

BS EN 14471:2013+A1:2015



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Chimneys — System chimneys with plastic flue liners — Requirements and test methods

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National foreword

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conduits intérieurs en plastique - Prescriptions et méthodes
d'essai

Abgasanlagen - Systemabgasanlagen mit
Kunststoffinnenrohren - Anforderungen und Prüfungen

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Foreword

This document (EN 14471:2013+A1:2015) has been prepared by Technical Committee CEN/TC 166 "Chimneys", the secretariat of which is held by ASI.

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of an identical text or by endorsement, at the latest by July 2015, and conflicting national standards shall be withdrawn at the latest by October 2016.

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

This document includes Amendment 1 approved by CEN on 2014-11-04.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

This document supersedes A1 EN 14471:2013 A1.

The main modifications compared to EN 14471:2005 are the following:

- the Normative References were updated;
- additions were made in Clause 3 (Terms and definitions);
- Clause 4 was revised;
- the requirements in Clause 5 were completely revised;
- all annexes were revised and some annexes were added.

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(s).

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

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

Introduction

The objective of this European Standard is to evaluate the behaviour of system chimneys with plastic flue liners.

A system chimney with a plastic flue liner may be a single wall chimney (only the plastic flue liner) or may be a double wall chimney or a flue liner with enclosure or with outer wall. The system chimney according to this standard can consist of a plastic liner only (e.g. single wall) or a system with plastic inner liner (e.g. concentric or with outer wall). The system chimney is defined by the manufacturer, whereas the requirements for the installation are defined by the national regulations of the member states.

1 Scope

This European Standard specifies the performance requirements and test methods for system chimneys with plastic flue liners used to convey the products of combustion from appliances to the outside atmosphere under dry and wet conditions. It also specifies the requirements for marking, manufacturer's instructions and evaluation of conformity.

This European Standard describes chimney components from which system chimneys can be assembled.

This European Standard is not applicable to chimneys with sootfire resistance classification class G.

This European Standard is not applicable for chimneys with the following classification:

corrosion resistance class 2 concerning natural wood¹⁾;

corrosion resistance class 3;

pressure class N2.

This European Standard is applicable to chimneys designed so that no condensate accumulation can occur, e.g. with a minimum inclination of 3° to the horizontal.

This European Standard is not applicable

- for system chimneys with plastic coated flue liners;
- to structurally independent (free-standing or self-supporting) chimneys.

Chimneys with components which need further processing during the installation to reach the final material properties are no system chimneys and therefore also not covered by this standard.

This European Standard does not cover the requirements for horizontal terminals (as defined for C1 installation types in CEN/TR 1749) regarding aerodynamic behaviour, rainwater ingress and icing behaviour.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 13216-1:2004, *Chimneys — Test methods for system chimneys — Part 1: General test methods*

EN 13384-1:2002+A2:2008, *Chimneys — Thermal and fluid dynamic calculation methods — Part 1: Chimneys serving one appliance*

EN 13501-1:2007+A1:2009, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests*

EN 13501-2, *Fire classification of construction products and building elements — Part 2: Classification using data from fire resistance tests, excluding ventilation services*

¹⁾ There is no sufficient knowledge on data for flue gas condensate from appliances fired with natural wood.

EN 13823, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item*

EN 14241-1, *Chimneys — Elastomeric seals and elastomeric sealants — Material requirements and test methods - Part 1: Seals in flue liners*

EN 14297, *Chimneys — Freeze-thaw resistance test method for chimney products*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529)*

EN ISO 75-1, *Plastics — Determination of temperature of deflection under load — Part 1: General test method (ISO 75-1)*

EN ISO 178, *Plastics — Determination of flexural properties (ISO 178)*

EN ISO 179-1, *Plastics — Determination of Charpy impact properties — Part 1: Non-instrumented impact test (ISO 179-1)*

EN ISO 306, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST) (ISO 306)*

EN ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles (ISO 527-1)*

EN ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2)*

EN ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics (ISO 1043-1)*

EN ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method (ISO 1133-1)*

EN ISO 1133-2, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 2: Method for materials sensitive to time-temperature history and/or moisture (ISO 1133-2)*

EN ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183-1)*

EN ISO 8256, *Plastics — Determination of tensile-impact strength (ISO 8256)*

EN ISO 9969, *Thermoplastics pipes — Determination of ring stiffness (ISO 9969)*

EN ISO 11925-2, *Reaction to fire tests — Ignitability of products subjected to direct impingement of flame — Part 2: Single-flame source test (ISO 11925-2)*

EN ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization (ISO 11357-3)*

EN ISO 14021, *Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling) (ISO 14021)*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance 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, EN 13216-1:2004 and the following apply.

