SLOVENSKI STANDARD
SIST EN 13084-1:2001

01-junij-2001

Free-standing industrial chimneys - Part 1: General requirements

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Freistehende Schornsteine - Teil 1: Allgemeine Anforderungen

Cheminées auto-portantes - Partie 1: Exigences générales

Ta slovenski standard je istoveten z: **EN 13084-1:2000**

ICS:

91.060.40 Dimniki, jaški, kanali Chimneys, shafts, ducts

SIST EN 13084-1:2001 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13084-1

August 2000

ICS 91.060.40

English version

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13084-1:2000 E

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC297 "Free-standing industrial chimneys", the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by February 2001, and conflicting national standards shall be withdrawn at the latest by February 2001.

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

Annex A is normative. Annex B is informative.

1 Scope

This European Standard deals with the general requirements and the basic performance criteria for the design and construction of all types of free-standing chimneys including their liners. A chimney may also be considered as free-standing, if it is guyed or laterally supported or if it stands on another structure.

Chimneys externally attached to buildings are to be considered as free-standing chimneys in accordance with this European Standard when at least one of the following criteria is met:

– the distance between the lateral supports is greater than 4 m;

– the free-standing height above the uppermost structural attachment is greater than 3 m;

– the horizontal distance between the building and the outer surface of the chimney is greater than 1 m

Chimneys attached to free-standing masts are considered as free-standing chimneys.

The structural design of free-standing chimneys takes into account operational conditions and other actions to verify mechanical resistance and stability and safety in use. Detailed requirements relating to specialized designs are given in the standards for concrete chimneys, steel chimneys and liners.

NOTE In other parts of the series EN 13084 rules will be given where chimney products in accordance with EN 1443 (and the relating product standards) may be used in free-standing chimneys.

2 Normative references

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

EN 287-1
Approval testing of welders - Fusion welding - Part 1: Steels

EN 288-1
Specification and approval of welding procedures for metallic materials - Part 1: General rules for fusion welding

EN 719
Welding coordination - Tasks and responsibilities

EN 729-2
Quality requirements for welding - Fusion welding of metallic materials - Part 2: Comprehensive quality requirements

EN 1443
Chimneys - General requirements

prEN 13084-2:1998
Free-standing industrial chimneys[1] – Concrete chimneys

prEN 13084-4:1998
Free-standing industrial chimneys[1] – Brick liners - Design and execution

prEN 13084-5:1998
Free-standing industrial chimneys[1] - Materials for brick liners - Product specifications

prEN 13084-6:1999
Free-standing industrial chimneys[1] - Steel liners - Design and execution

prEN 13384-1:1998
Chimneys - Thermal and fluid dynamic calculation methods - Part 1: Chimneys serving one appliance

ENV 1991-1
Eurocode 1 - Basis of design and actions on structures – Part 1: Basis of design

ENV 1991-2-1
Eurocode 1: Basis of design and actions on structures – Part 2-1: Actions on structures - Densities, self-weight and imposed loads

ENV 1991-2-4
Eurocode 1: Basis of design and actions on structures – Part 2-4: Actions on structures - Wind actions

ENV 1993-3-2
Eurocode 3: Design of steel structures – Part 3-2: Towers, masts and chimneys – Chimneys

ENV 1998-3
Eurocode 8: Design provisions for earthquake resistance of structures – Part 3: Towers, masts and chimneys

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 Windshield: Structural element designed to protect the flue from wind actions. It may also function as a flue.

3.2 Lining system: Total system, if any, which separates the flue gases from the windshield. This comprises a liner and its supports, the space between liner and windshield and insulation, where existing.

3.3 Liner: Structural membrane of the lining system.

3.4 Accessible space: Space between windshield and liner that is designed for entry by personnel.

3.5 Spoiler: Device attached to the surface of a chimney with the objective of reducing cross wind response.

3.6 Chimney cap: Protective cap at the top of the chimney which covers the top of the chimney.

3.7 Climbing sockets: Threaded sockets inserted in the concrete windshield to enable climbing dogs to be attached to the surface.

