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Water-tube boilers and auxiliary installations - Part 5: Workmanship and construction of pressure parts of the boiler

Wasserrohrkessel und Anlagenkomponenten - Teil 5: Verarbeitung und Bauausführung für drucktragende Kesselteile

Chaudières à tubes d'eau et installations auxiliaires - Partie 5 : Fabrication et construction des parties sous pression de la chaudière

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Water-tube boilers and auxiliary installations - Part 5: Workmanship and construction of pressure parts of the boiler

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 12952-5:2011) 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 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by May 2012, and conflicting national standards shall be withdrawn at the latest by May 2012.

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

This document supersedes EN 12952-5:2001.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

Annex G provides details of significant technical changes between this European Standard and the previous edition.

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 of the boiler;*

— 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 pulverized solid fuels for the boiler;*

— Part 10: *Requirements for safeguards against excessive pressure;*

— Part 11: *Requirements for limiting devices 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 using liquefied pressurized ammonia and ammonia water solution;*

— Part 15: *Acceptance tests;*

— Part 16: *Requirements for grate and fluidized-bed firing systems for solid fuels for the boiler;*

— CR 12952 Part 17: *Guideline for the involvement of an inspection body independent of the manufacturer.*

NOTE 1 A Part 18 on operating instructions is currently in preparation.

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 2 Part 4 and Part 15 are not applicable during the design, construction and installation stages.

NOTE 3 A "Boiler Helpdesk" has been established in CEN/TC 269 which may be contacted for any questions regarding the application of European Standards series EN 12952 and EN 12953, see the following website: http://www.boiler-helpdesk.din.de.

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

1 Scope

This European Standard specifies requirements for the workmanship and construction of water-tube boilers as defined in EN 12952-1:2001.

2 Normative references

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

EN 287-1:2011, *Qualification test of welders — Fusion welding — Part 1: Steels*

EN 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

EN 571-1:1997, *Non destructive testing — Penetrant testing — Part 1: General principles*

EN 1092-1:2007, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1418:1997, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials*

EN 1759-1:2004, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, Class designated — Part 1: Steel flanges, NPS 1/2 to 24*

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

EN 10028-2, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

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

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 10253-2:2007, *Butt-welding pipe fittings — Part 2: Non alloy and ferritic alloy steels with specific inspection requirements*

EN 10253-4:2008, *Butt-welding pipe fittings — Part 4: Wrought austenitic and austenitic-ferritic (duplex) stainless steels with specific inspection requirements*

EN 12952-1:2001, *Water-tube boilers and auxiliary installations — Part 1: General*

EN 12952-2:2011, *Water-tube boilers and auxiliary installations — Part 2: Materials for pressure parts of boilers and accessories*

EN 12952-3:2011, *Water-tube boilers and auxiliary installations — Part 3: Design and calculation for pressure parts*

EN 12952-6:2011, *Water-tube boilers and auxiliary installations — Part 6: Inspection during construction; documentation and marking of pressure parts of the boiler*

EN 12952-7:2002, *Water-tube boilers and auxiliary installations — Part 7: Requirements for equipment for the boiler*

EN ISO 148-1:2010, *Metallic materials — Charpy pendulum impact test — Part 1: Test method (ISO 148-1:2009)*

EN ISO 4759-1:2000, *Tolerances for fasteners — Part 1: Bolts, screws, studs and nuts — Product grades A, B and C (ISO 4759-1:2000)*

EN ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2003, corrected version:2005, including Technical Corrigendum 1:2006)*

EN ISO 6520-1, *Welding and allied processes — Classification of geometric imperfections in metallic materials — Part 1: Fusion welding (ISO 6520-1:2007)*

EN ISO 6892-1:2009, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1:2009)*

EN ISO 14555:2006, *Welding — Arc stud welding of metallic materials (ISO 14555:2006)*

EN ISO 15609 (all parts), *Specification and qualification of welding procedures for metallic materials — Welding procedure specification*

EN ISO 15613, *Specification and qualification of welding procedure for metallic materials — Qualification based on pre-production welding test (ISO 15613:2004)*

EN ISO 15614-1:2004, *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 17638:2009, *Non-destructive testing of welds — Magnetic particle testing (ISO 17638:2003)*

EN ISO 17663:2009, *Welding — Quality requirements for heat treatment in connection with welding and allied processes (ISO 17663:2009)*

EN ISO 23277:2009, *Non-destructive testing of welds — Penetrant testing of welds — Acceptance levels (ISO 23277:2006)*

EN ISO 23278:2009, *Non-destructive testing of welds — Magnetic particle testing of welds — Acceptance levels (ISO 23278:2006)*

CEN ISO/TR 15608, *Welding — Guidelines for a metallic material grouping system (ISO/TR 15608:2005)*

3 Terms and definitions

For the purposes of this document the terms and definitions given in EN 12952-1:2001 and the following apply.