3.1

characterization

identification (finger print) of the material by determining a combination of properties covering the thermal, mechanical and physicochemical behaviour

3.2

material

material composition of which an individual component is made, being the result of a manufacturing process in which the raw material(s) is transformed by extrusion, moulding, welding, etc. in its intended shape

3.3

material test

test in which specific properties of a material as defined in 3.2 are tested

Note 1 to entry: The material test does not include the effects of the performance of the chimney system resulting in stress etc. on the individual components.

3.4

flue

passage for conveying the products of combustion to the outside atmosphere

3.5

flue gas

gaseous portion of the products of combustion conveyed in a flue

3.6

products of combustion

products resulting from the combustion of fuel (gaseous, liquid and solid constituents)

3.7

flue liner

wall of a chimney consisting of components the surface of which is in contact with products of combustion

[SOURCE: EN 1443:2003, 3.5]

3.8

coated flue liner

flue liner where material is applied to the inner surface of the flue liner to change the surface properties

3.9

chimney

structure consisting of a wall or walls enclosing a flue or flues

3.10

chimney component

any part of a chimney

[SOURCE: EN 1443:2003, 3.7]

3.11

chimney fitting

chimney component conveying products of combustion except a chimney section

3.12

chimney section

straight chimney component conveying products of combustion

3.13

single wall chimney

chimney where the flue liner is the chimney

3.14

multi-wall chimney

chimney consisting of a flue liner and at least one additional wall

3.15

outer wall

external wall of a chimney the surface of which comes in contact with ambient or external environment, or is within cladding or enclosure

3.16

cladding

additional non-structural outer wall around a chimney for protection against heat transfer or weathering, or for decorative purposes

3.17

external installation

part of a chimney which is located outside the building

3.18

internal installation

part of a chimney which is located inside a building

3.19

joint

connection between two components

3.20

support

chimney accessory used to fix (or transfer the load of) chimney components to structural elements (building, mast, etc.)

3.21

connecting flue pipe

component or components connecting the heating appliance outlet and the chimney

3.22

terminal

fitting installed at the outlet of a chimney

3.23

system chimney

chimney that is installed using a combination of compatible chimney components, obtained or specified from one manufacturing source with product responsibility for the whole chimney

3.24

enclosure

barrier that when built around a chimney will give additional safety in case of fire and may provide additional heat transfer resistance

3.25

dry operating condition

condition when a chimney is designed to operate normally with the temperature of the inner surface of the flue liner above the water dew point

3.26

wet operating condition

condition when the chimney is designed to operate normally with the temperature of the inner surface of the flue liner at or below the water dew point

3.27

condensate

liquid products formed when the flue gas is at or below the water dew point

3.28

negative pressure chimney

chimney designed to operate with the pressure inside the flue less than the pressure outside the flue

3.29

positive pressure chimney

chimney designed to operate with the pressure inside the flue greater than the pressure outside the flue

3.30

sootfire

combustion of the flammable residue deposited on the flue liner

3.31

sootfire resistant chimney

chimney that is capable of withstanding a specified thermal shock

3.32

thermal resistance of a chimney

resistance to heat transfer through the wall or walls of the chimney

3.33

reaction to fire

response of a product in contributing by its own decomposition to a fire to which it is exposed, under specified conditions

3.34

resistance to fire of a chimney

ability of the chimney to prevent ignition of adjacent combustible materials and to prevent the spread of fire to adjacent areas

3.35

nominal working temperature

average flue gas temperature obtained during the nominal output test for the maximum temperature level

symbol : T_{nom} in °C

3.36

material test temperature

temperature the material is actually exposed to in the oven during long-term resistance to thermal load

symbol : T_{m} in °C

3.37

performance test temperature

temperature of the medium in the flue liner of a system chimney which is exposed to during the test according to 7.2 to 7.6

symbol : T_f in °C

3.38

free-standing chimney

chimney, externally attached to a building, which meets at least one of the following criteria:

- distance between the lateral supports is greater than 4 m;
- free-standing height above the uppermost structural attachment is greater than 3 m;
- horizontal distance between the building and the outer surface of the chimney is greater than 1 m.

