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English version

Water-tube boilers and auxiliary installations - Part 2: Materials for pressure parts of boilers and accessories

Chaudières à tubes d'eau et installations auxiliaires - Partie
2: Matériaux des parties sous pression des chaudières et
accessoires

Wasserrohrkessel und Anlagenkomponenten - Teil 2:
Werkstoffe für drucktragende Kesselteile und Zubehör

This European Standard was approved by CEN on 19 February 2001.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 269 "Shell and water-tube boilers", the secretariat of which is held by DIN.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of the Pressure Equipment Directive (PED)¹. For relationship with Pressure Equipment Directive see informative annex ZA, which is an integral Part of this Standard.

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of an identical text or by endorsement, at the latest by June 2002, and conflicting national standards shall be withdrawn at the latest by June 2002.

In accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard as their National Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

The European Standard series EN 12952 concerning water-tube boilers and auxiliary installations consists of the following parts:

- Part 1: General
- Part 2: Materials for pressure parts of boilers and accessories
- Part 3: Design and calculation for pressure parts
- Part 4: In-service boiler life expectancy calculations
- Part 5: Workmanship and construction of pressure parts of the boiler
- Part 6: Inspection during construction, documentation and marking of pressure parts of the boiler
- Part 7: Requirements for equipment for the boiler
- Part 8: Requirements for firing systems for liquid and gaseous fuels for the boiler
- Part 9: Requirements for firing systems for pulverised solid fuels for the boiler
- Part 10: Requirements for safeguards against excessive pressure
- Part 11: Requirements for limiting devices and safety circuits of the boiler and accessories
- Part 12: Requirements for boiler feedwater and boiler water quality
- Part 13: Requirements for flue gas cleaning systems
- Part 14: Requirements for flue gas DENOX-systems
- Part 15: Acceptance tests
- Part 16: Requirements for grate and fluidized bed firing systems for solid fuels for the boiler

Although these Parts may be obtained separately, it should be recognized that the Parts are inter-dependent. As such, the design and manufacture of boilers requires the application of more than one Part in order for the requirements of the European Standard to be satisfactorily fulfilled.

NOTE: Part 4 is not applicable during the design, construction and installation stages.

The annexes A, B and C of this European Standard are normative, the annex ZA is informative.

¹) Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment; OJEC L181.

1 Scope

This EN 12952-2 covers the requirements for the following materials for use in pressure parts of water-tube boilers and for parts welded on pressure parts:

- plates;
- wrought seamless tubes;
- electrically welded tubes;
- submerged, plasma and TIG arc-welded tubes;
- forgings;
- castings;
- rolled bars;
- welding consumables;
- fasteners;
- seamless composite tubes.

2 Normative references

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

EN 440, *Welding consumables – Wire electrodes and deposits for gas shielded metal arc welding of non alloy and fine grain steels – Classification.*

EN 499, *Welding consumables – Covered electrodes for manual metal arc welding of non alloy and fine grain steels – Classification.*

EN 756, *Welding consumables – Wire electrodes and wire-flux combinations for submerged arc welding of non alloy and fine grain steels – Classification.*

EN 758, *Welding consumables – Tubular cored electrodes for metal arc welding with and without a gas shield of non alloy and fine grain steels – Classification.*

EN 759, *Welding consumables – Technical delivery conditions for welding filler metals – Type of product, dimensions, tolerances and marking.*

prEN 764-4:1999, *Pressure equipment – Part 4: Establishment of technical delivery conditions for materials.*

prEN 764-5:1999, *Pressure equipment – Part 5: Compliance and inspection documentation of materials.*

prEN 1092-1:2001, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, PN designated – Part 1: Steel flanges.*

EN 1503-1, *Valves – Materials for bodies, bonnets and covers – Part 1: Steels specified in European Standards.*

EN 1503-2, *Valves – Materials for bodies, bonnets and covers – Part 2: Steels other than those specified in European Standards.*

EN 1599, *Welding consumables – Covered electrodes for manual metal arc welding of creep-resisting steels – Classification.*

EN 1668, *Welding consumables – Rods, wires and deposits for tungsten inert gas welding of non alloy and fine grain steels – Classification.*

prEN 1759-1:2000, *Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories, class designated – Part 1: Steel flanges, NPS ½ to 24.*

