

Heating boilers — Heating boilers with forced draught burners — Nominal heat output not exceeding 10 MW and maximum operating temperature of 110 °C

ICS 01.040.91; 91.140.10

National foreword

This British Standard is the UK implementation of EN 14394:2005+A1:2008. It supersedes BS EN 14394:2005 which is withdrawn.

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

The UK participation in its preparation was entrusted to Technical Committee RHE/10, Heating boilers.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 12 January 2006

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ISBN 978 0 580 64353 8

Amendments/corrigenda issued since publication

Date	Comments
30 November 2008	Implementation of CEN amendment A1:2008

English Version

**Heating boilers - Heating boilers with forced draught burners -
Nominal heat output not exceeding 10 MW and maximum
operating temperature of 110 °C**

Chaudières de chauffage - Chaudières avec brûleurs à air
soufflé - Puissance utile inférieure ou égale à 10 MW et
température maximale de service de 110 °C

Heizkessel - Heizkessel mit Gebläsebrennern -
Nennwärmeleistung kleiner oder gleich 10 MW und einer
maximalen Betriebstemperatur von 110 °C

This European Standard was approved by CEN on 14 October 2005 and includes Amendment 1 approved by CEN on 28 June 2008.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

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

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Foreword

This document (EN 14394:2005+A1:2008) has been prepared by Technical Committee CEN/TC 57 “Central heating boilers”, 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 2009 and conflicting national standards shall be withdrawn at the latest by February 2009.

This document includes Amendment 1 approved by CEN on 2008-06-28.

The start and finish of text introduced or altered by amendment is indicated in the text by tags $\boxed{A_1}$ $\boxed{A_1}$.

This document supersedes EN 14394:2005.

According to edition 2005 the following fundamental changes are given:

- Consideration of the Directive 97/23/EC Pressure Equipment Directive (PED) and including of Annex ZB;
- Correction of some typing errors.

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 Directives.

$\boxed{A_1}$ For relationship with EU Directives, see informative Annexes ZA and ZB, which are integral parts of this document. $\boxed{A_1}$

$\boxed{A_1}$ The requirements and test methods related to the Essential Requirements of the Council Directive 90/396/EEC relating to appliances burning gaseous fuels (Gas Appliance Directive – GAD) for assemblies made up of a boiler body complying with EN 303-1 and a forced draught gas burner complying with EN 676 with a nominal heat output not exceeding 1.000 kW are covered in the Harmonized European Standard EN 303-3:1998 and its Amendment A2:2004. For assemblies with a heat output between 1.000 kW and 10 MW however no Harmonized European Standard does exist at the moment. The relevant clauses of EN 303-3:1998 can be taken as a basis to prove conformity with the essential requirements of the GAD. $\boxed{A_1}$

This European Standard specifies requirements for boilers operating with a temperature of 100 °C and 110 °C which are not covered by the Pressure Equipment Directive (PED, $TS \leq 110$ °C), on the other hand the document specifies requirements for those boilers, which have a maximum allowable temperature $TS > 110$ °C (according to the PED).

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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

A1 This European Standard specifies the requirements and test methods for the design, manufacturing, safe operation and the rational energy usage for standard boilers and low temperature boilers (with „boiler" in the sense of „boiler body") from steel and cast iron to be equipped with separately marketed forced draught burners according to the relevant burner standards (for automatic forced draught burners for gaseous fuels see EN 676 and for atomising oil burners see EN 267) up to a nominal heat output of 10 MW. They are operated, either with negative pressure (natural draught boiler) or with positive pressure (pressurised boiler) in the combustion chamber, in accordance with the boiler manufacturer's instructions. **A1**

A1 This European Standard specifies requirements for boilers with normal operating temperatures between 100 °C and 110 °C and has a "dual structure":

- For boilers where the shut off temperature of the safety temperature limiter does not exceed 110 °C the Pressure Equipment Directive (PED) requires "Sound Engineering Practice",
- For boilers where the shut off temperature of the safety temperature limiter exceeds 110 °C this European Standard specifies the requirements of the PED as stated in Annex ZB.

NOTE 1 The "maximum allowable temperature TS" is defined in the PED and its Guidelines. **A1**

Boilers in accordance with this European Standard are designed for the heating of central heating installations in which the heat carrier is water, and the maximum allowable operating temperature of which is up to 110 °C and the maximum safety temperature limiter of 120 °C. The maximum allowable operating pressure is 10 bar.

This standard does not apply to gas boilers with atmospheric burners, boilers for solid fuels, oil or gas fired condensation boilers, boilers with oil vaporisation burners. For these boilers there are further requirements.

For gas-fired central heating boilers equipped with a forced draught burner of nominal heat output not exceeding 1000 kW, see **A1** EN 303-7 **A1**.

For shell boilers with a nominal heat output exceeding 10 MW and a maximum safety temperature limiter exceeding 120 °C, see EN 12953 series.

A1 NOTE 2 Definitions for standard boiler and low temperature boiler see Council Directive 92/42/EEC. **A1**

2 Normative references

The following referenced documents are indispensable for the application of this European Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 267, *Forced draught oil burners – Definitions, requirements, testing, marking*

EN 287–1, *Qualification test of welders – Fusion welding – Part 1: Steels*

A1 *deleted text* **A1**

EN 303–1, *Heating boilers - Part 1: Heating boilers with forced draught burners - Terminology, general requirements, testing and marking*

EN 303-2, *Heating boilers - Part 2: Heating boilers with forced draught burners - Special requirements for boilers with atomising oil burners*

A1 EN 303-3, *Heating boilers - Part 3: Gas-fired central heating boilers - Assembly comprising a boiler body and a forced draught burner* **A1**

EN 304, *Heating boilers – Test code for heating boilers for atomising oil burners*

EN 1561, *Founding – Grey cast irons*

EN 1563, *Founding – Spheroidal graphite cast irons*

EN 10025-1, *Hot rolled products of structural steels - Part 1: General technical delivery conditions*

EN 10025-2, *Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10025-3, *Hot rolled products of structural steels - Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

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

EN 10088-2, *Stainless steels - Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes*

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 10216-1, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10216-2, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10216-3, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 3: Alloy fine grain steel tubes*

EN 10216-4, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 4: Non-alloy and alloy steel tubes with specified low temperature properties*

EN 10216-5, *Seamless steel tubes for pressure purposes - Technical delivery conditions - Part 5: Stainless steel tubes*

EN 10217-1, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-2, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-3, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 3: Alloy fine grain steel tubes*

EN 10217-4, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 4: Electric welded non-alloy steel tubes with specified low temperature properties*

EN 10217-5, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-6, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties*

EN 10217-7, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 7: Stainless steel tubes*

EN 10226-1, *Pipe threads where pressure tight joints are made on the threads - Part 1: Taper external threads and parallel internal threads - Dimensions, tolerances and designation*

EN 10226-3, *Pipes threads where pressure tight joint are made on the threads - Part 3: Verification by means of limit gauges*

- EN 12828, *Heating systems in buildings - Design for water-based heating systems*
- EN 12953-8, *Shell boilers - Part 8: Requirements for safeguards against excessive pressure*
- EN 22553, *Welded, brazed and soldered joints – Symbolic representation on drawings (ISO 2553:1992)*
- EN 60335-1, *Household and similar electrical appliances - Safety - Part 1: General requirements (IEC 60335-1:2001, modified)*
- EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*
- EN 60730-2-9, *Automatic electrical controls for household and similar use - Part 2-9: Particular requirements for temperature sensing controls (IEC 60730-2-9:2000, modified)*
- EN ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads - Part 1: Dimensions, tolerances and designation (ISO 228-1:2000)*
- EN ISO 228-2, *Pipe threads where pressure-tight joints are not made on the threads - Part 2: Verification by means of limit gauges (ISO 228-2:1987)*
- EN ISO 4063, *Welding and allied processes – Nomenclature of processes and reference numbers (ISO 4063:1998)*
- EN ISO 6506-1, *Metallic materials – Brinell hardness test – Part 1: Test method*  (ISO 6506-1:2005) 
- EN ISO 9606-2, *Qualification test of welders - Fusion welding - Part 2: Aluminium and aluminium alloys (ISO 9606-2:2004)*
- EN ISO 15607, *Specification and qualification of welding procedures for metallic materials - General rules (ISO 15607:2003)*
- EN ISO 15609-1,  *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2004)* 
- EN ISO 15610, *Specification and qualification of welding procedures for metallic materials - Qualification based on tested welding consumables (ISO 15610:2003)*
- EN ISO 15611, *Specification and qualification of welding procedures for metallic materials - Qualification based on previous welding experience (ISO 15611:2003)*
- EN ISO 15612, *Specification and qualification of welding procedures for metallic materials - Qualification by adoption of a standard welding procedure (ISO 15612: 2004)*
- EN ISO 15613, *Specification and qualification of welding procedures for metallic materials - Qualification based on pre-production welding test (ISO 15613:2004)*
- EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*
- EN ISO 15614-2, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 2: Arc welding of aluminium and its alloys (ISO 15614-2:2005)*
- ISO 185, *Grey cast irons – Classification*
- ISO 857-1, *Welding and allied processes – Vocabulary – Part 1: Metal welding processes*
- ISO 7005-1, *Metallic flanges – Part 1: Steel flanges*
- ISO 7005-2, *Metallic flanges – Part 2: Cast iron flanges*
- ISO 7005-3, *Metallic flanges – Part 3: Copper alloy and composite flanges*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1

maximum allowable pressure PS

maximum pressure for which the equipment is designed, as specified by the manufacturer