A chimney attached to a free-standing mast is considered as a free-standing chimney.

A chimney can also be considered as free-standing if it is guyed or laterally supported or if it stands on another structure.

[SOURCE: EN 13084-1:2007]

3.39

flexible flue liner

flue liner that is designed to change its shape by elastic deformation to accommodate bends in the route of the flue without significantly changing the cross section

3.40

flow resistance of a terminal

pressure loss in a terminal due to the flow in the flue duct and where appropriate in the air duct gas at a given temperature and velocity

Note 1 to entry: For balanced flue applications there is a pressure loss for the flue and also for the air supply. For non-balanced flue applications there is a pressure loss only for the flue.

3.41

coefficient of flow resistance

ratio between the flow resistance of a terminal and the dynamic pressure of the medium due to a directional and/or cross sectional change in the terminal

3.42

wind velocity pressure

pressure generated on the terminal due to wind

3.43

coefficient of wind velocity pressure

ratio between the pressure generated by wind in the flue duct and where appropriate in the air duct and the dynamic pressure of the wind

Note 1 to entry: For balanced flue applications it is the ratio of the differential pressure generated by wind between the flue duct and the air duct and the dynamic pressure of the wind.

3.44

recirculation factor

ratio between the amounts of flue gas returning from the flue gas outlet to the air supply duct and the air flow in the air supply duct

3.45

wind direction characteristics

range of the angles of wind directions in a vertical plane

3.46

rainwater ingress

water which enters the flue duct or the air duct

3.47

icing behaviour

ice sticking to the terminal caused by condensing flue gas under freezing conditions

3.48

room-sealed appliance

appliance, in which the combustion circuit (air supply, combustion chamber, heat exchanger and evacuation of the products of combustion) is sealed with respect to the room in which the appliance is installed

3.49

balanced flue terminal

terminal where the air entry to the combustion air supply duct is adjacent to the discharge of combustion products from the flue

Note 1 to entry: The inlet and outlet being so positioned that wind effects are substantially balanced.

3.50

test sample

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

4 Classification and designation

4.1 General

The classification system of EN 1443 is followed.

Chimneys shall be classified in accordance with classes of convenience for the following parameters:

- temperature;
- pressure;
- sootfire resistance;
- condensate resistance;
- corrosion resistance;
- thermal resistance;
- distance from combustibles;
- location;
- reaction to fire;
- outer wall.

4.2 Temperature classes

For temperature classes for chimneys, see Table 1.

NOTE Temperature classes up to T600 do not necessarily imply that all of these classes are applicable for system chimneys with plastic flue liners.

Table 1 — Temperature classes

Temperature class	Nominal working temperature in °C	Performance test temperature n ° C
T 080	≤ 80	100
T 100	≤ 100	120
T 120	≤ 120	150
T 140	≤ 140	170
T 160	≤ 160	190
T 200	≤ 200	250
T 250	≤ 250	300
T 300	≤ 300	350
T 400	≤ 400	500
T 450	≤ 450	550
T 600	≤ 600	700

4.3 Pressure classes

Pressure classes in accordance with EN 1443:2003, Table 5 are:

- negative pressure chimneys: N1 and N2; A1 *deleted text* A1

A1 NOTE N2 is excluded in the scope of this standard. A1

- positive pressure chimneys: P1 and P2;
- high positive pressure chimneys: H1 and H2.

4.4 Sootfire resistance classes

Sootfire resistance classes:

- G chimneys with sootfire resistance; A1 *deleted text* A1

A1 NOTE G is excluded in the scope of this standard. A1

- O chimneys without sootfire resistance.

4.5 Condensate resistance classes

Condensate resistance classes:

- W chimneys operating under wet conditions;

— D chimneys operating under dry conditions.

4.6 Corrosion resistance classes

Corrosion resistance classes for chimneys which convey products of combustion from various fuels are given in Table 2.