EN 10002-1, *Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature.*

- EN 10002-5, *Metallic materials – Tensile testing – Part 5: Method of testing at elevated temperature.*
- EN 10021, *General technical delivery requirements for steel and iron products.*
- EN 10028-1, *Flat products made of steels for pressure purposes – Part 1: General requirements.*
- EN 10028-2, *Flat products made of steels for pressure purposes – Part 2: Non alloy and alloy steels with specified elevated temperature properties.*
- EN 10028-3, *Flat products made of steels for pressure purposes – Part 3: Weldable fine grain steels, normalized.*
- EN 10045-1, *Metallic materials – Charpy impact test – Part 1: Test method.*
- EN 10160, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method).*
- EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product – Technical delivery conditions.*
- EN 10204, *Metallic products – Types of inspection documents.*
- EN 10213-1, *Technical delivery conditions for steel castings for pressure purposes – Part 1: General.*
- EN 10213-2, *Technical delivery conditions for steel castings for pressure purposes – Part 2: Steel grades for use at room temperature and elevated temperatures.*
- prEN 10216-1:1995, *Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 1: Non alloy steel tubes with specified room temperature properties.*
- prEN 10216-2:1998, *Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 2: Non alloy and alloy steel tubes with specified elevated temperature properties.*
- prEN 10216-3:1998, *Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 3: Non alloy and alloy fine grain steel tubes.*
- prEN 10216-5:1998, *Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 5: Stainless steel tubes.*
- prEN 10217-2:1998, *Welded steel tubes for pressure purposes – Technical delivery conditions – Part 2: Electric welded non alloy and alloy steel tubes with specified elevated temperature properties.*
- prEN 10217-3:1998, *Welded steel tubes for pressure purposes – Technical delivery conditions – Part 3: Alloy fine grain steel tubes.*
- EN 10222-2, *Steel forgings for pressure purposes – Part 2: Ferritic and martensitic steels with specified elevated temperature properties.*
- EN 10222-3, *Steel forgings for pressure purposes – Part 3: Nickel steels with specified low temperature properties.*
- EN 10222-4, *Steel forgings for pressure purposes – Part 4: Weldable fine grain steels with high proof strength.*
- EN 10222-5, *Steel forgings for pressure purposes – Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.*
- EN 10228-1, *Non-destructive testing of steel forgings – Part 1: Magnetic particle inspection.*
- EN 10228-2, *Non-destructive testing of steel forgings – Part 2: Penetrant testing.*
- EN 10228-3, *Non-destructive testing of steel forgings – Part 3: Ultrasonic testing of ferritic or martensitic steel forgings.*
- EN 10236, *Metallic materials – Tube – Ring expanding test.*
- EN 10246-6, *Non-destructive testing of steel tubes – Part 6: Automatic full peripheral ultrasonic testing of seamless steel tubes for the detection of transverse imperfections.*

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EN 10246-7, *Non-destructive testing of steel tubes – Part 7: Automatic full peripheral ultrasonic testing of seamless and welded (except submerged arc welded) steel tubes for the detection of longitudinal imperfections.*

EN 10253-1, *Butt welding pipe fittings – Part 1: Wrought carbon steel for general use and without specific inspection requirements.*

prEN 10253-2:1999, *Butt welding pipe fittings – Part 2: Wrought carbon and ferritic alloy steel with specific inspection requirements.*

EN 10254, *Steel closed die forgings – General technical delivery conditions.*

EN 10273, *Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties.*

EN 12070, *Welding consumables – Wire electrodes, wires and rods for arc welding of creep-resisting steels – Classification.*

EN 12071, *Welding consumables – Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels – Classification.*

EN 12074, *Welding consumables – Quality requirements for manufacture, supply and distribution of consumables for welding and allied processes.*

EN 12536, *Welding consumables – Rods for gas welding of non alloy and creep-resisting steels – Classification.*

prEN 12952-3:1997, *Water-tube boilers and auxiliary installations – Part 3: Design and calculation for pressure parts.*

prEN 12952-5:2000, *Water-tube boilers and auxiliary installations – Part 5: Workmanship and construction of pressure parts of the boiler.*

prEN 12952-6:1997, *Water-tube boilers – Part 6: Inspection during construction, documentation and marking.*

prEN 12952-7:1998, *Water-tube boilers – Part 7: Requirements for equipment.*

prEN 12952-12:1998, *Water-tube boilers – Part 12: Requirements for feedwater and boiler water quality.*

prEN 13479-1:1999, *Welding consumables – Test methods and quality requirements for conformity evaluation of consumables – Part 1: Primary methods and evaluation.*

ENV 22605-3, *Steel products for pressure purposes – Derivation and verification of elevated temperature properties – Part 3: An alternative procedure for deriving the elevated temperature yield or proof stress properties when data are limited (ISO 2605-3:1985).*

ISO 2566-1, *Steel – Conversion of elongation values – Part 1: Carbon and low alloy steels.*

ISO 2566-2, *Steel – Conversion of elongation values – Part 2: Austenitic steels.*

ISO 3419, *Non alloy and alloy steel butt-welding fittings.*

ISO 5251, *Stainless steel butt-welding fittings.*

ISO 6303, *Pressure vessel steels not included in ISO 2604, Parts 1 to 6 – Derivation of long-time stress rupture properties.*

ISO 7005-1, *Metallic flanges – Part 1: Steel flanges.*

CR ISO 15608, *Welding-Guidelines for a metallic material grouping system (ISO/TR 15608:2000).*

3 General requirements

3.1 Selection of materials with regard to service conditions

The manufacturer of the water-tube boilers shall select the material (including welding consumables) for the manufacture of the boilers so that, when the delivered material (including welding consumables) complies with the requirements specified in the material order and when the design rules in EN 12952-3 and the rules for the fabrication, inspection and testing of the boilers in EN 12952-5 and EN 12952-6 are observed, the boilers can be operated without hazard under the service conditions (pressures, temperatures, environments, etc.) for the life time provided in the order for the boiler.

The materials specified in clause 4 which satisfy the elongation and impact energy requirements of 4.2.5.3 and 4.2.5.4 respectively shall not be considered prone to brittle fracture during manufacture and subsequent operation in accordance with the provisions of this European Standard. It is also considered that for operation within the parameters specified in EN 12952-3 using feedwater and boiler water as specified in prEN 12952-12 the selected materials will not be significantly affected by ageing or chemical attack.