[1]) The future main title of the series EN 13084 will be "Free-standing chimneys".

3.8 Down draught: Negative pressure on the lee-side of the chimney top, which affects the flue gases to be drawn down.

3.9 Guyed chimney: Chimney, the stability of which is ensured by guy ropes.

3.10 Intransient heat flow: Flow of heat, where the temperature of each point does not change with time.

3.11 Transient heat flow: Flow of heat, where the temperature changes with time.

3.12 Positive pressure: Exists, if the pressure inside the liner is greater than the pressure outside the liner.

3.13 Negative pressure: Exists, if the pressure inside the liner is lower than the pressure outside the liner.

3.14 Flue gas: Gaseous products of combustion or other processes, including air, which may comprise of solids or liquids.

3.16 Steel chimney: Chimney the windshield of which is made of steel.

4 Performance requirements: General design

4.1 Materials

Materials shall conform to the appropriate CEN or ISO standards. Where none of these standards do exist, other materials may be used if their properties are well defined and their suitability has been proven. This proof shall take account of the mechanical, thermal and chemical loads as well as the radiation.

For concrete and steel chimneys as well as for liners see prEN 13084-2:1998, prEN 13084-4:1998, EN 13084-5:1998, prEN 13084-6:1999 or ENV 1993-3-2 respectively.

4.2 Flue gas considerations

4.2.1 General

Thermal and flow calculations shall be carried out to ensure that the flue gases will be conveyed from the combustion appliance to atmosphere taking into account the effects of the flue gases on the environment and the safety in use. However, the effect of the flue gases concerning the pollution with gaseous and particle components is not the subject matter of this standard.

To carry out these calculations, design parameters as stated in clause 4.2.2 are required. This also applies to the assessment of chemical attack on those structural elements which are in contact with flue gases.

4.2.2 Design parameters

The following design parameters shall take into account the various operating conditions during normal and defined abnormal operations:

a) nature of chimney operation, whether continuous, intermittent or occasional;

b) planned frequency of shut-downs for internal inspection and maintenance;

c) composition of the flue gases and concentrations of chemicals in the flue gases deleterious for the chimney;

d) concentration of dust and particularly of abrasive dust in the flue gas;

e) mass flow of each flue gas stream;

f) flue gas temperature at entry of each flue gas duct into chimney;

g) range of maximum acid dew point temperatures of the flue gases;

h) admissible or required pressure at entry of flue gas ducts into chimney;

i) altitude of the site and any special local topographic features (nearby hills, cliffs etc.);

j) maximum, average and minimum outside temperature;

k) maximum, average and minimum atmospheric pressure;

l) maximum, average and minimum humidity of the ambient air;

m) relevant design parameters used for appliances (for example boiler) to which the chimney is connected.

4.2.3 Heat flow calculations

Temperatures in the flue gas carrying tube, in thermal insulating layers and in the windshield shall be determined. The drop in the temperature of the flue gases as they pass up to the outlet shall be calculated.

Values for thermal conductivity and the heat transfer coefficient may be taken from table 1 and table 2 respectively Values for materials not included in these tables or values differing from these, may be taken if their source is referenced.

Table 1 - Thermal conductivity for building materials

Material	Description	Bulk density ρ kg/m³	Temperature T ° C	Thermal conductivity λ W/(m·K)
Concrete		2400		2,1
Lightweight concrete		1000 1200 1400 1600 1800 2000		0,47 0,59 0,72 0,87 0,99 1,20
Brickwork		1800 2000 2200		0,81 0,96 1,00
Acid resistant brickwork				1,2
Brickwork of diatomaceous clay		800 800 800 500 500 500	200 400 600 200 400 600	0,18 0,19 0,21 0,09 0,10 0,11
Cellular glass		130	20 200 300	0,05 0,09 0,12
Mineral wool resistant up to 750 °C		90	50 100 150 200 250 300 400 500 600	0,038 0,045 0,053 0,064 0,076 0,090 0,122 0,168 0,230
		125	50 100 150 200 250 300 400 500 600	0,039 0,046 0,053 0,061 0,070 0,080 0,105 0,140 0,180

continued

Table 1 (concluded)

