

$T_i = 250°C$

$h_i = 16{,}67\ W/m^2 \cdot K$

- external conditions

$T_e = 50°C$

$h_e = 9{,}09\ W/m^2 \cdot K$

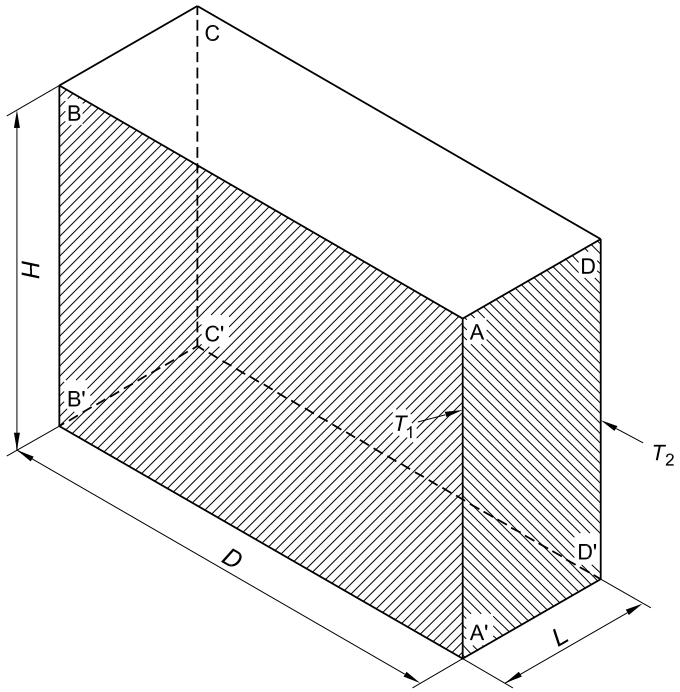
A.2.3 Specific conditions for the cavities

A.2.3.1 General

The cavities are considered like materials with thermal equivalent characteristics. It is considered that the heat flux transmitted by convection-conduction and the heat flux transmitted by radiation are reduced to a conduction problem.

The thermal equivalent conductivity of the cavity is calculated by a specific computer program unconnected with the program of the thermal resistance of the outer wall.

The following notation scheme is used for the cavity:



Key

L width of the cavity in m

H height of the cavity in m

D length of the cavity in m

The views ABB'A' and DCC'D' are respectively at the temperatures T_1 and T_2

The views ADD'A' and BCC'B' are supposed adiabatic.

Figure A.2 - Notation scheme used for the cavity

A.2.3.2 Heat transmitted by conduction-convection in the air

$\Phi c = hc \cdot (H.D) \cdot (T_1 - T_2)$ in W (A.3)

with hc, convection coefficient in $W/m^2 k$

with A = H/L and

$$Gr = \frac{p^2 \cdot g \cdot \beta}{\mu^2} \cdot L^3 \cdot (T_1 - T_2) \quad (A.4)$$

μ = air dynamic viscosity ($kg \cdot m^{-1} \cdot s^{-1}$)

ρ = density $kg \cdot m^{-3}$

$$\beta = \frac{1}{T} \quad (A.5)$$

β = coefficient of thermal volumetric expansion, in k^{-1}

g = 9,81 $m \cdot s^{-2}$

For the air at 170°C, Gr = $2{,}34 \cdot 10^7 \cdot L^3 \cdot (T_1 - T_2)$

hc = λ air/L in conduction only, for the air at 170°C, λ_{air} = 0,0366 W/m K

air = air thermal conductivity, in W/(mK) At the transition,

Gr = $4007 \cdot A^{4/9}$

for Gr > $4007 \cdot A^{4/9}$, we will take

$$hc = \frac{4{,}6 \cdot 10^{-3} \cdot Gr^{1/4}}{L \cdot A^{1/9}} \qquad \text{(A.6)}$$

for *Gr* < $4007 \cdot A^{4/9}$, we will take *hc* = 0,0366 / L

A.2.3.3 Heat transmitted by radiation

Ør = *hr*·(H·D)·(T_1-T_2) in *W*

Ø is the heat flux transmitted by radiation, in *W*

hr is the radiation coefficient in $W/m^2 K$

$$hr = \frac{4 \cdot \sigma \cdot T_m^{\,3}}{2 \cdot \left[\frac{1}{\varepsilon} - \frac{F_{12}}{1 + F_{12}} \right]} \qquad \text{(A.7)}$$