3.2

test pressure

pressure to which all boilers and their parts are subjected during production in the works of the manufacturer or during setting up by the installer

3.3

type test pressure

pressure to which the pre-production heating boiler(s) and associated parts are subjected before start of mass production in the manufacturing works

3.4

temperature

3.4.1

maximum/minimum allowable temperature TS

maximum/minimum temperatures for which the equipment is designed, as specified by the manufacturer

3.4.2

operating temperature

maximum allowable temperature at which the boiler can be operated under normal operation conditions at the maximum setting of the boiler's water temperature controller

3.5

heat output P (heat output range)

amount of heat transferred to the water per unit of time

The heat output range is the span of output below the nominal heat output specified by the manufacturer over which the boiler meets the requirements of this standard and over which it can be used.

3.6

nominal heat output $\langle A_1 \rangle P_n \langle A_1 \rangle$

continuous output specified by the manufacturer in accordance with the requirements of this standard. It is the maximum useful quantity of heat transferred to the heat carrier per hour

3.7

heat input Q_B

amount of heat in unit time which is supplied to the furnace of the heating boiler by the fuel based on its net calorific value H_i

3.8

boiler efficiency $\langle A_1 \rangle \eta_K \langle A_1 \rangle$

ratio of the nominal output (P_n) to the heat input (Q_B) supplied by the fuel

$$\eta_K = \frac{P_n}{Q_B}$$

3.9

required draught

pressure differential between the static air pressure in the place of installation and the static pressure of the exhaust gases, as measured in the exhaust gas measuring section, which is required for correct operation of the boiler at nominal output

3.10

gas side resistance

pressure differential between the combustion chamber and the boiler outlet

3.11

soundness of combustion system

pressure tightness of the combustion circuit through which the exhaust gases flow

3.12

exit flue temperature t_A

temperature measured at the flue outlet of the boiler

3.13

flue gas loss

quantity of heat per unit time which leaves the flue gas exit of the boiler unused

3.14

combustion circuit

comprises the combustion chamber, the heat exchanger, and the combustion product circuit up to the flue exit

3.15

standby loss q_B

quantity of heat which is necessary to maintain the boiler at a given temperature when no heat output is used. It is stated as q_B in relation to the heat input Q_B .

3.16

water side resistance

pressure loss across the boiler measured at the flow and return connections of the boiler, with a volume flow corresponding to the nominal heat output

3.17

control thermostat

device enabling the water temperature to be kept automatically, within a given range, at a predetermined value

3.18

safety temperature limiter

device that causes safety shutdown and non-volatile lockout so as to prevent the water temperature exceeding a pre-set limit

4 Requirements

4.1 Construction requirements

4.1.1 General requirements

Boilers shall be fire-resistant and safe to operate. They shall be made of non-combustible materials and shall be resistant to deformation and shall be such that:

- they can withstand the stresses arising during normal operation and hydraulic tests;
- the burner and the boiler cannot become heated or pressurised to create a hazard;
- dangerous accumulations of combustible gases (fuels mixed with air) in the combustion chamber and in the flues are prevented and
- gases cannot leak from the boiler in dangerous quantities;
- thermal insulation; only asbestos-free materials are allowable.

Combustible materials are allowable for:

- components of accessories e. g. burner covers, if the parts are fitted outside of the boiler;
- internal components of controls and safety equipment;
- operating handles;
- electrical equipment.

Component parts of covers, operating, control and safety devices and electrical accessories shall be arranged in such a way that their surface temperatures, under steady state conditions, do not exceed those specified either by the manufacturer or in the component part standard.

The materials for the parts subject to pressure shall be in accordance with generally accepted technical requirements. They shall be suitable for the purpose and treatment intended. The mechanical and physical properties as well as the chemical composition of the materials shall be guaranteed by the relevant material producer/supplier.

4.1.2 Production documentation

4.1.2.1 Drawings

The following shall be specified in the boiler drawings or in the relevant documents:

- specified materials;
- welding process, the weld type (generally the symbol for the weld type is sufficient) and the welding fillers;
- maximum allowable operating temperature in °C;
- maximum allowable operating pressure in bar;
- test pressure in bar;
- nominal heat output or the heat output range for every boiler size in kW.

4.1.2.2 Manufacturing controls

Manufacturing control shall be carried out.

4.1.3 Heating boilers of steel and of non-ferrous materials

4.1.3.1 Execution of welding work

Boiler manufacturers who carry out welding work shall meet the following requirements of EN 287–1 and EN ISO 9606-2:

- only welders who are qualified in the welding of the materials to be processed may be used;
- equipment shall be available to allow defect free welding to be carried out;
- supervision of the welding shall be carried out by staff qualified in welding (at least one supervisor shall be so qualified).

4.1.3.2 Welded joints and welding fillers

The materials shall be suitable for welding. The materials in accordance with Clause 5 are suitable for welding and do not require additional heat treatment after welding.

The welding procedure shall be in accordance with EN ISO 15607, EN ISO 15609-1, EN ISO 15610, EN ISO 15611, EN ISO 15612 and EN ISO 15613   

The welded joints shall not show any cracks or bonding faults and shall be defect free over the whole cross-section for butt welds. One-sided fillet welds, and half Y-welds which have been welded through, shall be kept substantially free from bending stresses. Smoke tubes, inserted stays and similar components need not be counterwelded. Double fillet welds are only permissible when sufficiently cooled. Projections into the flue gas side in areas of high thermal stresses shall be avoided.

Corner welds, edge welds and similar welded connections which are subjected to high bending stresses during production and operation are to be avoided.

For welded longitudinal stay bars or stay tubes the shearing cross section of the fillet weld should be at least 1,25 times the required stay bar or stay tube cross sectional area.

See Table 1 for details on the welding joints mentioned. Welding fillers shall be suitable for the material being used.

The terms used in Table 1 are in accordance with EN 22553. The reference numbers of welding processes are in accordance with ISO 857-1 and EN ISO 4063.

Table 1 – Weld joints and welding processes

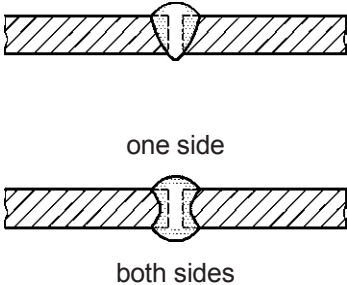
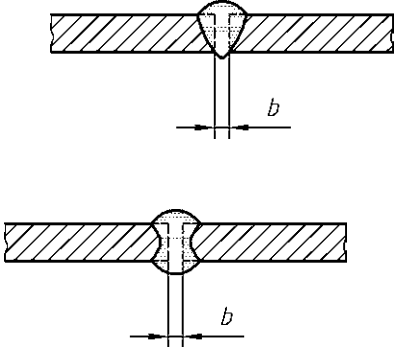
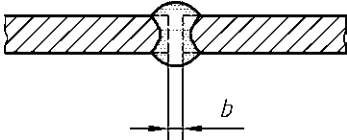
No.	Term	Material thickness t in mm	Welding process ^a	Remarks
1.1	Square butt weld  one side both sides	≤ 6 (8)	135 12 131 (111)	Permissible up to $t = 8$ mm on use of deep penetration electrodes or welding on both sides
1.2	Square butt weld  b b	≥ 6 up to 12	12	Root gap $b = 2$ mm to 4 mm with stiffener, powder holder necessary
1.3	Square butt weld (double)  b	> 8 up to 12	135 12 (111)	Root gap $b = 2$ mm to 4 mm Deep penetration electrodes shall be used for manual electro welding

Table 1 (continued)