Table 2 — Corrosion resistance classes

Corrosion resistance class	1 Possible fuel types	2 Possible fuel types	3 Possible fuel types
gas	gas: sulphur-content $\leq 50 \text{ mg/m}^3$, natural gas L + H	gas natural gas L + H	gas natural gas L + H
liquid	kerosene: sulphur-content $\leq 50 \text{ mg/m}^3$	oil: sulphur-content $\leq 0,2 \text{ mass } \%$ kerosene: sulphur-content $\geq 50 \text{ mg/m}^3$	oil: sulphur-content $> 0,2 \text{ mass } \%$ kerosene: sulphur-content $\geq 50 \text{ mg/m}^3$
wood	-	wood in open fire places	wood in open fire places wood in closed stoves
coal	-	-	coal
peat	-	-	peat
NOTE Definition of corrosion resistance class 2 in accordance with EN 1443. In the scope of this European Standard natural wood is excluded, see Clause 1.			

4.7 Thermal resistance

The designation of the thermal resistance is given as Rxx, where xx is the value in $\text{m}^2 \text{ K/W}$ multiplied by 100, rounded to the nearest integer, e.g. R22 is $R = 0,22 \text{ m}^2 \text{ K/W}$.

4.8 Distance to combustible material

The designation of the distance of the outer surface of the chimney to combustible material shall be given as xx, where xx is the value in whole millimetres.

4.9 Location

Classes for location:

- LI internal installation of (components of) chimneys;
- LE both internal and external installation of (components of) chimneys.

4.10 Reaction to fire

Classes for reaction to fire in accordance with EN 13501-1:

- A1 No contribution to a fire / non-combustible;
- A2 No contribution to a fire / non-combustible;

- B Very limited contribution to a fire;
- C Limited – but some – contribution to a fire;
- D Not negligible contribution to a fire;
- E Poor fire reaction properties;
- F No performance criteria.

For further information and additional classifications, see EN 13501-1.

4.11 Outer wall classes

Classes for outer walls:

- U chimney which is designed and tested to be assembled only without outer wall;
- U0 chimney which is designed and tested to be assembled within non-combustible outer wall;
- U1 chimney which is designed and tested to be assembled within combustible outer wall.

4.12 Designation

The designation of a chimney shall consist of:

- the number of the corresponding European Standard;
- temperature class (see Table 1), related to thermal performance and long term resistance to thermal load;
- pressure class; (see 4.3), related to gas tightness;
- condensate resistance class; (see 4.5), related to durability against condensing flue gas;
- corrosion resistance class; (see 4.6), related to durability against condensate;
- sootfire resistance; in this standard only class O (see 4.4);
- distance to combustible material (see 4.8), related to thermal performance;
- location (see 4.9), related to durability against weathering;
- reaction to fire (see 4.10);
- outer walls (see 4.11), related to protection against environmental influences and related to thermal performance.

EXAMPLE EN 14471 - T120 P1 W 1 O50 LI E U0

5 Dimensions and tolerances

The following requirements apply:

- Thickness of the component shall not be less than the minimum thickness declared by the manufacturer.
- The measured internal diameter of the fitting or section shall not be less than the minimum internal diameter declared by the manufacturer.

- External circumference of the fitting or section shall be within $\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$ mm up to 600 mm internal diameter and within $\begin{smallmatrix} +13 \\ -0 \end{smallmatrix}$ mm over 600 mm internal diameter, of that declared by the manufacturer;
- Installed length of a fitting or section (measured on an assembly including at least one joint) shall be within ± 5 mm of the installed length declared by the manufacturer;
- Density of insulation in a fitting or a section shall be within $\begin{smallmatrix} +30 \\ -0 \end{smallmatrix}$ % of that declared by the manufacturer.

Diameters are classified in accordance with Table 3.

Table 3 — Classification of diameters

Size group	Declared internal diameter mm
1	$d \leq 100$
2	$100 < d \leq 160$
3	$160 < d \leq 400$
4	$d > 400$

6 Performance requirements

6.1 General

All components shall be made in such a way that they are appropriate for the intended purpose.

Unless otherwise stated, performance requirements on fittings shall be the same as those for chimney sections.