3.2 Selection of materials with regard to fabrication

The selection of the materials of construction for pressure parts of water-tube boilers and to parts welded on pressure parts shall take into account the suitability of the material with regard to fabrication, e.g. cold and hot forming, weldability, expanding, and heat treatment.

NOTE: The rules for forming or post-weld heat treatment are included in EN 12952-5.

3.3 Material specification

3.3.1 General

The selection and order of materials for pressure parts shall be based on one of the following material specifications for pressure equipment in the form of:

- a) Harmonized European material Standards
- b) European Material Data Sheets (EMDS)
- c) Particular material appraisals.

3.3.2 European Standards

Materials in accordance with harmonized European Standards shall be selected for types, treatment conditions and dimensions of products frequently used in Europe.

NOTE: Materials in accordance with European Standards are given in annex A.

3.3.3 European approvals for materials

European approvals for materials are intended for repeated use. They are established in accordance with prEN 764-4 and apply to materials or treatment conditions and product forms or dimensions not covered in a European material Standard for pressure equipment.

The European approvals for materials for pressure equipment result in European Material Data Sheets.

NOTE: Reference of available European Material Data Sheets is published in the Official Journal of the European Community.

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3.3.4 Particular material appraisals

Particular material appraisals apply for individual cases as for example:

- a) a material or a product form or a thickness not covered by a European material Standard or EMDS intended for use in a particular pressure equipment;
- b) a product specified in a European material Standard or EMDS for materials for pressure equipment is intended in an exceptional case for service conditions outside its specified range of application.

Where relevant to the pressure equipment under consideration the requirements given in prEN 764-4 should be considered.

3.4 Consideration of special material properties

When materials are chosen with properties other than those specified in the material specification, or which may influence the life time or the safe service behaviour of the water-tube boiler, they shall be taken into account when selecting the material and its dimensions.

NOTE: Examples are the scaling or ageing behaviour of the material.

3.5 Contents of material specification

The different types of specifications for materials for water-tube boilers include the clauses given in table 3.1 as a minimum.

Table 3.1 — Content of specifications for materials for pressure parts

Clauses	EN- Standards	European material data sheets		Particular material appraisals
		unrestricted	restricted	
Scope	X	see prEN 764-4		
References	X			
Definitions	(X)			
Requirements	X			
Inspection	X			
Marking	X			
Guidelines for processing the material etc. (welding, heat treatment, forming, flame-cutting)	Z			
Restrictions on application	Z			
X = in all cases (X) = if necessary Z = the relevant guidelines for fabrication and the restrictions on application are, where necessary, given in EN 12952-5 ¹⁾ If applicable by reference to a European Standard for pressure purposes				

3.6 Compliance and inspection documentation of materials

Manufacturers and stockists of materials for pressure parts including welding consumables shall follow the requirements in accordance with prEN 764-5. They shall provide sufficient evidence of their capability to deliver materials with consistent quality in accordance with the specifications and prEN 764-5.

4 Materials for pressure parts

4.1 Materials covered by harmonized European material Standards for pressure purposes

4.1.1 Flat products, forgings, castings, tubes, fittings, flanges and valve bodies

The material shall be ordered and delivered in accordance with annex A and the relevant European Standards EN 10028-2, EN 10028-3, EN 10213-1, EN 10213-2, prEN 10216-2, prEN 10216-3, prEN 10217-2, prEN 10217-3, EN 10222-2, EN 10222-5, EN 10253-1, EN 10254 and EN 10273. The additional requirements given in this Part shall be taken into account. Harmonized supporting standards are prEN 1092-1, EN 1503-1, EN 1503-2, prEN 1759-1.

4.1.2 Cast iron

Nodular cast iron shall not be used in the construction of pressure parts, except for valves and fittings as indicated in prEN 12952-7, within the design limits specified in EN 12952-3. The use of other types of cast iron shall not be permitted.

4.1.3 Studs, bolts and nuts

Studs, bolts and nuts shall be ordered and delivered in accordance with the requirements of EN 12952-3.

4.1.4 Welding consumables

The welding consumables (electrodes, filler wires, filler rods, fluxes, fusible inserts) shall be selected so that the mechanical properties of the weld metal are compatible with the relevant requirements of the base materials from EN 440, EN 499, EN 756, EN 758, EN 759, EN 1599, EN 1668, EN 12070, EN 12071, EN 12074 and EN 12536.

The welding consumables shall be ordered and delivered according to specifications approved in accordance with EN 12074 and prEN 13479-1.

4.1.5 Verification of properties

The properties shall conform to the requirements of the European material Standards. Compliance with the delivery requirements shall be documented in the inspection document.

4.1.6 Requirements for non-destructive examination

The non-destructive examination (NDE) requirement for various forms of material shall be as given below.

a) plates:

NDE in accordance with EN 10160 class S1.

b) tubes – seamless:

Seamless tubes shall be tested in accordance with prEN 10216 (Series) test category II .

For unalloyed seamless tubes with design temperatures below 450 °C and design pressures below 42 bar, it is permitted to perform category 1 in accordance with prEN 10216-2.

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1) longitudinal imperfections:

NDE in accordance with EN 10246-7

Acceptance level: U2 sub-category B for cold finished and machined tubes
U2 sub-category C for all other conditions

2) transverse imperfection:

NDE in accordance with prEN 10246-6

Acceptance level: U2 sub-category C for all headers with outside diameters > 142 mm.