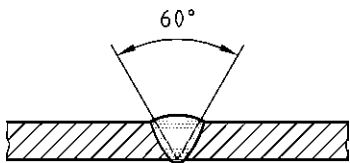
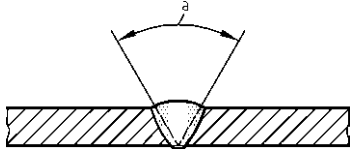
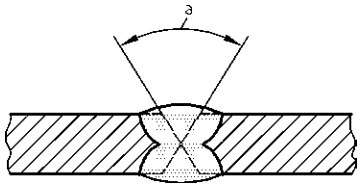
No.	Term	Material thickness t in mm	Welding process ^a	Remarks
1.4	Single-V butt weld 	up to 12	(111)	Weld preparation V-seam 60°
1.5	Single-V butt weld a) 30 ° to 50 ° 	up to 12	135 12	Weld preparation V-seam 30° to 50° depending on thickness of material
1.6	Double-V butt weld a) 30 ° to 50 ° 	greater than 12	135 12	Weld preparation double V-seam 30° to 50° depending on material thickness

Table 1 (continued)

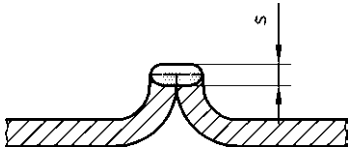
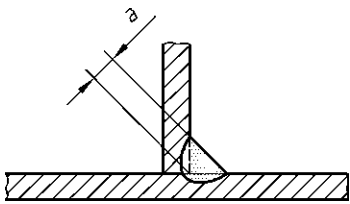
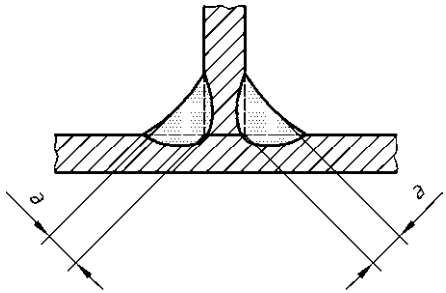
No.	Term	Material thick- ness t in mm	Welding process ^a	Remarks
1.7	Butt weld between plates with raised edges 	≤ 6	135 141 131 (111)	Only permissible in exceptional cases for parts welded in. Moreover, the welds have to be kept largely free from bending stresses. Not suitable for directly fired wall parts $s = 0,8 t$
2	Fillet weld 	≤ 6	135 12 (111)	Welds of this type are to be kept largely free from bending stresses $a = t$
2.1	Double fillet weld 	≤ 12	135 12 (111)	$a = t$
		> 12	135 12 (111)	$a = 2/3 t$

Table 1 (continued)

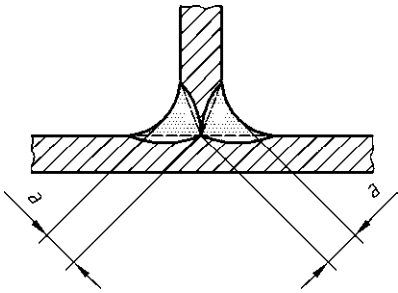
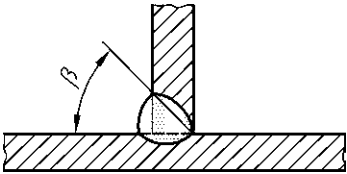
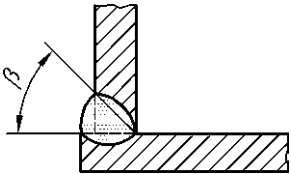
No.	Term	Material thickness t in mm	Welding process ^a	Remarks
2.2	Double-bevel butt weld 	≤ 12	135 12 (111)	$A = t$
		> 12	135 12 (111)	$a = 2/3 t$
2.3	Single-bevel butt weld 	≤ 12	135 12 (111)	For (111) $\beta = 60^\circ$
		> 12	135 12	For 135, 12 $\beta = 45^\circ$ to 50°
2.4	Single-bevel butt weld 	≤ 12	135 12 (111)	For (111) $\beta = 60^\circ$ For 135, 12 $\beta = 45^\circ$ to 50°

Table 1 (continued)

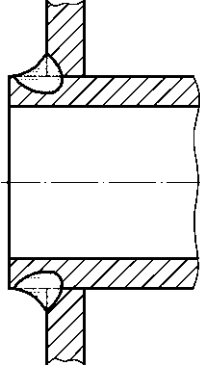
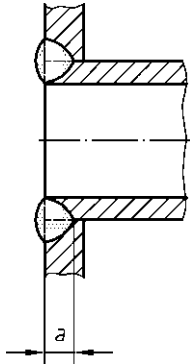
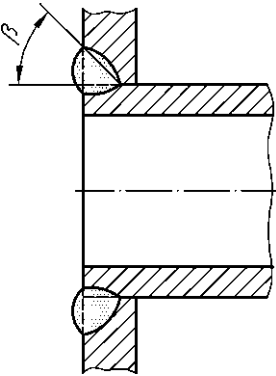
No.	Term	Material thickness t in mm	Welding process ^a	Remarks
2.5		≤ 12	135 (111)	Tube end shall not project beyond fillet weld if it is subjected to heat radiation
2.6		≤ 6	135 (111)	Welding in of tube under high thermal stress $a \geq t$

Table 1 (continued)

No.	Term	Material thickness t in mm	Welding process ^a	Remarks
2.7			135 (111)	Welding in of tube under high thermal stress For (111) $\beta = 60^\circ$ For 135 $\beta = 45^\circ$ to 50°
^a Reference numbers of welding processes in accordance with ISO 857-1 or EN ISO 4063.				
Reference number		Process		
12		Submerged arc welding		
111		Metal-arc welding with covered electrode		
131		Metal-arc inert gas welding; MIG welding		
135		Metal-arc-active gas welding; MAG welding		
141		Tungsten inert gas arc welding; TIG welding		

4.2 Burner matching

4.2.1 Matching with forced draught oil burner according to EN 267

- The requirements according to EN 303-2 have to be met, or in case of nominal heat input exceeds the range of the scope according to EN 303-2,
- the tests according EN 303-2 have to be carried out.

4.2.2 Matching with automatic forced draught burner for gaseous fuels according to EN 676

- The requirements according to EN 303-3 have to be met, or in case of nominal heat input exceeds the range of the scope according to EN 303-3,
- the tests according to EN 303-3 have to be carried out. 

5 Materials

5.1 General

The materials for heating boilers shall be manufactured and tested in accordance with the generally recognised rules. The specification of the materials shall have an inspection certificate EN 10204:2004, 3.1; a test report 2.2 according to EN 10204 may be sufficient for boilers with $TS \leq 110$ °C. This does not apply to small components, e.g. sockets up to DN 50, screws and nuts.

Other materials are only permissible on production of evidence showing equivalent performance. Comprehensive test specifications, e.g. impact test, shall be considered by the particular material appraisal.

A method of material traceability shall be taken into account. Suitable procedures shall be established and maintained for identifying the material making up the components of the heating boiler which contribute to pressure resistance by suitable means from receipt, through production, up to the final test of the manufactured heating boiler.

5.2 Steel boiler

5.2.1 The following plates and forgings from carbon steels according to EN 10025-1 to -3 should apply within the following limits:

— grade S 235 JRG 2 for wall thickness up to 20 mm.

A particular material appraisal is required to confirm that the material has sufficient ductility for the application.

These grades are only permitted for a max. temperature of 300 °C to determine from the reference temperature and the temperature allowance according to Table 5.

These grades are not applicable for flame tubes and other similar components in contact with fire for steam boilers with an allowable operating pressure greater than 6 bar.

5.2.2 The following plates from carbon steels according to EN 10028-2 should apply within the following limits:

— grade P 235 GH, P 265 GH and P 295 GH.

These grades apply for heated cylindrical shells under external pressure (flame tubes) for wall thickness up to 22 mm and for heated straight wall thickness up to 25 mm.

5.2.3 For tubes, see EN 10216-1 to EN 10216-5 (seamless steel tubes for pressure purposes) and EN 10217-1 to EN 10217-7 (welded steel tubes for pressure purposes).

5.2.4 Plates and strips of stainless steels

All materials according to EN 10088-1 and EN 10088-2 can be used.

A particular material appraisal is required to confirm that the material has sufficient ductility for the application.

5.3 Boilers of cast materials

5.3.1 General

The manufacturer shall have personnel and equipment capable of carrying out the necessary material tests. During the manufacture of the boiler and other cast iron parts subject to pressure the following tests shall be carried out using separately cast test pieces for each batch:

- a) tensile test in accordance with ISO 185, Type A; the values given in Table 2 are to be confirmed by the tensile test;

- b) chemical analysis (C, Si, Mn, P, S);
- c) Brinell hardness test in accordance with EN ISO 6506-1;
- d) impact value (for graphite iron only).

The results of the tests shall either be recorded in registers countersigned by the works tester responsible, or works certificates in accordance with EN 10204 shall be drawn up. Works certificates and registers shall be kept for at least five years by the manufacturer and shall be accessible for examination.