6.2 Resistance to the combination of mechanical and thermal load

6.2.1 General

The thermal performance of the system chimney shall be performed in accordance with the thermal test of EN 13216-1 and shall also be performed with a second test in accordance with 7.2.

In case of

- nominal working temperature is lower than or equal to 120 °C, or
- nominal working temperature is lower than or equal to 200 °C and the flue liner is ventilated outside (ventilated circular gap between flue liner and outer wall),

the test of 7.2 shall be performed and is sufficient.

For each size group, one size shall be tested. After this test, the requirements of 6.2.2 shall be fulfilled.

The system chimney shall be guided at least at the bottom (support) of the vertical section and at the top (outlet) of the vertical section.

The heating appliance or the adapter of the heating appliance is no support of the system chimney.

6.2.2 Mechanical behaviour and stability

6.2.2.1 Vertical installation

The chimney sections, fittings and other components like supports shall not show any physical damage (e.g. cracks) on visual examination.

For rigid pipes and fittings the change of diameter or length of sections and fittings shall not exceed 2 %, the change of angles (e.g. elbows) shall not exceed 2°.

Flexible flue liners are normally used with length more than 1,5 m and for that reason they can be tested with length more than 1,5 m. For flexible liners which are mounted in segments the joints have to be included in the test.

Flexible flue systems are mostly fixed at the top and at the bottom. In this case the additional weight for the mechanical load has to be mounted in a way that it is possible for the flexible liner to be compressed in the lower area and elongated in the upper area. The additional weight for the mechanical load has to be calculated according to the difference of the maximum height declared by the manufacturer and the real installed height of the test chimney.

The requirement of the change in length (maximum 2 %) according to the text in the standard is for sections up to 1,5 m. In the upper part flexible pipes elongate and in the lower part they got compressed if the liner is fixed at the bottom. According to the standard the requirement of length change not more than 2 % is equal for both, elongation and compressing.

The change in length of flexible liners is affected by the way of installation. Especially the duct is important.

E.g.: If the flexible liner is mounted inside an enclosure or with outer wall which is not much wider than the flexible liner, the test results could be different from the test inside a bigger enclosure or outer wall. The reason is the offsetting of the flexible liner in a bigger enclosure or outer wall, and thus the reaction forces of compressing and elongation cannot interact.

The requirement of the limit of the change in length for the compressed and elongated segments can be substituted by reference to the whole length of the test chimney if the offsetting of the flexible liner is prevented by mounting it inside an enclosure or outer wall with an inner diameter not more than 2x outer diameter of the flexible liner according to the manufacturer declaration also for the test. If the manufacturer declares a bigger enclosure or outer wall, the type test has to consider the declared diameters. The possibility of offsetting also has to be checked.

6.2.2.2 Non-vertical installation with supports not more than 1,5 m apart

The chimney sections, fittings and other components like supports shall not show any physical damage (e.g. cracks) on visual examination.

The change of diameter or length of sections and fittings shall not exceed 2 %, the change of angles (e.g. elbows) shall not exceed 2°.

The vertical deviation from the original position of the segment shall not be more than 2 mm per metre between supports.

These requirements are fulfilled without test if every section is supported separately.

6.2.2.3 Non-vertical installation with supports more than 1,5 m apart

The chimney sections, fittings and other components like supports shall not show any physical damage (e.g. cracks) on visual examination.

The change of diameter or length of sections and fittings shall not exceed 2 %, the change of angles (e.g. elbows) shall not exceed 2°.

The inclination to the horizontal of the segment shall always be greater than 3° at any point between the supports and shall not have changed by more than 5°.

These requirements are fulfilled without test if every section is supported separately.

6.3 Components subject to wind load

When tested in accordance with 7.3, chimney components designated suitable for external installation with a length of the external unsupported part more than 10 times the diameter or more than 1 m, shall not show any physical damage on visual examination.

6.4 Fire resistance

The sootfire resistance for all plastic system chimney products shall be declared zero.

For the fire resistance from external to external the performance criteria of integrity and insulation shall be declared in accordance with EN 13501-2 in relation to the outer wall. For single wall system chimney products the fire resistance from external to external shall be declared zero.

6.5 Hygiene, health and environment

6.5.1 Gas tightness

The leakage rate, determined in accordance with 7.5.1, shall not be greater than that given in Table 4.