3) tube ends:

NDE in accordance with annex B of EN 10246-7;

Acceptance level: U2 sub-category B or C as for longitudinal imperfections.

NOTE: This is only mandatory for fixed length tubes. When the tubes are in close end to end contact, it can be accepted that 100 % (full length) ultrasonic examination has taken place, and therefore no additional tube end examination is required.

c) tubes - welded:

Welded tubes of test category II in accordance with prEN 10217- 2

For unalloyed welded steel tubes with design temperatures below 450 °C and design pressures below 42 bar, it is permitted to perform category I in accordance with prEN 10217-2. However, the longitudinal weld shall be subject to ultrasonic examination.

1) longitudinal imperfections:

NDE in accordance with EN 10246-7

Acceptance level: U2 sub-category C

2) transverse imperfection:

NDE in accordance with prEN 10246-6

Acceptance level: U2 sub-category C for all headers with outside diameter > 142 mm.

3) tube ends:

NDE in accordance with annex B of EN 10246-7;

Acceptance level: U2 sub-category C as for longitudinal imperfections.

NOTE: This is only mandatory for fixed length tubes. When the tubes are in close end to end contact, it can be assumed that 100 % (full length) ultrasonic examination has taken place, and therefore no additional tube end examination is required. The requirements annex I, 3.1.2. and 3.1.3 of Pressure Equipment Directive 97/23/EC should be taken into account.

d) forgings:

Forgings produced in accordance with EN 10222-2, EN 10222-3, EN 10222-4, prEN 10222-5 and solid bars produced in accordance with EN 10222-2 required for the production of tubular sections by machining, shall be tested in accordance with the requirements for tubes taking into consideration EN 10228-1 to EN 10228-3, steel closed die forgings shall be delivered in accordance with EN 10254.

e) steel castings:

Steel castings shall be delivered and tested in accordance with EN 10213-1 and EN 10213-2.

4.1.7 Inspection documents

The type of inspection document to be applied shall be as specified in clause 6 and prEN 764-5.

NOTE: Additional tests may be specified to cover additional or deviating requirements.

4.1.8 Marking

For reasons of traceability, each product shall be individually marked or, if delivered in bundles or boxes, may be marked with a label secured to the bundle or box.

The marking shall at least cover the following:

- the symbol of the manufacturer's works;
- the steel grade or material grade or material number;
- the cast number;
- the stamp of the inspection representative if specified by the boiler manufacturer, or nominated in prEN 764-5;
- the sample or batch number, or any other number by which the test sample can be identified;
- the heat treatment condition (if relevant);
- the direction of rolling for flat products (if relevant).

Marking shall be carried out in accordance with the requirements of 6.3 of EN 12952-5. For methods of marking see European Standards for materials.

4.2 Material covered by European Approvals of material for pressure equipment – technical requirements

4.2.1 General

The material shall be covered by a European Material Data Sheet (EMDS) established in prEN 764-4. This data sheet shall meet the requirements in accordance with table 3-1.

NOTE: The term "cast", when related to chemical composition, is used in the same way as in all European base materials standards and refers to the material in its molten condition.

4.2.2 Manufacture

If the properties specified can be reliably achieved only when special methods of manufacture are applied (e.g. vacuum melting, treatment of the cast with nitrogen binding elements, or, in the case of welded tubes, defined welding methods are applied), these methods shall be considered.

Rimming steels and semi-killed steels shall not be used.

4.2.3 Heat treatment condition

The heat treatment condition of the material at the time of delivery shall be specified.

NOTE: Plates to be hot formed may be supplied in any suitable condition, e.g. as rolled, hot finished, normalized and tempered.

Carbon and carbon manganese steel plates (Steel group 1, 2) to be cold formed shall be supplied in the normalized condition.

Low alloy steel plates (Steel group 4, 5) to be cold formed shall be supplied in the normalized and tempered condition except that, where metallurgically suitable and where post-welded heat treatment will suffice as the tempering treatment, plates supplied in the normalized condition shall be permitted.

Electrically welded tubes shall be supplied in the normalized condition.

4.2.4 Chemical composition

The chemical composition for the cast analysis and for the product analysis shall be specified. For steels intended for welding or forming, the values specified should not exceed the values given in table 4-1. Steels for which the values are higher than those given in table 4.1 may be used subject to appropriate welding approvals with appropriate heat treatment.

Table 4.1 — General requirements for the chemical composition of steels for pressure parts

Steel	Maximum content according to analysis					
	% C		% P		% S	
	cast	product	cast	product	cast	product
Ferritic steels	0,23	(0,25)	0,035	(0,040)	0,030	(0,035)
Austenitic steels	0,10	(0,11)	0,035	(0,040)	0,015	(0,020)

Elements not specified in the EMDS shall not be added intentionally, except for finishing the cast. All reasonable precautions shall be taken to prevent the addition of elements from scrap or other materials used in the manufacture, but residual elements may be present, provided the mechanical properties and applicability are not adversely affected.

4.2.5 Mechanical and technological properties

4.2.5.1 General

The following property values shall be specified for each type of material, so that they reflect the specific properties of the individual steel grade.

4.2.5.2 Tensile properties at room temperature

The tests shall be carried out in accordance with EN 10002-1.

a) Yield or proof strength values

For all ferritic steels, the minimum value for the upper yield strength $R_{\text{ch}, \text{min}}$ or, for cases where no yield phenomenon occurs, the minimum proof strength for 0,2 % non-proportional extension $R_{\text{p}0,2, \text{min}}$ shall be specified.