Material	Description	Bulk density ρ kg/m³	Temperature T °C	Thermal conductivity λ W/(m·K)
Stainless steel	X5CrNi18 10	7900		15
	X6CrNiTi 18 10	7900		15
	X6CrNiMoTi 17 12 2	7980		15
	X2CrNiMo 18 14 3	7980		15
	X1NiCrMoCu25 20 5	8000		14
NOTE Where no values for bulk density and temperature are given, the thermal conductivity λ may be assumed as independent of these values.				

Table 2 - Heat transfer coefficients [1)]

Zone	Heat transfer coefficient α W/(m²·K)
inner surface of the liner	8+w [2)]
in case of accessible space between windshield and liner:	
outer surface of the liner	8
inner surface of the windshield	8
in case of non-accessible space between windshield and liner:	
outer surface of the liner:	
temperature > 80 °C	20
temperature ≤ 80 °C	12
inner surface of the windshield	8
outer surface of the windshield	24 [3)]

1) These values are approximate values which lead to sufficiently accurate results for flue gas carrying tubes with an interior diameter of more than 1 m.

2) w is the mean flue gas velocity in metres per second. A detailed calculation of α is given in Annex A.

3) For verification of the suitability of the materials as regards temperature a value α=6 W/(m²·K) shall be taken.

4.2.4 Flow calculations

Flow calculations shall include calculations of pressure conditions inside the flue gas carrying tube and of flow velocity. They have to take into account the density of the flue gases and of the ambient air as well as energy losses, such as directional losses, losses due to friction and due to the joints. If flue gas can permeate through the liner, for example in a brickwork liner, no positive pressure is allowed during normal operation conditions.

NOTE The start up pressure is not a normal operating condition in accordance with this European Standard.

The calculation shall be carried out in accordance with Annex A. In case of chimneys with a height of less than 20 m, the calculation may be carried out in accordance with prEN 13384-1:1998, provided that the conditions given in that standard apply.

4.2.5 Chemical attack

Chemical attack of the structural elements in contact with flue gases can occur by condensation of different flue gases to acid, for example sulphuric or hydrochloric acid polluted by chlorides or fluorides. Depending on the nature and period of time of the attack the chemical effect is graded into:

a) low;

b) medium;

c) high;

d) very high.

The chemical attack of flue gases containing SO_3 is graded according to table 3 depending on the period during which the temperature falls below the acid dew point. Periods during which the installation is out of service are to be disregarded when determining the operating hours.

Table 3 applies to flue gases containing 50 mg/m^3 of SO_3. In the case of other values of SO_3 concentration, the operating hours given in Table 3 vary in inverse proportion to the SO_3 content. If the SO_3 content is not known, a

2 % conversion of SO_2 into SO_3 may be assumed unless other values can be proven. For other flue gases, the level of chemical attack shall be determined by other methods.

The temperature of the acid dew point of flue gases containing water vapour (H_2O) and sulphur trioxide (SO_3) can be taken from figure 1.