T_m = mean temperature (T_1+T_2)/2, in K

σ = Stefan-Bolzman constant

ε = clay emissivity equal to 0,9

F_{12} is the form factor of the face 1 towards face 2

With the heat flux transmitted in the cavity (Øc and Ør), we may determine a network of equivalent electrical resistances for the cavity. Thus, we may calculate the thermal equivalent resistance of the cavity and its thermal conductivity.

A.2.4 Calculations

A.2.4.1 Mesh

After the mesh of the outer wall is generated, the following parameters for an (x, y) direction are added to the data:

— number of nodes in the "x" direction,

— number of nodes in the "y" direction,

— number of the different materials in the block (clay, insulation or cavity),

— dimensions of the mesh along the "x" direction,

— dimensions of the mesh along the "y" direction,

— air characteristics: temperatures (T_i, T_e) and heat transfer coefficients (*hi,he*),

— materials' characteristics : thermal conductivity.

A.2.4.2 Finite difference equation

The heat flux density received by each network (i,j) is determined according the Forrier's law:

$\Phi = - \lambda_{i,j}$, grad $T_{i,j}$

$T_{i,j}$, : temperature of the node i,j

λ: thermal conductivity of the node i,j

For each internal node and each boundary node, an equation is produced. For whole network a linear system of *n* equations with *n* unknown $T_{i,j}$ is obtained.

Starting from the initial system, all the temperatures are equal:

$T_O = T_{i,j} = (T_i+T_e)/2$

From this condition, the temperatures of the network are calculated by using the method of "Gauss Seidel".

Having calculated the network temperatures, the surface temperatures (T_{si},T_{se}) are determined and then the heat flux density on the internal and external boundaries is obtained:

$\varphi = h_i (T_i-T_{si})$ in W/m^2

$\varphi = h_e (T_{se}-T_e)$ in W/m^2

T_{se} : external surface temperature

T_{si} : internal surface temperature

$R_{th} = (T_i-T_e)/ \varphi$ in $m^2°C/W$

and for the block $R = R_{th} - 1/h_i - 1/h_e$ in $m^2°C/W$

A.3 Approximate thermal resistance values

Table A.1 gives the approximate thermal resistance values for clay/ceramic outer walls.

Table A.1: Thermal resistance of clay/ceramic outer walls

Perforations	Overall wall thickness mm	Insulation	R $m^2 \cdot K/W$
Without	up to 50	without	0,05
With 1 row	up to 30	without	0,08
With 1 row	from 30 to 60	without	0,12
With 2 rows	from 60	without	0,2
With 1 row	from 30 to 60	added	0,85
With 2 rows	from 60	integrated	1,05

Annex B
(normative)

Sampling procedures for an AQL of 10 % and Inspection Level S2

B.1 Acceptability determination

B.1.1 General

Single or double sampling may be used.

B.1.2 Single sampling

If the number of defectives found in the sample is equal to or less than the acceptance number, the batch shall be accepted. If the number of defectives is equal to or greater than the rejection number, the batch shall be rejected.

When reduced inspection is in effect and the acceptance number has been exceeded, but the rejection number has not been reached, the batch shall be accepted and normal inspection reinstated. If the rejection number has been reached or exceeded, the batch shall be rejected and normal inspection reinstated.

B.1.3 Double sampling

The number of sample units shall be equal to the first sample size in the plan. If the number of defectives found in the first sample is equal to or less than the first acceptance number, the batch shall be accepted. If the number of defectives found in the first sample is equal to or greater than the first rejection number, the batch shall be rejected. If the number of defectives found in the first sample is between the first acceptance and rejection numbers, the second sample of the size given in the plan shall be inspected.

The number of defectives found in the first and second samples shall be accumulated. If the cumulative number of defectives is equal to or less than the second acceptance number, the batch shall be accepted. If the cumulative number of defectives is equal to or greater than the second rejection number, the batch shall be rejected. If this occurs on reduced inspection, normal inspection shall be reinstated for the next batch.