For austenitic steels, the minimum proof strength values for 1 % non-proportional extension $R_{\text{p}1,0, \text{min}}$ and, where appropriate, additionally $R_{\text{p}0,2, \text{min}}$ values shall be specified.

b) Tensile strength

For the tensile strength, a minimum value $R_{\text{m}, \text{min}}$ and, unless no maximum yield or proof strength value is specified, a maximum value $R_{\text{m}, \text{max}}$ shall be specified.

The specified minimum tensile strength shall be not less than 320 N/mm². The specified maximum tensile strength should not exceed the specified minimum tensile strength by more than

- 120 N/mm² for carbon and carbon manganese steels;
- 150 N/mm² for alloy steels, except austenitic steels;
- 200 N/mm² for austenitic steels.

4.2.5.3 Elongation at fracture

The minimum percentage elongation at fracture A_{min} shall be specified for longitudinal and transverse direction if possible. The gauge length shall be as recommended for the relevant product form and thickness in EN 10002-1.

Transverse test specimens shall be taken where the form and thickness of the products permit.

Steels shall have a specified minimum elongation after fracture measured on a gauge length $L_0 = 5,65\sqrt{S_0}$ (S_0 = original cross sectional area within the gauge length) that is:

≥ 14 % for the transverse direction, or in those rare cases where it is the more critical direction, the longitudinal

direction and

≥ 16 % for the longitudinal direction, or where this is the less critical direction, the transverse direction.

However, lower elongation values than specified in 4.2 (e. g. fasteners or castings) may also be applied, provided that appropriate measures are proposed, discussed and agreed to compensate for these lower values.

NOTE: Examples for compensation: – application of higher safety factors in design;
– performance of appropriate burst tests to demonstrate ductile material behaviour.

For gauge lengths other than $L_0 = 5,65 \sqrt{S_0}$ the minimum value for elongation after fracture shall be determined by conversion of the above specified values of 14 % and 16 % using the conversion tables given

- in ISO 2566-1 for carbon and low alloy steels;
- in ISO 2566-2 for austenitic steels.

4.2.5.4 Charpy V – notch impact energy

The tests shall be carried out with Charpy V-notch specimens in accordance with EN 10045-1. Transverse specimens shall be used, if possible.

The specified mean impact energy value obtained from a set of three specimens at a temperature not greater than 20 °C but not higher than the lowest scheduled operating temperature shall be

- ≥ 27 J for transverse specimens or
- ≥ 35 J for longitudinal specimens.

Only one individual value may be lower than the mean value, but it shall not be less than 70 % of the mean value. The sequential test method in accordance with EN 10021 shall be applied.

4.2.5.5 Elevated temperature proof strength

The test shall be carried out in accordance with EN 10002-5.

For materials intended for the application at temperatures above 50 °C,

- the minimum 0,2 % non-proportional proof strength values $R_{p0,2, \min}$, or
- the minimum 1 % non-proportional proof strength values $R_{p1,0, \min}$ as defined in 4.2.5.2 a)

shall be specified, preferably for the following series of temperatures:

100 °C, 150 °C, 200 °C etc. up to the highest temperature for which proof strength values are used for the design.

The minimum values specified for room temperature may be used for temperatures equal to or less than 50 °C.

Between 50 °C and 100 °C the values shall be derived by linear interpolation between the 50 °C values and the 100 °C values.

The specified minimum elevated temperature proof strength values shall be derived in accordance with ENV 22605-3.

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4.2.5.6 Creep rupture strength

For materials intended for the application at temperatures in the creep range, the average stress rupture values shall be specified in accordance with ISO 6303, taking into account the requirements of annex B.

When only stress rupture values with extended time or stress extrapolation or such values derived from an insufficient number of test results (see ISO 6303) are available, account of this shall be taken either by increasing the safety factor or by shortened intervals between repeated inspections.

The material supplier shall provide the boiler manufacturer with a written statement declaring that the product supplied complies with the specified properties and that the manufacturing processes have remained equivalent to those for the steel from which the test results were obtained.

4.2.5.7 Technological properties

Where necessary, requirements for formability shall be specified e.g. on the basis of flattening or drift expanding tests or on the basis of tests for the deformation properties perpendicular to the surface of the product (see EN 10164) or requirements for other technological properties important for the processing or use of the material.

4.2.5.8 Other properties

Where necessary, the requirements for properties other than those covered under 4.2.5.2 to 4.2.5.7 shall be specified e.g., requirements referring to the corrosion resistance of the material and the relevant verification procedure.

4.2.5.9 Surface condition and internal soundness

The products shall be free from surface and internal defects which might impair their usability.

The requirements for non-destructive examination shall be the same as for the same type of products of a comparable material listed in annex A and as given in 4.1.6.

4.2.5.10 Dimensions and tolerances on dimensions, shape and weight

Dimensions and tolerances on dimensions, shape and weight shall, where possible, be specified by reference to the appropriate dimensional standard.