The repair of parts subject to pressure by welding is not permissible.

A particular material appraisal is required to confirm that the material has sufficient ductility for the application.

5.3.2 Parts of cast iron subject to pressure

The mechanical properties of cast iron used for parts subject to pressure shall, as a minimum, correspond to the values listed in Table 2.

Table 2 – Minimum requirements on cast iron

Cast iron with lamellar graphite ^a (EN 1561)		
– Tensile strength R_m	≥	200 N/mm ²
– Brinell hardness according to EN 1561 EN-GJL 200		160 HB to 220 HB 2,5/187,5
Spheroidal graphite iron (ferritically annealed; EN 1563):		
– Tensile strength R_m	≥	400 N/mm ²
– Impact value according to EN 1563 EN-GJS 400	≥	23 J/cm ²
^a In agreement with the competent person a lamellar graphite with a minimum tensile strength (determined at tensile test piece) can be used which is 10 % below the value of the minimum tensile strength.		

5.3.3 Cast parts of non-ferrous metals subject to pressure according to Table 3 and 4

Table 3 – Examples of aluminium and aluminium alloys

	Thickness	Tensile strength R_m	Temperature range
	Mm	N/mm ²	°C
Al 99,5	up to 50	75 min.	up to 300
Al Mg2 Mn 0,8	up to 50	275 min.	up to 250

Table 4 – Examples for copper and copper alloys

	Thickness	Tensile strength R_m	Temperature range
	mm	N/mm ²	°C
SF - Cu	up to 5	200	up to 250
Cu Ni 30 Fe	up to 10	310	up to 350

5.3.4 Tube connections for heating boilers from cast and valves of copper alloys

Tube connections from cast up to G1½:

— this applies only for a max. allowable operating pressure of ≤ 6 bar.

Valves with a nominal diameter ≤ DN 200:

— made from cast with lamellar graphite.

Valves of copper alloys:

— G-CuSn5ZnPb, G-CuSn10Zn, G-CuSn10, G-Cu5SZnMn, G-CuAl9, G-CuPb5Sn, GK-CuZn67Pb and CuZn40

6 Design

6.1 Boilers of steel

6.1.1 The boilers are designed by calculation as given below.

For materials given in 5.1 the calculated values of Table 5 may be used. For the calculated strength-test the calculation for predominantly loads due to internal or external pressure is sufficient.

A1 An experimental design method can be applied. The wall thickness shall not in any case be less than that given in Table 6. **A1**

6.1.2 For boilers up to a nominal heat output of ≤ 350 kW with a max. allowable operating pressure up to 6 bar - the calculation for the strength according to 6.1.1 - can be replaced by a hydraulic pressure test with a max. permissible operating pressure of $2 \times p_1$. During the test the boiler shall not shown any visible deformation and leakage.

6.1.3 For boilers up to a nominal heat output of > 350 kW and ≤ 2000 kW with a max. allowable operating pressure ≤ 6 bar, the calculation for the strength according to 6.1.1 can be limited on components accessible for calculation, if the hydraulic pressure test carried out with a test pressure of $2 \times p_1$.

Table 5 – Calculation values for yield stress at room temperature and the 0,2 %-proof stress at higher temperature for plates of steel S 235 JRG 2 (according to EN 10025-1 to -3)

Wall thickness	Yield stress at room temperature	0,2 %-proof stress ^a in N/mm ²			
		100 °C	200 °C	250 °C	300 °C
mm	N/mm ²				
≤ 16	205	187	161	143	122
> 16	195	180	155	136	117

^a The strength values for 100 °C apply also for 120 °C. For the other ranges a linear interpolation may be applied; up-rounding is not permissible.

Table 6 – Minimum wall thickness for heating boilers of steel and other materials other than cast iron

Wall	Permissible heat output in kW	Minimum wall thickness ^a in mm	
		Ferritic steels	Austenitic steels according to EN 10088-1 and EN 10088-2 and other stainless steels
For walls of the combustion chamber in contact with fire and water and flat walls of the convection heating surface	≤ 100	4	2
	> 100 ≤ 300	5	3
	> 300 ≤ 4000	6	4
	> 4000	8	4
For walls only in contact with water and for rigidly stable	≤ 100	3	1
	> 100 ≤ 300	4	2
	> 300	5	2
Other tubes		2,9; 2 mm for outside diameter < 17,2 mm, non-heated tubes	1
^a Deviations are possible if calculated - according to Annexes A to E – within the fixed limits (see A.7) or if no calculation is possible and the boiler has passed the test			

6.1.4 Basis for calculation

6.1.4.1 The calculation applies for static loads.

6.1.4.2 Deviations from the calculation equations are possible if it is provided by other means e. g. material testing, experiments, stress analyses, or the like that the safety requirements are met.

6.1.4.3 Some important values for calculation to be used and symbols/units are given in Table 7. The meaning of the head indicators and subscripts is explained in Table 8.

6.1.4.4 $\langle A_1 \rangle$ The design pressure p_1 shall be greater than or equal to the maximum allowable pressure PS . $\langle A_1 \rangle$

6.1.4.5 The design temperature is composed of the reference temperature and the temperature allowance according to Table 9. The temperature allowances shall be considered minimum values. For boilers with reliable, thermostatically controlled flow temperature (type-tested safety temperature limiters are considered to be reliable).

6.1.4.6 The allowable stress σ_{zul} is decisive for the dimensioning due to predominantly static loading and is obtained from Equation (1) to read

$$\sigma_{zul} = \frac{K}{S} \quad (1)$$

in which case the resulting smallest value is decisive which is obtained from the ratio of the design strength values K to the safety factors S from Table 10.

6.1.4.7 At test pressure p' the allowable stress shall be (see Equation 1)

$$\sigma'_{\text{zul}} = \frac{K'}{S'} \quad (2)$$

where the design strength value K' and the safety factor S' shall be taken from Table 11.

6.1.4.8 An allowance c_1 shall be made to the calculated wall thickness s_0 and the like for consideration of wall thickness under tolerances allowable in accordance with the pertinent standards.

6.1.4.9 For ferritic steels the corrosion allowance to regard wear by corrosion shall be $c_2 = 1$ mm. It shall be omitted if the actual wall thickness $s_e \geq 30$ mm. It shall also be omitted if the walls are adequately protected.

6.1.4.10 For austenitic steels and non-metallics the corrosion allowance shall be omitted.

6.1.4.11 Assessment of weld seams

For boilers with a temperature $TS \leq 110$ °C the calculation of boiler components which are tensile strained the seams may be assessed by $VN = 0,8$. ND-testing is not applicable.

An assessment by $VN = 1,0$ may be possible if the seams are tested additionally.

For boilers with a temperature $TS > 110$ °C the following welding factor may apply:

- for equipment subjected to destructive and non-destructive tests which confirm that the whole series of joints show no significant defects: 1;
- for equipment subject to random non-destructive testing: 0,85;
- for equipment not subjected to non-destructive testing other than visual inspection: 0,7.

If necessary, the type of stress and the mechanical and technological properties of the joint may also be taken into account.

The non-destructive tests (NDT) of permanent joints shall be carried out by suitable qualified personnel.

Table 7 – Design values with symbols and units

Symbol	Design value	Unit
B	Width	mm
c	Wall thickness allowance	mm
d	Diameter	mm
h	Height	mm
L	Length	mm
p	Design pressure (gauge)	N/mm ²
P_0	Absolute pressure (thermodynamic and hydrodynamic parameter)	N/mm ²
PS	Maximum allowable pressure	N/mm ²
P_2	Allowable total pressure (gauge) (e. g. for hot water generators)	N/mm ²
P_3	Barometric pressure (atmospheric air pressure)	N/mm ²
P_4	(Applicable) working gauge pressure	N/mm ²
P_5	Hydrostatic head	N/mm ²
P_6	Dynamic pressure drop (pressure drops due to friction, acceleration, deflection, etc.)	N/mm ²
P'	Test pressure	N/mm ²
r	Radius	mm
s	Required wall thickness of main body weakened by openings, and with allowance	mm

Table 7 (continued)