When reduced inspection is in effect and, after the second sample, the acceptance number has been exceeded but the rejection number has not yet been reached, the batch shall be accepted and normal inspection reinstated.

B.2 Normal inspection

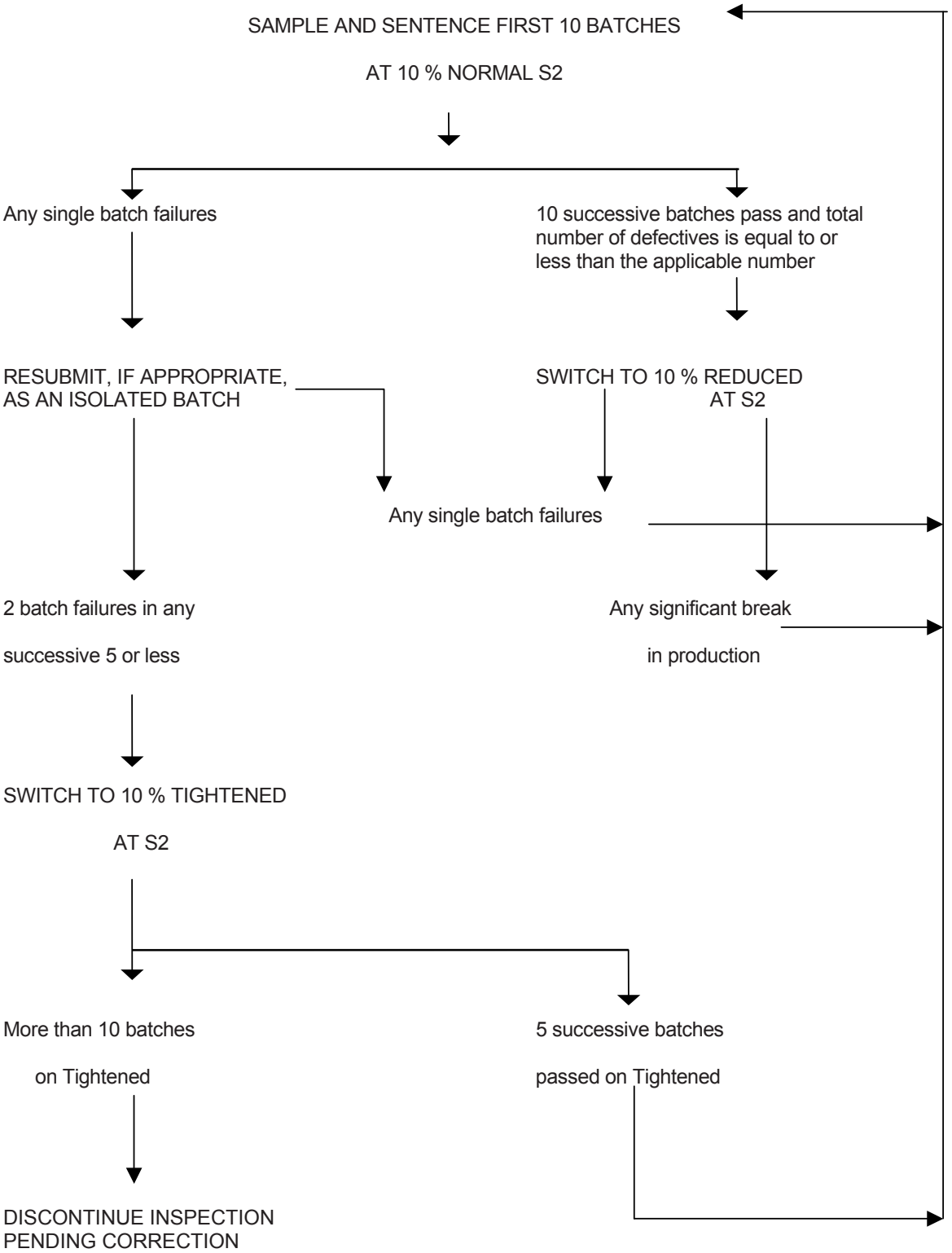
Table B.1- Sampling plans for normal inspection