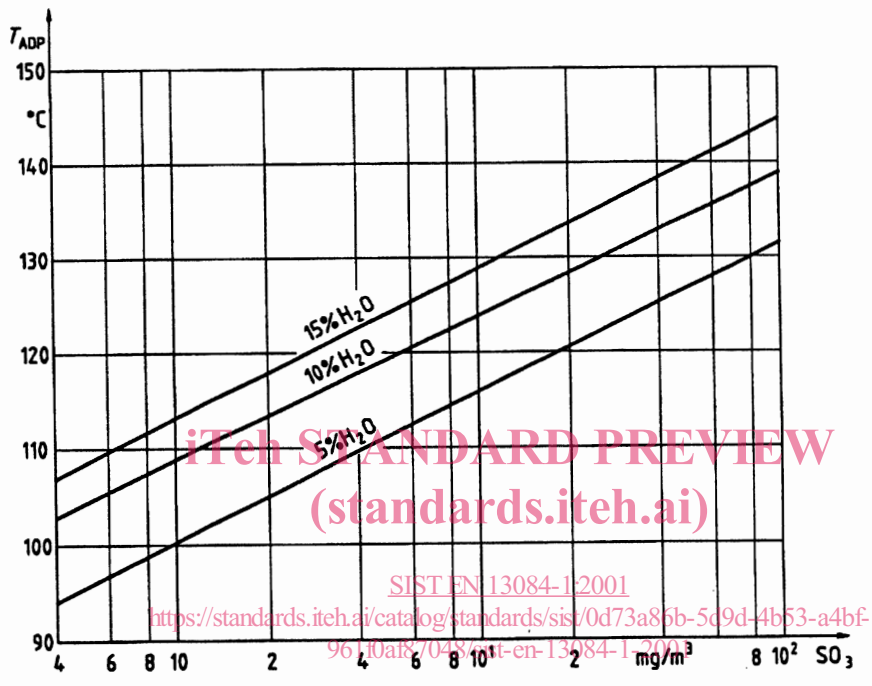

Figure 1 - Temperature of the acid dew point, T_{ADP}, of flue gases containing water vapour (H_2O) and sulphur trioxide (SO_3)

Table 3 - Chemical attack due to flue gases containing 50 mg/m³ of SO_3

Degree of chemical attack	Operating hours per year [1]			
	Liner face in contact with flue gas		Parts of the chimney protected by the liner	
	T_{ADP}>150 °C	T_{ADP}≤150 °C	T_{ADP}>150 °C	T_{ADP}≤150 °C
low	< 10	< 30	< 50	< 150
medium	10 to 50	30 to 150	50 to 250	150 to 750
high	50 to 1 000	150 to 3 000	250 to 5 000	750 to 15 000[2]
very high	> 1 000	> 3 000	> 5 000	> 15 000[2]

[1] during which the temperature of the attacked component is below the acid dew point of the flue gases which are in contact with that component.

[2] only for interpolation purposes (see 3rd paragraph of this clause), however, in no case more than 8760 h (1 year).

The presence of chlorides or fluorides in the flue gas condensate can radically increase corrosion rates. Estimation of the corrosion rate in these circumstances depends upon a number of complex factors and would require the advice of a corrosion expert in each individual case.

In the absence of such advice,

- the degree of chemical attack may be considered as "low", if the temperature of chimney components in contact with flue gas is below acid dewpoint for periods of less than 25 hours per year and the concentrations of HCl ≤ 30 mg/m³ and HF ≤ 5 mg/m³;

- the degree of chemical attack shall be considered as "very high", regardless of temperature and exposure time, if halogen concentrations at 20°C and 1 bar pressure exceed the following limits:

- Hydrogen fluoride: 300 mg/m³;
- Elementary chlorine: 1300 mg/m³;
- Hydrogen chloride: 1300 mg/m³.

Condensing flue gas conditions occuring longer than 10 hours per year downstream of a flue gas desulphurization system shall be classified as causing "very high" chemical attack.

While a chimney may generally be at a temperature above acid dew point, care shall be taken to prevent small areas being subjected to local cooling and therefore being at risk of localised acid corrosion. Local cooling may be due to

- air leaks;
- fin cooling of flanges, spoilers or other attachments;
- support points;
- down draught effects at top of the chimney.

Chemical attack can also occur if, for example, dry flue gases become moist at the chimney top as a result of atmospheric influences and affect the inside or outside of the chimney or if the flue gases passing up towards the top or during start-up of the installation cool down to such an extent that condensation occurs.

4.3 Environmental effects

4.3.1 Noise

The noise produced from the chimney shall not exceed permissible noise levels. Under normal conditions this requirement is met if the velocity of the flue gases at the chimney top is less than 25 m/s. In exceptional cases, for example if the flue gas fan is situated in the chimney, or if the velocity is more than 25 m/s, it has to be proven that the permissible noise level is met.