Symbol	Design value	Unit
s_e	Actual wall thickness	mm
s_o	Wall thickness of main body, without openings, and without allowances	mm
v	Ligament efficiency, weld factor	—
A	Area	mm ²
E	Modulus of elasticity	N/mm ²
F	Force	N
G	Shear modulus	N/mm ²
I	Second moment of area	mm ⁴
K	Design strength value	N/mm ²
M	Moment	N/mm
S	Safety factor	—
S'	Safety factor, during pressure test	—
U	Out-of-roundness	%
δ_5	Elongation at fracture (gauge length ration = 5)	%
ϑ	Design temperature	°C
ν	Poisson's ratio = 0,3 for steel	—
φ	Angle	degrees
σ	Stress	N/mm ²
$\bar{\sigma}$	Mean stress	N/mm ²
σ_l	Longitudinal stress	N/mm ²
σ_u	Circumferential stress	N/mm ²
σ_v	Stress intensity	N/mm ²
σ_{zul}	Allowable stress under static loading	N/mm ²
$\boxed{A_1} \tilde{\sigma} \boxed{A_1}$	Allowable stress under cyclic loading	N/mm ²
$\bar{\sigma}$	Minimum value for tensile strength at 20 °C	N/mm ²
σ_S	Allowable stress under test pressure p	N/mm ²

Table 8 – Head superscript and subscripts

Superscript or subscript	Meaning
Head superscript ^	Maximum value, e. g. $\hat{p}$
Head superscript ^v	Minimum value, e. g. $\check{p}$
Head superscript ¯	Mean value, e. g. $\bar{\sigma}$
Head superscript ~	Pulsating, e. g. $\tilde{\sigma}$
Head superscript '	Pertaining to pressure test, e. g. p'
Subscript	Numerical index, e. g. n_i



Table 9 – Reference temperatures and temperature allowances

Physical state	Reference temperature	Temperature allowance			
		Unheated components	Heated components		
			Heating predominantly by		Screened against radiation
			Radiation	Convection	
Water, or water/steam mixture	Saturation temperature at allowable working gauge pressure p_1 , or allowable total pressure p_2 , respectively	0 °C	50 °C for headers (30 + 3 x s_e) °C, at least 50 °C	(15 + 2 x s_e) °C, but 50 °C max.	20 °C

Table 10 – The design strength values K and related safety factors S for rolled and forged steels with acceptance test certificate to EN 10204 for material ($\delta_s \geq 14$ %)

Design strength values K covering materials	Safety factor S	
	for internal pressure	for external pressure
$\check{\sigma}_B$ at 20 °C	2,4	2,4
$\check{\sigma}_{S/\vartheta}$ or $\sigma_{0,2\vartheta}$	1,5	1,8

Table 11 – Design strength values K and related safety factors S at test pressure p'

Material	Design strength values K^a	Safety factors S^a
Rolled and forged steels	σ_S at 20 °C	1,05
Cast steel	σ_S at 20 °C	1,33
Cast iron with nodular graphite	σ_S at 20 °C	2,2
Cast iron with lamellar graphite	σ_S at 20 °C	5,0
^a Only for components without openings or branches		

6.1.5 Cylindrical shells under internal pressure

See Annex A.

6.1.6 Spherical shells and dished heads under internal and external pressure

See Annex B.

6.1.7 Dished fire tube heads

See Annex C.

6.1.8 Flat walls, stayings and girder stays

See Annex D.

6.1.9 Cylindrical shells under external pressure

See Annex E.

6.2 Heating boilers of cast material

The wall thicknesses given in the production drawing shall not be less than the minimum wall thicknesses listed in Table 12. The actual minimum wall thicknesses during manufacture of the boiler sections and other parts subject to pressure shall be greater than 0,8 times the thickness given in the drawing.

The manufacturer can add additional identical sections to increase the output of a boiler range as long as the additionally heat output is not more than 25 % of the higher nominal heat output $\overline{P_n}$ of the relevant row of Table 12.

Table 12 – Minimum wall thicknesses of boiler sections of cast material

Nominal heat output $\overline{P_n}$ kW	Minimum wall thickness for cast iron with	
	lamellar graphite, aluminium mm	Spheroidal ferritic graphite-annealed copper mm
$\overline{P_n} \leq 30$	3,5	3,0
$30 < \overline{P_n} \leq 70$	4,0	3,5
$70 < \overline{P_n} \leq 300$	4,5	4,0
$300 < \overline{P_n} \leq 1000$	5,5	5,0
$1000 < \overline{P_n}$	6,5	6,0

6.3 Further requirements

6.3.1 Venting of the water space and flue gas passages

The boiler and its parts shall be designed in such a way that the water spaces can be properly vented. The boiler shall be so designed that under normal operation in accordance with the manufacturer's instructions no undue boiling noises occur.

The combustion chamber and the flue gas passages shall be designed in such a way that no dangerous accumulation of combustible gases is possible.

6.3.2 Cleaning of heating surfaces

The heating surfaces shall be accessible from the flue gas side for inspection and cleaning with chemical agents and brushes by means of a sufficient number and appropriate arrangement of cleaning openings. If special tools (for example special brushes) are required for cleaning and maintenance of the boiler these shall be supplied.

6.3.3 Inspection of the flame

A facility shall be provided which allows inspection of the flame. It shall permit assessment of the flame and shall be

arranged or designed in such a way that the automatic flame safety device of the burner cannot be affected, by for example other sources of light. If the burner is attached to a hinged boiler door which can be opened by the operator without tools, burner operation shall not be possible if the door is open.

6.3.4 Water tightness

Holes for screws and similar components which are used for the attachment of removable parts shall not open into spaces through which water flows. This does not apply to pockets for measuring, control and safety equipment.

6.3.5 Replacement parts

Replacement and spare parts (e. g. inserts, shaped firebricks, turbulators etc.) shall be designed, made or marked in such a way that their installation in accordance with the manufacturer's instructions is correct.

6.3.6 Water connections

Connecting sockets shall comply with EN 10226-1 and EN 10226-3 and EN ISO 228-1 and EN ISO 228-2 and flange connections shall comply with ISO 7005-1, ISO 7005-2 and ISO 7005-3. The arrangement of the connections shall be such that they are easily accessible and shall be chosen in such a way that the function of each respective connection can be adequately fulfilled. There shall be sufficient space around the connection to allow the installation of the connecting pipes with the necessary tools.

Threaded pipe connections above DN 50 are not recommended. Threaded pipe connections with nominal diameters above DN 80 are not permissible. If connections are fitted with flanges, the mating flanges and seals shall also be supplied. Each boiler shall have at least one connection for filling and draining. This connection may be common. Each boiler shall have an opening for draining on its front or rearside side at his deepest point. The size of the connection shall be as a minimum:

- for fill connections:
 - G 1/2 for nominal heat outputs up to 70 kW;
 - G 3/4 for nominal heat outputs above 70 kW.
- for drainage connections for steam boilers of steel:
 - DN 25 for nominal heat outputs up to 1 MW;
 - DN 35 for nominal heat outputs from 1 MW up to 6 MW;
 - DN 50 for nominal heat outputs above 6 MW.
- for drainage connections for boilers of cast:
 - DN 25 for nominal heat outputs up to 150 kW;
 - DN 32 for nominal heat outputs from 150 kW up to 350 kW;
 - DN 50 for nominal heat outputs above 350 kW.

It is possible to provide these connections outside the boiler if satisfactory filling and draining of the boiler can be assured.

6.3.7 Connections for control and indicating equipment, and safety temperature limiter

Each boiler shall have connections for pockets for temperature control, safety temperature limiter and a thermometer with a minimum nominal connection of G 1/2. If the control equipment is supplied with the boiler, these requirements need not apply. In this case the control equipment shall not be replaced by other equipment.

The connections shall be so positioned that the temperature measured is representative of the boiler temperature. If other connections are designated for safety devices, such as pressure switch, manometer, low water cut-out or safety valve, the nominal connection, especially for the safety valve, shall be designed for the range of capacity and the range of service.

[A1] Requirements for heating systems, e.g. for safety valves, see EN 12828; for heating boilers with a temperature $T_S > 110\text{ °C}$ the requirements of EN 12953-8 shall be met. **[A1]**

6.3.8 Cleaning and inspection openings

Boilers shall be provided with openings to permit cleaning and inspection of the boiler interior.

Sufficient space shall be provided to access to the relevant spaces.

6.3.9 Burner matching dimensions

The matching dimensions shall be agreed between boiler and burner manufacturer.

The requirements of EN 303-1 are applicable for nominal heat outputs up to 1 000 kW.

6.3.10 Thermal insulation

If thermal insulation is used it shall not markedly change its insulation properties at any place due to the effect of heat and ageing, and shall withstand normal thermal and mechanical stresses. Under normal conditions it shall not release any harmful substances. It shall be made of non-combustible material.

The minimum distance from the surfaces of the flue gas carrying parts to combustible material shall be such, that the combustible material shall have a max. temperature of 85 °C .

6.3.11 Water side resistance of the boiler

The water side resistances are to be determined for those flows which correspond to the nominal heat output with two temperature differences of 10 K and 20 K between the flow and return connections of the boiler. The results are to be stated in mbar for each boiler size.

6.3.12 Soundness of the combustion system

6.3.12.1 General

The combustion systems of all boilers shall be sound.