4.2.5.11 Testing and inspection

For assessing the conformity of the delivered material with the requirements, the technical delivery conditions shall specify the following:

- a) the types of inspection documents (see clause 6);
 - b) the properties to be verified (e.g. cast analysis, tensile properties);
 - c) the conditions applicable for specific inspection and testing (acceptance testing), namely:
 - 1) the composition and maximum size of the test unit (e.g. the maximum weight or number of products of the same cast, heat treatment batch) and
 - the numbers of sample products per test unit and;
 - the number of samples per sample product;
- to be taken and tested;

- 2) the location and direction of the test pieces in the product;
- 3) where necessary, the additional conditions for sampling and conditions for the preparation of the samples and test pieces;
- 4) the European Standards in which the test methods are described;
- 5) the test repetitions to be carried out in accordance with EN 10021.

4.2.5.12 Marking

The technical delivery conditions shall specify, for the individual product forms, appropriate conditions for marking and shall comply with 4.1.8.

4.2.5.13 Supplementary requirements

The water-tube boiler manufacturer shall specify any additional tests considered appropriate.

NOTE: Where appropriate, the EMDS shall cover guidelines for processing the material and/or restrictions for the application (see table 3-1).

4.3 Materials with particular materials appraisals

Particular material appraisals shall be applied for materials used in special cases not covered in 3.3.2 and 3.3.3 and not intended for frequent use. The materials shall be specified in a material specification and shall be approved by an responsible authority in accordance with 3.3.4.

Where appropriate, the particular material appraisals shall, cover guidelines for processing the material. The individual application for which the material is intended shall be clearly specified in the scope of the respective material specification.

5 Material for non-pressure parts

Materials for supporting lugs, fins, baffles and similar non-pressure parts welded to water-tube boiler components shall be supplied to material specifications covering at least requirements for the chemical composition and the tensile properties. Impact properties shall be specified when required by in-service conditions. These materials shall be compatible with the material to which they are attached.

6 Inspection documentation

Inspections and tests shall be certified in accordance with prEN 764-5:

- with 2.2 test report in accordance with EN 10204 for attachment materials;
- with 3.1.B inspection certificate in accordance with EN 10204 in the case of established materials and a certified QM system, unless the purchaser orders an inspection certificate of the type 3.1.A, 3.1.C or an inspection report 3.2 which is the requirement for the direct inspection route in accordance with prEN 764-5. The certificates shall contain information on the manufacturer's approval in accordance with this standard and the name of the responsible authority;
- with the type of inspection document specified in the EMDS in the case of new materials;
- with test report 2.2 for welding consumables.

Annex A (normative)

Materials covered by European material Standards

A.1 Pressure parts

Pressure parts of water-tube boilers covered by this European Standard shall be constructed from steel products in accordance with table A-1.

Steel products shall be of the types listed in the European Standards, see clause 2, manufactured in accordance with these standards, and which comply in all respects with the minimum requirements of this Part.

A.2 Fittings

Non-alloy and alloy steel butt-welding fittings shall be in accordance with ISO 3419;

Stainless steel butt-welding fittings shall be in accordance with ISO 5251.

A.3 Flanges

Steel flanges shall be in accordance with prEN 1092-1, EN 1759-1 or ISO 7005-1 as appropriate.

A.4 Valves

Metal valves for use in flanged tubing systems shall be in accordance with EN 1503-1 or EN 1503-2.

Table A.1 — List of European standardised steels grouped according to product forms

Product form	EN standard	Material description	Grade	Restrictions		Material group to CR ISO 15608
				Heat treatment	Thickness mm min. max.	
plate and strip	EN 10028-2	elevated temperature properties	P235GH	N	0 150	1.1
plate and strip	EN 10028-2	elevated temperature properties	P265GH	N	0 150	1.1
plate and strip	EN 10028-2	elevated temperature properties	P295GH	N	0 150	1.2
plate and strip	EN 10028-2	elevated temperature properties	P355GH	N	0 150	1.2
plate and strip	EN 10028-2	elevated temperature properties	16Mo3	N	0 150	1.1
plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	NT	0 60	5.1
plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	NT Q	60 100	5.1
plate and strip	EN 10028-2	elevated temperature properties	13CrMo4-5	Q	100 150	5.1
plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	NT	0 60	5.2
plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	NT Q	60 100	5.2
plate and strip	EN 10028-2	elevated temperature properties	10CrMo9-10	Q	100 150	5.2
plate and strip	EN 10028-2	elevated temperature properties	11CrMo9-10	NT Q	0 60	5.2
plate and strip	EN 10028-2	elevated temperature properties	11CrMo9-10	Q	60 100	5.2
plate and strip	EN 10028-3	fine grain steel	P275NH	N	0 150	1.1
plate and strip	EN 10028-3	fine grain steel	P355NH	N	0 150	1.2
plate and strip	EN 10028-3	fine grain steel	P460NH	N	0 150	2.1
tube, seamless	prEN 10216-2	elevated temperature properties	P195GH	N	0 16	1.1
tube, seamless	prEN 10216-2	elevated temperature properties	P235GH	N	0 60	1.1
tube, seamless	prEN 10216-2	elevated temperature properties	P265GH	N	0 60	1.1
tube, seamless	prEN 10216-2	elevated temperature properties	8MoB5-4	N	0 16	5.1
tube, seamless	prEN 10216-2	elevated temperature properties	16Mo3	N	0 60	1.2
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo9-1+I	I	0 60	5.4
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo9-1+NT	NT	0 60	5.4
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo5+I	I	0 100	5.3
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo5+NT1	NT	0 100	5.3
tube, seamless	prEN 10216-2	elevated temperature properties	X11CrMo5+NT2	NT	0 100	5.3
tube, seamless	prEN 10216-2	elevated temperature properties	13CrMo4-5	NT	0 60	5.1
tube, seamless	prEN 10216-2	elevated temperature properties	10CrMo9-10	NT	0 60	5.2
tube, seamless	prEN 10216-2	elevated temperature properties	11CrMo9-10	QT	0 60	5.2
tube, seamless	prEN 10216-2	elevated temperature properties	X10CrMoVNb9-1	NT	0 120	6.4
tube, seamless	prEN 10216-2	elevated temperature properties	15NiCuMoNb5-6-4	NT	0 80	2.1
tube, seamless	prEN 10216-2	elevated temperature properties	X20CrMoV11-1	NT	0 80	6.4
tube, seamless	prEN 10216-2	elevated temperature properties	10CrMo5-5	NT	0 60	5.1