Batch size	Single sampling			Double sampling					
	Sample size	Accept number	Reject number	First sample size	Accept number	Reject number	Second sample size	Accept number	Reject number
2 to 1200	5	1	2	3	0	2	3	1	2
1201 to 20000	8	2	3	5	0	3	5	3	4

SAMPLING PROCEDURES

Summary of Sampling Procedures

Continuous Batches



B.3 Normal to reduced inspection

A reduced inspection level as shown in Table B.1 shall be used when normal inspection is in effect, provided that the following conditions are satisfied.

a) the preceding ten batches have been on normal inspection, and none have been rejected on original inspection.

b) the total number of defectives in the samples from the ten preceding batches (or such other number required by Table B.1) is equal to or less than the limit number given in Table B.1.

When double sampling is in use, all samples inspected should be included, not first samples only.

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of EU Construction Products Directives

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under the mandate M/105 "Chimneys", as amended, given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European standard shown in this Annex meet the requirements of the Mandate M/105 “Chimneys”, as amended, given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the outer wall element covered by this European standard for their intended use indicated herein; reference shall be made to the information accompanying the CE marking.

WARNING: Other requirements and other EU Directives, not affecting the fitness for intended use, can be applicable to the construction products falling within the scope of this European Standard.

NOTE 1 In addition to any specific clauses relating to dangerous substances contained in this European Standard, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be complied with, when and where they apply.

NOTE 2 An informative database of European and national provisions on dangerous substances is available at the Construction web site on EUROPA (accessed through http://europa.eu.int/comm/enterprise/construction/internal/dangsub/dangmain.htm).

This Annex establishes the conditions for the CE marking of the clay/ceramic outer walls intended for the uses indicated in Table ZA.1 and shows the relevant clauses applicable.

This Annex has the same scope as Clause 1 of this standard and is defined by Table ZA.1.

Table ZA.1 – Scope and relevant clauses

Construction product : Outer wall elements covered in clause 1 of this standard Intended uses: Chimneys as established in clause 1 of this standard			
Performance characteristic	Requirement clauses in this standard	Levels and/or classes	Notes
Resistance to fire	9.1. External to external		
Thermal resistance	10 Thermal resistance	None	Declared value
Thermal shock resistance	8 Thermal shock	None	Declare the test temperature
Compressive strength	6 Compressive strength	None	Pass/fail criteria
Flexural strength	7 Flexural strength under wind loading	None	Declared least lateral dimension in mm
Durability: freeze/thaw	12 Freeze/thaw resistance	None	Pass/fail criteria

The requirement of a certain characteristic is not applicable in those Member States (MSs) where there are no regulatory requirements on that characteristic for intended use of the product. In this case, as placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option “No performance determined” (NPD) in the information accompanying the CE marking (see Clause ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

ZA.2 Procedure of attestation of conformity of clay/ceramic outer walls

ZA.2.1 System of attestation of conformity

The system of attestation of conformity for clay/ceramic outer walls of chimneys indicated in Table ZA.1, in accordance with the decision of the Commission 95/467/EC as amended, as given in Annex III of the mandate M/105 ‘Chimneys’, is shown in Table ZA.2 for the indicated intended use.

Table ZA.2 - Attestation of conformity system

Product	Intended use	Level or class (Reaction to fire)	Attestation of conformity system
Outer walls	Chimneys	Any	2+
System 2+: See CPD Annex III.2.(ii), third possibility			

The evaluation of conformity of the products in Table ZA.1 shall be based on the evaluation of conformity procedure resulting from the clauses of this EN indicated in Table ZA.3.

Table ZA.3 - Assignation of evaluation of conformity tasks

Tasks			Content of the task	Clauses to apply
Tasks for the manufacturer	Factory production control (F.P.C)		Parameters related to all characteristics of Table ZA.1	13.4
	Initial type testing		All characteristics of Table ZA.1	13.1 and 13.2
Tasks under the responsibility of the FPC certification body	Certification of F.P.C on the basis of	Initial inspection of factory and of F.P.C	Parameters related to all characteristics of Table ZA.1	13.4
		Continuous surveillance, assessment and approval of F.P.C	Parameters related to all characteristics of Table ZA.1	13.4

ZA.2.2 EC Certificate and Declaration of conformity

When compliance with this annex is achieved, the manufacturer or his agent established in the EEA, shall prepare and retain a declaration of conformity, which entitles the manufacturer to affix the CE marking.