6.3.12.2 Boilers with negative pressure

With a negative pressure in the combustion chamber of 0,05 mbar, the air leakage on a mass basis shall be a maximum of 1 % of the flue gas mass flow at nominal heat output.

6.3.12.3 Boilers with positive pressure

With a positive pressure in the combustion chamber of 1,2 times the operating pressure stated by the manufacturer the leakage rate based on mass flow shall not exceed 2 % of the flue gas mass flow at the nominal heat output.

6.3.13 Safety temperature limiter and control thermostat

[A1] Each boiler shall be fitted with a fail-safe safety temperature limiter as specified below and a control thermostat with a value of max. 110 °C .

- For boilers where the shut off temperature of the safety temperature limiter does not exceed 110 °C , the safety temperature limiter shall comply with the requirements of EN 60730-2-9 for type 2 devices with a value stated by the manufacturer, which shall be less than 110 °C , or a lower value stated by the manufacturer.

manufacturer and the control thermostat shall comply with the requirements of EN 60730–2–9 for type 1 devices with a maximum operating temperature of 110 °C.

- For boilers where the shut off temperature of the safety temperature limiter exceeds 110 °C, the safety temperature limiter shall comply with the requirements of EN 60730–2–9 for type 2 devices with the value stated by the manufacturer, which shall be less than 120 °C, or a lower value stated by the manufacturer and the control thermostat shall comply with the requirements of EN 60730–2–9 for type 1 devices with a maximum operating temperature of 110 °C. 

6.3.14 Accessories for the boiler

If additional fittings have been fitted to the boiler by the manufacturer and if their maintenance is required for safe and correct operation it shall be possible for this to be carried out easily without major dismantling.

6.3.15 Electrical safety

6.3.15.1 General

Testing of electrical safety is carried out on the basis of EN 60335–1.

6.3.15.2 General specifications

- Type of electrical protection of the boiler (in accordance with EN 60529);
- details on electrical equipment (e. g. switches, relays).

6.3.15.3 Tests

To be checked by a visual test, a functional test or by measurement:

- protection against access to live parts;
- leakage current and electric strength;
- internal wiring;
- supply connection and external flexible cords;
- terminals for external conductors;
- provision for earthing;
- creepage distances, clearances and distances through insulation;
- safety requirements of the circuit diagram;
- non-interchangeable plugs.

6.3.15.4 Certificates

If a detailed declaration of conformity is necessary, the equipment manufacturer can provide the following information:

- heating;
- operation under overload conditions of appliances with heating elements;
- radio interference suppression (only for units);

– resistance to heat, fire and tracking.

7 Tests

7.1 General

Before the start of production, boilers shall be subjected to the rating test and combustion technology tests. During production the construction and water pressure tests shall be carried out.

The manufacturer shall ensure that the construction materials and welds are in conformity with the requirements of his factory production control system and that the results of all necessary tests conform to those requirements.

Tasks for the manufacturer:

- factory production control;
- further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan.

All boilers and their parts shall be subjected to a cold water pressure test in the works of the manufacturer. No leakage and no permanent deformation shall occur.

[A1] All boilers shall undergo a final inspection to assess visually and by examination of the accompanying documents. Test carried out during manufacture may be taken into account. As far as is necessary for safety reasons, the final inspection shall be carried out internally and externally on every part of the equipment, where appropriate in the course of manufacture (e.g. where examination during the final inspection is no longer possible). **[A1]**

7.2 Boilers of mild steel

7.2.1 Assessment test

[A1] The test shall verify that the design according to Annex A to E is adequate. **[A1]** If this test is carried as a hydraulic pressure test, the test period shall be at least 10 min. No leakage or noticeable permanent deformation shall occur during the test.

A record shall be made of the test giving the following details:

- exact description of the boiler tested stating the drawing number;
- test pressure in bar and duration of the test;
- test result and
- place and date of the test including the names of persons carrying out the test. The test report shall be signed by, as a minimum the works tester responsible and one witness.

[A1] *deleted text* **[A1]**

7.2.2 Test during production

The test pressure shall be

- **[A1]** for max. allowable temperature $TS \leq 110\text{ °C}$ ¹: $1,3 \cdot p_1$ **[A1]**

¹⁾ see Annex F.

— for max. allowable temperature $TS > 110\text{ }^{\circ}\text{C}^1$):

a) that corresponding to the maximum loading to which the pressure equipment may be subjected in service taking into account its maximum allowable pressure and its maximum allowable temperature, multiplied by the coefficient 1,25, or

b) the maximum allowable pressure multiplied by the coefficient 1,43, whichever is the greater.

 No leakage or noticeable permanent deformation shall occur during the test. 

7.3 Boilers of cast iron or non-ferrous metals

7.3.1 Assessment test (experimental design method)

 To assess the sections comply with the design requirements, three of each front, middle and back sections of each boiler shall be subjected to a burst test. The burst pressure shall be $> 4 \times p_1 + 2$ bar for boilers having a max. permissible operating pressure of 4 bar and $> 5,25 \times p_1$ for boilers having a max. permissible operating pressure of more than 4 bar.

Boilers of cast iron shall be subjected to a hydraulic burst test of $4 \times p_1$ with a minimum of 12 bar. No leakage shall occur during the test.

A water pressure test with a pressure of $2 \times p_1$, (minimum 6 bar) is sufficient if the strength of the tie bars shall be calculated with a max. permissible operating pressure of $4 \times p_1$ with a minimum of 12 bar. 

7.3.2 Test during production

Each boiler section shall be subjected to a cold water pressure test with a pressure of $2 \times PS$, (minimum 10 bar).

The wall thicknesses of the individual boiler sections shall be subjected to an examination during production. The limiting value of wall thickness at each measuring point shall be the nominal wall thickness less the permissible tolerance.

Boiler sections and parts which are subjected to pressure shall have the following information cast onto them:

- manufacturer or manufacturer's symbol;
- details of the material;
- cast date;
- model number;
- mark of approval if granted.

Each boiler shall be subjected to a water pressure test with a test pressure as given in 7.2.2, (minimum 4 bar) before fitting the thermal insulation at the manufacturer's works - for boilers which are site assembled by the installer, the boiler manufacturer shall provide instructions to carry out the pressure test. No leakage shall occur during the water test.

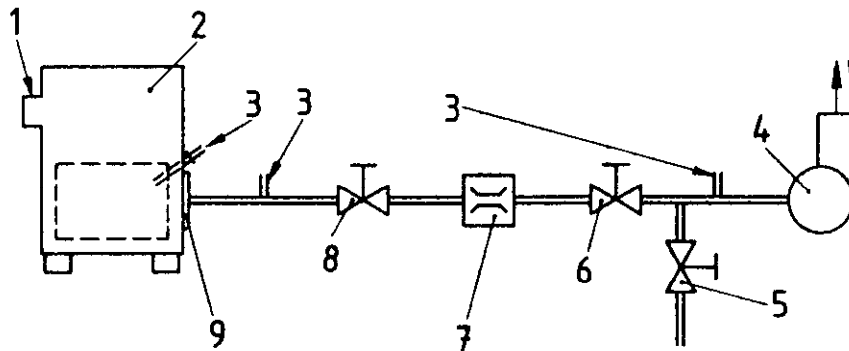
7.4 Test for gas side soundness

The specified limit values for permissible leakage rates are determined with the mass of the gases equivalent to the rated output.

The actual leakage rate of the boiler shall be determined using air at ambient temperature using a test rig in accordance with for example Figure 1.

The flue outlet shall be sealed and the doors and dampers shall be in their normal positions. The test rig is connected to the combustion chamber of the boiler under test either at the burner entry or a special entry.

The leakage rates obtained shall be corrected to standard conditions (0 °C and 1013 mbar).



Key

- | | |
|-------------------------------------|------------------------|
| 1 Flue gas outlet | 6 Valve 2 |
| 2 Boiler under test | 7 Flow meter |
| 3 Pressure/draught measuring points | 8 Valve 1 (regulating) |
| 4 Fan | 9 Burner plate |
| 5 Valve 3 (by-pass) | |

Figure 1 — Measuring point for determination of the gas side soundness

7.5 Marking

7.5.1 Boiler data plate

7.5.1.1 General

Each boiler shall be fitted with a data plate. The data plate shall be written in the language of the country of destination and attached to an accessible place.

7.5.1.2 Information on the data plate

The following information shall be given as a minimum:

- name and address of manufacturer and manufacturer's symbol, if applicable;
- trade name, type, under which the boiler is sold;
- serial number and year of manufacture (the manufacturer is free to use a code);
- nominal heat output or heat output range in kW;
- permissible operating pressure in bar;
- permissible operating temperature in °C;
- volume V in L;

- h) test pressure P_T , in bar;
- i) supply voltage in V;
- j) CE-marking according to the applied directives.