Annex B (normative)**Establishment of creep rupture strength values for new materials**

The establishment of creep rupture strength values for new materials shall be done in two steps as described in table B.1.

Table B.1 — Establishment of creep rupture strength values

	Available Test Data	Procedure for evaluation	Further tests
First step for preliminary data in data sheets (EMDS)	Creep tests (3 samples each) for 3 casts at min. 2 test temperatures ($\Delta t = 50^\circ\text{C} - 100^\circ\text{C}$) for more than 10 000 h (rupture). where embrittlement may occur, for each cast and temperature 1 notched sample for more than 10 000 h (rupture).	For scatter bands not greater than $\pm 10\%$ extrapolation factor < 3 for time. Max. application temp. \leq max. test temperature. For scatter bands greater than $\pm 10\%$ no extrapolated values in data sheets. In this case the calculation values shall be defined in each case.	From each manufacturer creep tests for (min. 5 samples) min. 1 cast with min. 2 test temperatures for more than 30 000 h (rupture). Where necessary for each test temperature min. 2 notched samples for more than 30 000 h (rupture).
Second step for final data in data sheets (EMDS)	Creep tests (min., 5 samples each) for min. 6 casts at test temperatures with $\Delta t \leq 50^\circ\text{C}$ up to 35 % max. intended operating time. where necessary for notched creep tests (min. 2 samples) at min. 2 temperatures in embrittlement range up to more than 30 000 h (rupture).	For scatter bands not greater than $\pm 20\%$ extrapolation factor < 3 for time. Max. application temperature $\leq 25^\circ\text{C}$ above max. test temperature.	New manufacturers of such materials shall test samples at least at one test temperature for more than 30 000 h (rupture). In the case of extension of the application range of the data sheet creep tests (min. 5 samples each) for one cast at min. 2 test temperatures more than 30 000 h (rupture).

Annex C (normative)

Chemical recovery boilers

C.1 General

This annex gives the special requirements applicable to the special materials of the pressure parts for chemical recovery boilers. These special requirements are additional to all the other requirements of this Part which shall continue to apply.

C.2 Special requirements for composite tubing

C.2.1 Composite tube

Composite tube consists of ferritic pressure retaining inner core and corrosion resistant outer cladding metallurgically bonded to each other.

C.2.2 General

Material manufactured in accordance with this annex shall conform to the applicable requirements of the current edition of the documents listed in 3.3 unless otherwise provided herein.

The composite tube shall be seamless tube manufactured by the hot extrusion process or hot extrusion followed by cold working. A billet with the two component materials shall be co-extruded at high temperature and high pressure in order to obtain a complete metallurgical bond.

All tube shall be furnished in the heat-treated condition. The heat treatment shall be performed at the temperature suitable for the two components to obtain optimum mechanical and corrosion properties.

The finished tubes shall be straight, see C.2.5.2 and free from injurious defects.

C.2.3 Chemical composition

The chemical composition shall be in accordance with 3.3 of this Part.

C.2.4 Mechanical and technological properties

C.2.4.1 Tensile test of ferritic pressure retaining inner core

The tensile test shall be performed on a number of tubes in accordance with C.2.4.2 (random lengths). The mechanical properties shall conform to the values given in the specification selected in accordance with 3.3.

C.2.4.2 Ring expanding test (composite tube)

One ring expanding test shall be carried out on a specimen from each end of each tube (random lengths). The ring shall be expanded to minimum of 30 % of inside diameter or to rupture, if this should occur earlier. The sample shall be free from defects as determined by visual inspection. The test shall be performed in accordance with EN 10236.

C.2.5 Tolerances

C.2.5.1 Permissible variations in OD and wall thickness

Outside diameter:	$\pm 0,5 \%$, but with a minimum $\pm 0,30$ mm
Total wall thickness:	OD < 50,8 mm + 22 % - 0 OD \geq 50,8 mm + 15 % - 0

Thickness of stainless steel component: $\pm 0,40$ mm

The thickness of the stainless steel component shall be checked by eddy current testing over the whole length of each tube.

C.2.5.2 Permissible variations in straightness

Out of straightness max. 1,5 mm/1 000 mm

C.2.6 Surface finish

The tubes shall be pickled free from scale.

C.2.7 Ultrasonic testing

C.2.7.1 Ultrasonic testing of the metallurgical bond in composite tubes

C.2.7.1.1 Extent of testing

The test procedure shall provide complete testing of the entire volume.

C.2.7.1.2 Reference standard

The reference standard shall be prepared from a length of tube of the same nominal dimensions, material, surface finish and nominal heat treatment as the tubes to be tested.