Table 4 — Leakage rate

Class	Leakage rate $l \cdot s^{-1} \cdot m^{-2}$	Test pressure Pa
N 1	2,0	40 for negative pressure chimneys
N 2	3,0	20 for negative pressure chimneys
P 1	0,006	200 for positive pressure chimneys
P 2	0,120	200 for positive pressure chimneys
H 1	0,006	5 000 for high positive pressure chimneys
H 2	0,120	5 000 for high positive pressure chimneys

6.5.2 Recycling

All products shall be marked in accordance with EN ISO 14021. The abbreviations of EN ISO 1043-1 shall be used.

6.6 Safety in use

6.6.1 Thermal performance

6.6.1.1 General

The appropriate test as defined in 6.2.1 shall be performed. After this test the requirements of 6.6.1.2 and 6.6.1.3 shall be fulfilled. The requirements of 6.6.1.4 shall be fulfilled also.

6.6.1.2 Accidental human contact

Where the system chimney is not protected from human contact, the temperature of the outer wall of the test assembly shall not be greater than 93 °C, when tested in accordance with 7.6.1.2.

If the temperature is higher than 93 °C, the manufacturer shall declare how to prevent accidental human contact.

6.6.1.3 Adjacent combustible materials

When tested in accordance with 7.6.1.2, the maximum surface temperature of combustible materials adjacent to the test chimney shall not be greater than 85 °C.

In case of:

- chimneys of temperature classes lower than or equal to T120; or
- chimneys of temperature classes lower than or equal to T200 and outside ventilation of the flue liner (ventilated circular gap between flue liner and outer wall/enclosure),

this requirement is fulfilled when the outer surface temperature of the system chimney is not higher than 85 °C.

6.6.1.4 Gas tightness

Before and after the test, the requirements of 6.5.1 shall be fulfilled.

6.6.2 Thermal resistance

If the thermal resistance is not declared to be zero, the thermal resistance value of the chimney section declared by the manufacturer shall be verified in accordance with 7.6.2.

6.6.3 Resistance against condensate

To proof the resistance against condensate the tightness against moisture and condensate has to be evaluated.

- Positive pressure chimneys (class P1 and H1) deemed to be sufficient tight against moisture and condensate without further tests.
- For single wall chimneys with negative pressure (N1) or positive pressure (P2 and H2) no condensate shall appear at the outer surface of sections or fittings including joints during the test in accordance with 7.6.3.
- For insulated double wall chimneys with negative pressure (N1) or positive pressure (P2 and H2) the mass increase of the insulation of sections or fittings shall not exceed 1,0 % during the test in accordance with 7.6.3.

6.6.4 Rainwater penetration resistance for insulated chimneys for external installation

For insulated double wall chimneys designated for external installation the mass increase of the insulation of sections or fittings shall not exceed 1,0 % during the test in accordance with 7.6.4.

6.6.5 Flow resistance

The manufacturer shall declare the flow resistance values for all components except terminals in accordance with 7.6.5. For requirements for terminals, see 6.6.6.

6.6.6 Terminals

6.6.6.1 Characteristics of a terminal

The manufacturer shall characterize the terminal by the type and the wind direction as described in Annex G.

6.6.6.2 Performance requirements

The terminal shall meet the requirements for the declared type of terminal as given in Annex G.

6.7 Materials, durability

6.7.1 General

The material shall be resistant against the mechanical, chemical and thermal attack.

The effects of combustion products and condensate as well as the effects of impact strength, sunlight (especially UV radiation) and low temperatures shall also be taken into account.

6.7.2 Characterization

The material shall be identified by the thermal, mechanical and physicochemical behaviour.

The characterization shall include the density and at least 5 more properties. At least one property has to be taken of each of the three groups of methods in Annex A.

The characterization methods shall be chosen in such a way that the characterization includes the relevant properties of the material. Examples are given in Annex B.

The material shall be characterized as described in 7.7.2. Tolerances for material properties are given in Table 5.

Table 5 — Criteria for characterization

Property	Value
impact strength	+ 20 %
yield stress	+ 20 %
density	$\pm 0,05 \text{ g/cm}^3$
melting temperature	$\pm 5 \text{ K}$
melting enthalpy	$\pm 20 \%$
ring stiffness	$\pm 20 \%$

6.7.3 Long-term resistance to thermal load

The material shall be capable of withstanding exposure to the nominal working temperature as described in 7.7.3.