7.5.1.3 Requirements of the data plate

The plate shall be durable with regard to material and lettering. The lettering shall be abrasion resistant. Under normal conditions the plate shall not discolour in such a way that the information becomes illegible.

7.5.1.4 Self-adhesive plates shall not lift off due to humidity or temperature.

8 Performance requirements

8.1 General

The requirements apply to the thermal performance testing of oil fired heating boilers which are tested on an approved test rig in accordance with the test code given in EN 304. The tests could be carried out in a similar way according to EN 304 as on-site tests.

8.2 Boiler efficiency

The boiler efficiency shall not be less than the appropriate values in Figure 2 for the nominal heat output and/or range of outputs.

When comparing test results with the values in Figure 2, the following tolerances for the excess air λ shall apply:

$< 300 \text{ kW}$:	$\pm 10\%$
$\geq 300 \text{ kW}$:	$\lambda = 1,18 \text{ up to } 1,22$

Under the conditions of 8.1 the boilers shall comply with the following useful efficiency requirements:

Table 13 — Boiler temperatures

Boilers	Efficiency at $\langle A_1 \rangle P_n \langle A_1 \rangle$		Efficiency at $0,3 \langle A_1 \rangle P_n \langle A_1 \rangle$	
	Minimum values	Average water temperature in ° C	Minimum values	Average water temperature in ° C
Standard				
$\langle A_1 \rangle P_n \langle A_1 \rangle \leq 400 \text{ kW}$	$\geq 84 + 2 \log \langle A_1 \rangle P_n \langle A_1 \rangle$	70	$\geq 80 + 3 \log \langle A_1 \rangle P_n \langle A_1 \rangle$	50
$\langle A_1 \rangle P_n \langle A_1 \rangle > 400 \text{ kW}$	$\geq 89,2^a$	70	$\geq 87,8^{b, d}$	50
Low temperature				
$\langle A_1 \rangle P_n \langle A_1 \rangle \leq 400 \text{ kW}$	$\geq 87,5 + 1,5 \log \langle A_1 \rangle P_n \langle A_1 \rangle$	70	$\geq 87,5 + 1,5 \log \langle A_1 \rangle P_n \langle A_1 \rangle$	40
$\langle A_1 \rangle P_n \langle A_1 \rangle > 400 \text{ kW}$	$\geq 91,4^c$	70	$\geq 91,4^{c, d}$	40
^a $84+2 \log 400=84+2 (2,60)=89,2$ ^b $80+3 \log 400=80+3 (2,60)=87,8$ ^c $87,5+1,5 \log 400=87,5+1,5 (2,60)=91,4$ ^d only for boilers up to 1 000 kW				

NOTE Low temperature boilers may be tested at part load with a water temperature > 40 °C to be sure to fulfil the required efficiency at 40 °C according to EU-Directive 92/42 EEC.

For heating boilers with a heat output range $\leq 400 \text{ kW}$ the boiler efficiency shall be calculated as follows:

- a) efficiency at full-load (nominal heat output) ($\langle A_1 \rangle P_n \langle A_1 \rangle$):
 $\geq 84 + 2 \cdot \log \langle A_1 \rangle P_n \langle A_1 \rangle$;
- b) efficiency at part-load ($0,3 \cdot \langle A_1 \rangle P_n \langle A_1 \rangle$):
 $\geq 80 + 3 \cdot \log \langle A_1 \rangle P_n \langle A_1 \rangle$.

For low temperature boilers with a heat output range $\leq 400 \text{ kW}$ the boiler efficiency for full load and part load shall be calculated as follows:

— at $\langle A_1 \rangle P_n \langle A_1 \rangle$ and $0,3 \langle A_1 \rangle P_n \langle A_1 \rangle \geq 87,5 + 1,5 \log \langle A_1 \rangle P_n \langle A_1 \rangle$

8.3 Draught requirements and flue gas resistance

See Figures 2 and 3.

8.4 Exit gas temperature

See EN 303-2.

8.5 Emission values

See EN 267.

8.6 Standby loss

For $\langle A_1 \rangle P_n \langle A_1 \rangle \leq 1 \text{ MW}$: see EN 303-2.

For $\langle A_1 \rangle P_n \langle A_1 \rangle > 1 \text{ MW}$:

$$\langle A_1 \rangle q_B = \frac{q_R \times \eta_k}{P_n} = \frac{q_R}{Q_B} \langle A_1 \rangle$$

where:

$$\langle A_1 \rangle \eta_k = \frac{P_n}{Q_B} \langle A_1 \rangle$$

q_B = standby loss;

q_R = calculated heat transferred to the heating boiler in kW;

η_k = boiler efficiency;

$\langle A_1 \rangle P_n \langle A_1 \rangle$ = nominal heat output in kW;

Q_B = heat input in kW.

The following mean values for the heat transfer should apply:

- for external surfaces: $q_{R1} = 50 \text{ W/m}^2$ conditions: minimum insulation thickness of 80 mm with insulation material ($\lambda \leq 0,045 \text{ W/m K}$) and the cover has been connected;
- for doors having large surfaces: $q_{R2} = 200 \text{ W/m}^2$ conditions: mean temperature shall not exceed the room temperature by max. 20 K - 25 K;
- for internal heat transfer of heat areas to the circulating air (for attached burners): $q_{R3} = 100 \text{ W/m}^2$ conditions: not necessary if a flue gas device is connected.

$$q_R = q_{R1} \times F_1 + q_{R2} \times F_2 + q_{R3} \times F_3$$

If the conditions are not met, the determination of the standby loss shall be carried out according to EN 304.

8.7 Surface temperature

See EN 303-1.

8.8 Floor temperatures

See EN 303-1.

9 Technical documentation

9.1 General

The documents listed below shall be available for each boiler in the language of the country of destination. The documents in accordance with 9.2 and 9.3 shall be supplied with every boiler.

9.2 Technical information and installation instructions

These documents shall include at least those details necessary for planning:

- the required draught in mbar;

- gas side resistance and combustion chamber pressure for boilers operating with positive pressure in mbar;
- exit flue gas temperature in °C;
- exit flue gas temperature for the range of output in °C;
- exit flue gas mass flow in kg/s;
- exit flue connection diameter in mm;
- water resistance in mbar;
- maximum heat input in kW;
- nominal heat output or heat output range in kW;
- standby loss;
- gas volume of the boiler in m³;
- range of temperature control in °C;
- fuel type;
- combustion chamber type;
- the combustion chamber dimensions and the combustion chamber volume;
- direct flame operation or flame reversal;
- boiler type: ON/OFF, modulating, multi stage;
- burner matching dimensions.

The installation instructions shall give information on the following:

- assembly of the boiler and if necessary the water pressure test (see 5.2.2 or 5.3.2);
- where the temperature beneath the boiler can exceed 50 °C information shall be given on additional insulation required if the floor is of combustible material;
- information on the installation and positioning of probes for control, indication and safety;
- commissioning, including information on the heat input needed for the required heat output.

In addition reference shall be made to the standards and regulations to be observed in respect of the installation safety equipment.

A1 For heating boilers with a temperature $TS > 110\text{ °C}$ the manufacturer shall provide elements relating to compliance with the materials specifications of the PED in one of the following forms: **A1**

- by using materials which comply with harmonised standards;
- by using materials covered by a European approval of pressure equipment materials;
- by a particular material appraisal.