This declaration shall include:

— name and address of the manufacturer, or his authorised representative established in the EEA, and the place of production;

— description of the product (type, identification, use,), and a copy of the information accompanying the CE marking;

— provisions to which the product conforms (i.e Annex ZA of this EN);

— particular conditions applicable to the use of the product (e.g. provisions for use under certain conditions),

— name and address (or identification number) of the approved laboratory(ies) - name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or his authorised representative.

The above mentioned declaration shall be presented in the official language or languages of the Member State in which the product is to be used.

ZA.3 CE Marking and labelling

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol to affix shall be in accordance with Directive 93/68/EC and shall be shown on the outer wall (or when not possible it may be on the accompanying label, the packaging or on the accompanying commercial documents e.g; a delivery note). The following information shall accompany the CE marking symbol:

— identification number of the certification body;

— name or identifying mark and registered address of the producer;

— the last two digits of the year in which the marking is affixed;

— number of the EC Certificate of conformity or factory production control certificate (if relevant);

— reference to this European Standard

— description of the product: generic name, material, dimensions,….and intended use;

— information on those relevant essential characteristics listed in Table ZA.1 which are to be declared presented as:

  — declared values and, where relevant, level or class (including "pass" for pass/fail requirements, where necessary) to declare for each essential characteristic as indicated in “Notes” in Table ZA.1.

  — “No performance determined” for characteristics where this is relevant;

  — as an alternative, a standard designation which shows some or all of the relevant characteristics (where the designation covers only some characteristics, it will be need to be supplemented with declared values for other characteristics as above.

The “No performance determined” (NPD) option may not be used where the characteristic is subject to a threshold level. Otherwise, the NPD option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

Figure ZA.1 and ZA.2 give example of the information to be given on the product, packaging and/or commercial documents.

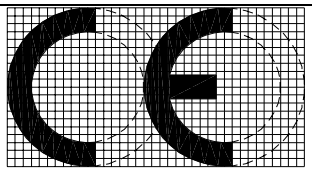
	CE conformity marking consisting of the 'CE' symbol given in directive 93/68/EC
0123-CPD-0001 AnyCo Ltd, P.O.Box 21, B - 1050	Identification number of the notified body Name or identifying mark and registered address of the producer
EN 13069 T600	Number of the European Standard and appropriate designation according to 15

Figure ZA.1 - Example CE marking information affixed on the product

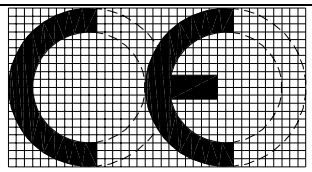
	CE conformity marking consisting of the 'CE' symbol given in directive 93/68/EC
0123-CPD-0001 05	Identification number of the certification body Last two digits of year of affixing of CE marking
AnyCo Ltd, P.O. Box 21, B – 1050 1234	Name or identifying mark and registered address of the producer Number of FPC certificate
EN 13069	Number. of European standard
Clay/ceramic outer wall T600 Compressive strength…….Pass Thermal resistance…….0,12 m²K/W Thermal shock resistance 1000 Resistance to fire EI 120 Flexural strength 300 mm Durability: Freeze/thaw……NPD	Description of product and appropriate designation according to clause 15 Information on mandated characteristics not included in the designation or threshold values to be given (see Table ZA.1)

Figure ZA.2 - Example CE marking information in the accompanying documents

In addition to any specific information relating to dangerous substance shown above, the product should also be accompanied, where and when required and in the appropriate form, by documentation listing any other legislation on dangerous substances for which compliance is claimed, together with any information required by that legislation.

NOTE European legislation without national derogations need not be mentioned.

Bibliography

[1] EN 45012, *General requirements for bodies operating assessment and certification/registration of quality system (ISO/IEC Guide 62:1996)*

[2] EN ISO 9001, *Quality management systems – Requirements (ISO 9001:2000)*

[3] EN 13501-2:2003, *Fire classification of construction products and building element – Part 2: Classification using data from fire resistance tests, excluding ventilation services.*

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