The tensile modulus and the yield stress shall be measured in all cases of rigid pipes and fittings.

In case of thermosetting plastics the flexural modulus and flexural strength shall also be determined.

In case of flexible tubes the ring stiffness shall be determined.

Other relevant properties like the density or the impact strength shall be measured before and after the period of exposure, if they are relevant to evaluate the deterioration of the material.

The properties shall be determined in accordance with the methods as listed in Annex C.

The properties shall not change more than the values as listed in Table 6.

Table 6 — Criteria for testing long-term resistance to thermal load

Property	Value
impact strength	$\leq 50 \%$
tensile modulus	$\leq 50 \%$
yield stress	$\leq 50 \%$
density	$\leq 2 \%$
flexural modulus	$\leq 50 \%$
flexural strength	$\leq 50 \%$
ring stiffness	$\leq 50 \%$
NOTE If these values are not met, it is allowed to take new reference values obtained after 24 h exposure in air at nominal working temperature (conditioning) to release processing pressures/effects. These effects are covered by the requirements for the mechanical stability of chimneys in accordance with 6.2 and 6.3.	

6.7.4 Long-term resistance to condensate exposure

The material shall be capable of withstanding exposure to condensate as described in 7.7.4.

The tensile modulus and the yield stress shall be measured in all cases of rigid pipes and fittings.

In case of thermosetting plastics the flexural modulus and flexural strength shall also be determined.

In case of flexible tubes the ring stiffness shall be determined.

Other relevant properties like the density or the impact strength shall be measured before and after the period of exposure, if they are relevant to evaluate the deterioration of the material.

The properties shall be determined in accordance with the methods as listed in Annex C.

The properties shall not change more than the values as listed in Table 7.

Table 7 — Criteria for long-term resistance to condensate exposure

Property	Value
impact strength	$\leq 50 \%$
tensile modulus	$\leq 50 \%$
yield stress	$\leq 50 \%$
density	$\leq 2 \%$
flexural modulus	$\leq 50 \%$
flexural strength	$\leq 50 \%$
ring stiffness	$\leq 50 \%$
NOTE If these values are not met, it is allowed to take new reference values obtained after 24 h exposure in air at nominal working temperature (conditioning) to release processing pressures/effects. These effects are covered by the requirements for the mechanical stability of chimneys in accordance with 6.2 and 6.3.	

6.7.5 Resistance to wet/dry cycling

After exposure in accordance with 7.7.5 the flue liner is disassembled and visual examined. It shall not show damages like cracks and pinholes.

The dimensions of the sections and fittings shall not change more than 2 %. The maximum deviations of the dimensions may not exceed the required values given in 6.2.2.

The tensile modulus and the yield stress shall be measured for rigid pipes and fittings in all cases.

In case of thermosetting plastics the flexural modulus and flexural strength shall also be determined.

In case of flexible tubes the ring stiffness shall be determined.

Other relevant properties like the density or the impact strength shall be measured additional before and after the period of exposure, if they are relevant to evaluate the deterioration of the material.

The properties shall be determined in accordance with the methods as listed in Annex C.

The properties shall not change more than the values as listed in Table 8.

Table 8 — Criteria for testing resistance to wet/dry cycling

property	Value
impact strength	$\leq 30 \%$
tensile modulus	$\leq 30 \%$
yield stress	$\leq 30 \%$
density	$\leq 2 \%$
flexural modulus	$\leq 30 \%$
flexural strength	$\leq 30 \%$
ring stiffness	$\leq 30 \%$
NOTE If these values are not met, it is allowed to take new reference values obtained after 24 h exposure in air at nominal working temperature (conditioning) to release processing pressure/effects.	

6.7.6 Resistance against weathering

The material of the components for conveying flue gas or combustion air intake that is exposed to UV and is made of plastic (e.g. outside installation, where location class conforms to 4.9 or terminals), shall be tested in accordance with 7.7.6.