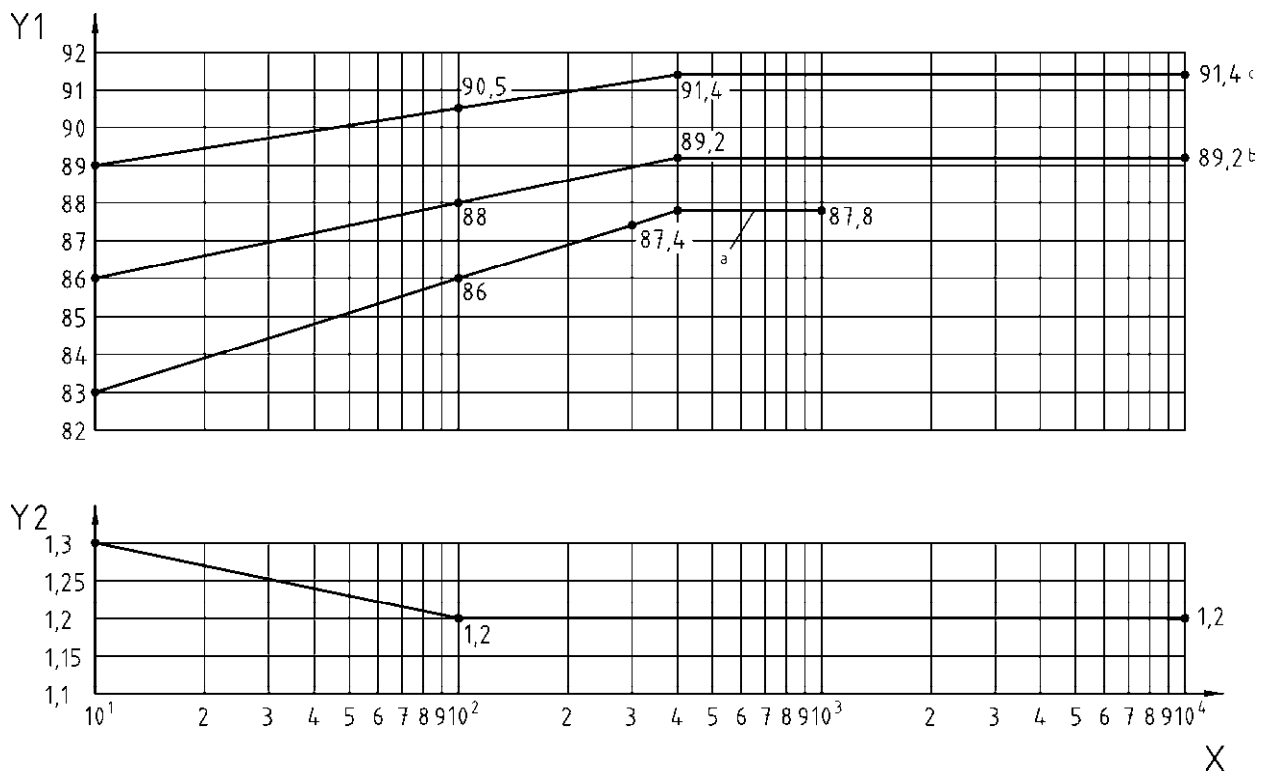
9.3 Operating instructions

The operating instructions shall contain information on:

- the operating of the boiler;
- cleaning and intervals between cleaning;
- action in case of faults;
- the reasons for maintenance by a competent person and the intervals between maintenance;
- type of fuel;
- warnings (Where the potential for misuse is known or can be clearly foreseen, the heating boiler shall be designed to prevent danger from such misuse or, if that is not possible, adequate warning given that the heating boiler shall not be used in that way).

Other printed matter (leaflets etc) shall not contain information contradicting the operating instructions.

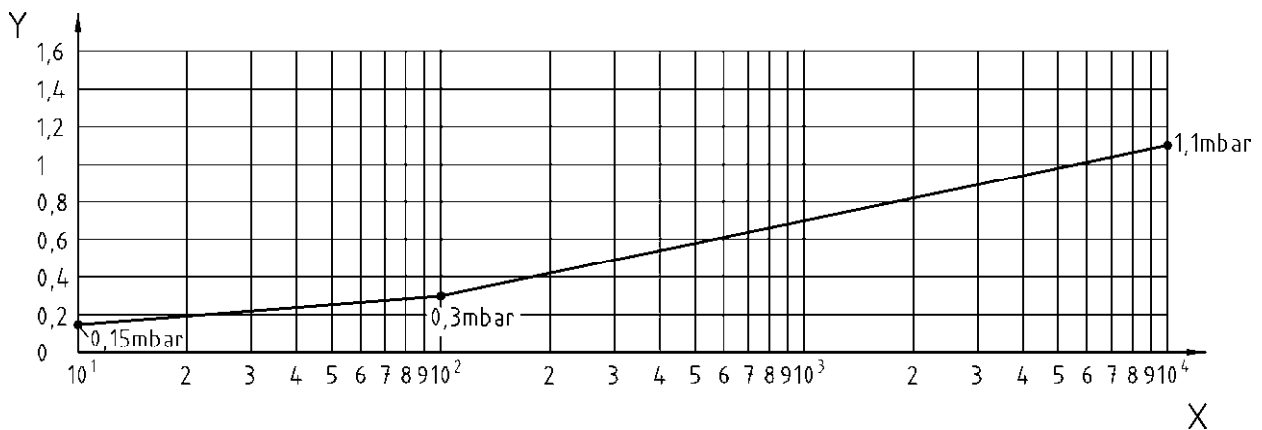
For heating boilers with a temperature $T_S > 110\text{ °C}$ the operating instructions shall be completed by the conformity declaration of the manufacturer.



Key

- Y1 Efficiency
- a $\eta_{k, \text{heating boiler, 30 \% } \eta_{k, \text{heating boiler}}}$
- Y2 Excess air
- b $\eta_{k, \text{heating boiler, } \eta_{k, \text{heating boiler}}}$
- X Heat output $\eta_{k, \text{low temperature boiler, } \eta_{k, \text{low temperature boiler}}}$ and 30 % $\eta_{k, \text{low temperature boiler, } \eta_{k, \text{low temperature boiler}}}$ (only for boilers up to 1 000 kW)
- c $\eta_{k, \text{low temperature boiler, } \eta_{k, \text{low temperature boiler}}}$ and 30 % $\eta_{k, \text{low temperature boiler, } \eta_{k, \text{low temperature boiler}}}$ (only for boilers up to 1 000 kW)

Figure 2— Requirements for heating boilers with forced draught burners

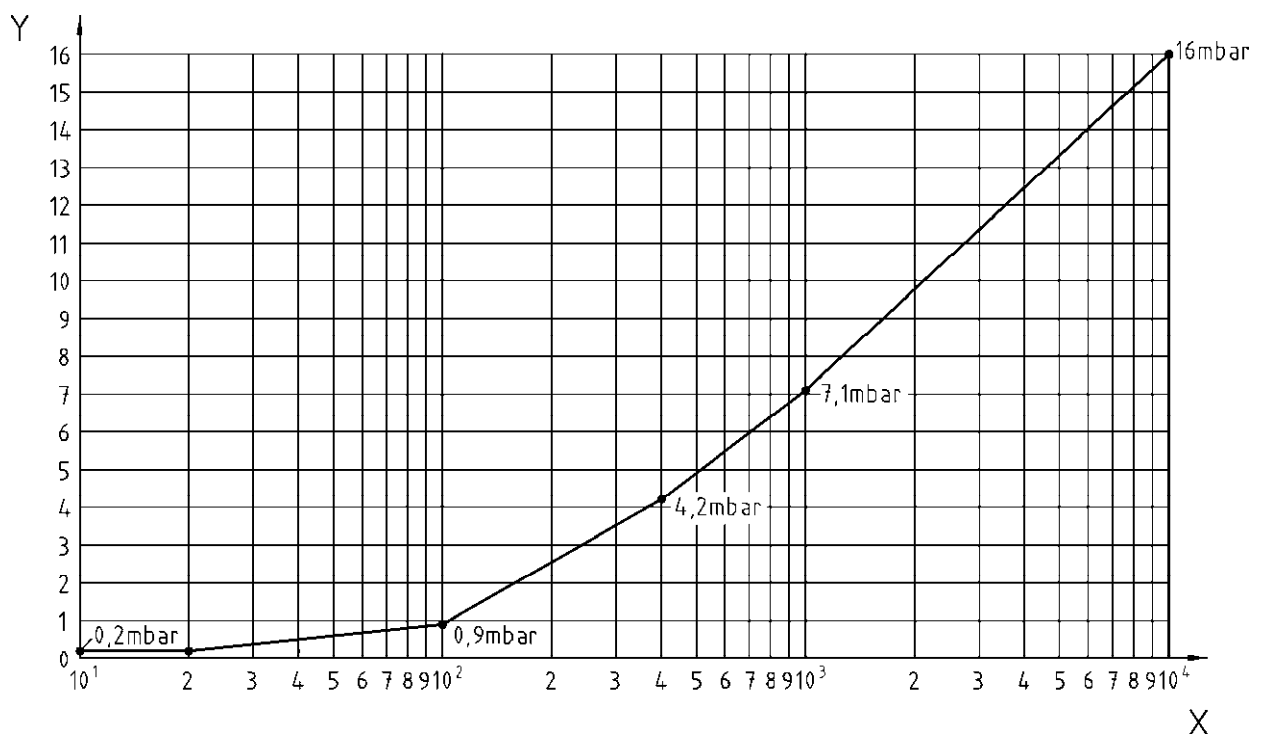


Key

Y Excess air

X Heat output $\langle \dot{Q} \rangle P_n \langle \dot{Q} \rangle$ in kW

Figure 3 – Draught requirements for boilers with negative pressure



Key

Y Pressure differential in mbar

X Heat output $\langle \dot{Q} \rangle P_n \langle \dot{Q} \rangle$ in kW

Figure 4 – Maximum flue gas resistance for boilers operated with a positive pressure