A flat bottom hole 5 mm in diameter shall be introduced radially from the bore surface of the tube. The bottom of the hole shall be positioned at the interface of the two materials. The flat bottom hole together with a chosen combination of probe beam width or diameter, scan pitch and speed shall produce unambiguously at least one signal at the ultrasonic testing apparatus corresponding to instantaneous detection of the bottom area of the flat bottom hole. This shall be the reference signal. The equipment shall be adjusted to produce a clearly identifiable reference signal pattern from the flat bottom hole. The amplitude of the reference signal from the flat bottom hole shall be used to set the visual standard on the cathode ray screen or the threshold in the electronic monitoring equipment.

C.2.7.1.3 Acceptance criteria

Any tube that does not produce a signal greater than the signal from the reference standard should be deemed to have passed the test. Tubes with defects which produce a signal greater than that from the reference standard shall be rejected.

On rejected tubes, the part with defective bonding shall be cropped off and the remaining part (parts) considered accepted.

C.2.7.2 Ultrasonic testing of composite tubes concerning longitudinal and transverse defects**C.2.7.2.1 Method of testing**

Immersion testing will be used. The scanning will be conducted using shear waves (approx. 45° refraction of the sound beam). For the longitudinal scanning the beams will be directed in two opposite circumferential directions and for the transversal scanning the beams will be directed in two opposite axial directions.

C.2.7.2.2 Reference standard

The reference standard shall be prepared from a length of tube of the same nominal dimensions, material, surface finish and nominal heat treatment as the tubes to be tested.

On the outside and inside surface, artificial notches shall be machined along the same line and with the dimensions and profile given in the table C.1. The dimensions and the profile shall be checked by the plastic replica technique.

Table C.1 — Artificial notches

Type	Location	Nom. Depth mm	Length mm	Profile
Longitudinal	Inside	5 % of the total nominal wall thickness but minimum 0,20 mm Tolerance: ± 10 %	25	U-shape
Longitudinal	Outside			
Transverse	Inside			
Transverse	Outside			

C.2.7.2.3 Calibration

For calibration purposes the reference standard shall be passed through the scanning head at the same rate and in the same directions as the tube to be tested.

C.2.8 Thickness check of stainless steel component**C.2.8.1 General**

The measuring shall be carried out with an eddy current instrument intended for measuring the thickness of non-metallic or non-magnetic layers on a ferromagnetic material.

C.2.8.2 Calibration

For the calibration two composite-tube pieces shall be used, one with a thickness of the stainless steel component as near the minimum tolerance limit and the other as near to the maximum tolerance limit as possible.

C.2.8.3 Acceptance criteria

Any tube that does not produce a signal outside the specified austenitic layer tolerances should be deemed to have passed the test.

Tubes with the austenitic layer outside the tolerances shall be rejected.

On rejected tubes, the part outside the tolerances shall be cropped off and the remaining part (parts) considered accepted.

C.2.9 Summary of tests and examinations

The tests and examinations shall be in accordance with table C.2. Ultrasonic testing is carried out instead of hydrostatic test, see table C.2.

Table C.2 — Extent of tests and examinations

Test	Extent
Ladle analysis	1 per heat
Tensile test at room temperature (carbon steel component only)	2 per lot of 2-15 tubes 3 per lot of 16-50 tubes 4 per lot of 51-100 tubes 6 per lot of ≥ 101 tubes (random lengths)
Ring expanding test	Each tube, both ends (random lengths)
Ultrasonic test	each tube (random lengths)
Thickness control of stainless steel	each tube (random lengths)
Dimensional check	Each tube, both ends
Visual inspection	Each tube, inside and outside

C.3 Marking

C.3.1 General

Tubes shall be longitudinally marked with black ink along their entire length and marked in accordance with 4.1.8.

C.3.2 Additional marking requirements

The following additional marking shall be made:

- steel grade or material grade or material number of both components;
- the cast number of both components;
- outside diameter and wall thickness.

Annex ZA (informative)**Clauses of this European Standard addressing essential requirements or other provisions of the Pressure Equipment Directive**

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of the Pressure Equipment Directive 97/23EC with regard to **materials for pressure parts of boilers and accessories**.

Warning: Other requirements and other EU Directives **may** be applicable to the product(s) falling within the scope of this standard.

The following clauses of this standard given in table ZA.1 are likely to support requirements of the Pressure Equipment Directive 97/23EC:

Table ZA.1 — Comparison between Pressure Equipment Directive 97/23EC and EN 12952-2 with respect to materials for pressure parts of boilers and accessories for water-tube boilers

EN 12952-2 harmonized clauses	Content	Pressure Equipment Directive 97/23EC Annex 1
3.1, 3.3	Appropriate material properties	4.1a
3.1, 3.2	Suitable for the processing procedures	4.1d
3.2	Undesirable joining effects	4.1e
4.1	Technical documentation – EN materials	4.2b 1st indent
6	Certification – Supplier compliance with spec.	4.3-1st para
6	Certification – Supplier specific product control	4.3-2nd para
6	Certification – Supplier quality assurance	4.3-3rd para

Compliance with the clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and the associated EFTA regulations.

Bibliography

- [1] EN 45012, *General requirements for bodies operating assessment and certification/registration of quality systems (ISO/IEC Guide 62 : 1996)*.
- [2] EN ISO 9001, *Quality management systems – Requirements (ISO 9001:2000)*.