After the exposure test the following requirements shall be met:

- Tensile-impact strength, as mentioned in Annex C, shall not change more than +100 % or -50 % (based on new material, where the tensile-impact strength was measured without exposure); all measured values after exposure have to be done after the exposure times of: 500 h, 1 000 h, 2 000 h and 4 000 h.
- In case of thermosetting plastics the flexural modulus and flexural strength, as mentioned in Annex C, shall not change more than 50 % (based on new material, where the tensile-impact strength was measured without exposure); all measured values after exposure have to be done after the exposure times of: 500 h, 1 000 h, 2 000 h and 4 000 h.

The exposure shall be done from the same side to the test pieces like the test pieces are planned to get in contact with weathering.

6.7.7 Geometrical stability

After exposure in accordance with 7.7.7, the change in internal diameter/length of the pipe shall not exceed 2 %.

For each size group of diameters one size shall be tested.

6.7.8 Reaction to fire

The manufacturer shall declare the class of reaction to fire as defined in 4.10 and test it in accordance with 7.7.8.

6.7.9 Freeze-thaw resistance

System chimney components made of plastic without fibre stabilization are considered to satisfy the requirement on freeze-thaw resistance. Others have to meet the requirements of 7.7.9.

6.7.10 Seals and sealants

Seals shall comply with the requirements and test methods defined in 7.7.10.

If sealants are used they shall comply following the requirements and test methods as defined in 7.7.10.

7 Test methods

7.1 General

Unless otherwise stated, a test chimney shall be installed in accordance with the manufacturer's installation instructions.

Unless otherwise stated, the accuracy of measurements shall be established to ensure that maximum or minimum specifications are not exceeded.

7.2 Resistance to the combination of mechanical and thermal load

7.2.1 Test sample

The test configuration as shown in Figure 1 shall be used.

The test chimney includes all relevant components, e.g. sections, fittings, fasteners, space holders, supports and terminals. The height of the chimney from the inlet of the flue gas to the terminal shall be equal to or higher than 4,5 m.

The vertical segment of the test chimney:

- shall comprise sections with a length no longer than 1,5 m each;
- shall be loaded with an extra weight corresponding to the weight of a chimney with the maximum height, as declared by the manufacturer. In case the vertical segment is supported at the top, the mechanical load shall be upended on the bottom of the vertical segment. In case the vertical segment is supported at the bottom, the mechanical load shall be put on top of the vertical segment;
- shall be installed without outer wall, only when the manufacturer declares suitability for installation without outer wall or without non-ventilated enclosure;
- shall be installed with outer wall with a thermal resistance of about 0,07 m²K/W (for example concrete elements with a wall thickness of 0,05 m), unless the manufacturer declares suitability for installation with a non-ventilated enclosure; or
- shall be installed with outer wall with the maximum thermal resistance declared by the manufacturer, when the manufacturer declares suitability for installation with a non-ventilated outer wall.

If the system chimney is tested with outer wall, the test is valid for test without outer wall as well.

The installation with a non-ventilated outer wall covers also the installation with a ventilated outer wall. The non-vertical segment of the test chimney:

- shall be an assembly of all components to be tested, like fittings for inspection, measurement of temperature or flue gas composition, condensate drain, variable length, variable elbow, etc;

- shall not have a total length greater than 2 m²⁾. If the assembly of all fittings to be tested would result in a non-vertical segment with a length of more than 2 m, the fittings shall be tested in two or more test series;
- is connected to the vertical segment preferably by an elbow.

For vertical installation and for non-vertical installation with supports not more than 1,5 m apart, the distance between supports shall meet the maximum value in accordance with the manufacturer's declaration.

For non-vertical installation with supports more than 1,5 m apart the test chimney shall:

- be assembled consisting of at least 2 sections with a joint in the middle between the supports;
- be built in such a way that the maximum angle to the vertical in accordance with the manufacturer's declaration is reached;
- be chosen so that the diameter meets the lowest inertia of the cross section (function of diameter and wall thickness); and
- be assembled so that it is quite straight before load.

In the case of testing flexible liners with a length more than 1,5 m the weight for the mechanical load may be mounted as a single weight in the middle of the test length of the flexible liner. It may also be split into single weights and to be mounted evenly distributed to the whole length of the test chimney. The vertical section of the test chimney shall have a minimum length of 4,5 m. It is permissible to extend this length for the test.

²⁾ The restriction in length of the non-vertical part is to minimize heat loss during testing.