3.1
cold forming
for ferritic steels, it is forming at temperatures below the maximum permissible temperature for post-weld heat treatment and for austenitic materials it is forming at temperatures below 300 °C

NOTE See Table 10.4-2.

3.2
hot forming
for ferritic steels, it is forming at temperatures at or above the maximum permissible temperature for post-weld heat treatment

NOTE See Table 10.4-2.

4 Symbols and abbreviations

For the purposes of this European Standard, the symbols given in EN 12952-1 shall apply. Throughout this European Standard, additional terminology and symbols have been included, where necessary, to meet the requirements of the specific text concerned. It should also be noted that in some clauses the same additional symbol is used in different equations to represent different terms. However, in all such cases, the special meaning of each symbol is indicated for each equation.

5 General

Water-tube boilers shall be manufactured and assembled in accordance with approved drawings, procedures and specifications and good engineering practice.

The workshops and sites associated with the construction of water-tube boilers shall be properly equipped and have suitable provisions for all the inspection and testing specified in EN 12952-6. The relevant manufacturing procedures shall be adequate and manufacturing personnel shall be competent and properly qualified for their assigned tasks. The procedures for the approval of welding and NDE personnel are given respectively in EN 12952-6:2011, Clause 7 and 9.2.

Appropriate records of manufacturing operations shall be maintained.

6 Pressure part

6.1 Drums, headers and similar pressure parts

6.1.1 Principles for manufacturing

Drums, headers and similar pressure parts shall be constructed from tubes, forgings, plates or castings. Drums and headers shall be in a suitably clean condition, both internally and externally, to enable proper visual inspection of the surface to be carried out before drilling of holes for tube stubs, branches, etc. and before welding of any permanent connections.

6.1.2 Manufacturing process for header ends

The ends of forged or other seamless steel tube headers shall be carried out by any one of the following methods:

a) forging or spinning;

b) welding in accordance with Clause 8, see also EN 12952-3:2011, Figure 10.3-1;

c) bolted flanges in accordance with relevant European Standards e.g. EN 1092-1:2007 or EN 1759-1:2004.

Bolted flanges in accordance with c) shall not be used where the bolts would be exposed to gases of combustion.

6.1.3 Material for header ends

Header ends shall be forged or machined from steel of a grade compatible with the bodies of the headers and profiled as shown in EN 12952-3:2011, Figure 10.3-1.

6.2 Material identification

The manufacturer shall maintain a system of material identification for all pressure parts and drum lifting lugs.

The system shall be such that material used in major pressure parts (drums, tubes for header shells with d_o > 142 mm) can be traced back to its origin. The identification of tubes which are not used for header shells and tubes for header shells with $d_o \leq 142$ mm shall be controlled by a system which permits positive identification of cast, on receipt into the manufacturer's works and maintenance of the material type identification throughout manufacturing operations by marking.

6.3 Material marking

6.3.1 General

The marking of materials shall be maintained throughout the process of manufacture. If original markings are discarded or parts without markings could be created by dividing up parts during the course of manufacture, markings shall be transferred, normally before fabrication.

Appropriate measures shall be taken to ensure that there is no possibility of confusion in the transfer of markings.

6.3.2 Responsible personnel

Marking transfer shall be performed by the manufacturer's nominated representative(s) except for materials for which an inspection certificate (3.2) to EN 10204:2004 is required and also not for components classified as small parts.

In the case of materials for which an inspection certificate (3.2) to EN 10204:2004 is required, the markings shall be transferred in accordance with the requirements of EN 12952-6:2011.

NOTE This does not apply to small parts which are those made from certified products, such as nipples, nozzles, flanges, compensating rings, with outside diameters equal to or less than 142 mm.

6.3.3 Method of marking

In general, material marking should be done by hard stamping using a low stress type metal stamp or etching.

NOTE Other marking methods may be used if the manufacturer can ensure that their use will not impair the safety of the boiler.

6.3.4 Marking of non-pressure parts

For welded non-pressure parts, marking need only be transferred if the identification of materials is not evident from the drawing or parts list.

6.3.5 Marking of bolts and nuts

Bolts and nuts for pressure purposes shall be marked with the manufacturer's brand mark and property class symbol, or the steel grade code number in accordance with EN ISO 4759-1:2000.

6.4 Marking during manufacture

6.4.1 Temporary marking

Temporary marks for the purpose of identification during manufacture e.g. parts numbers, welder numbers, radiograph numbers, etc. shall be made by any one, or a combination, of the following methods:

a) painting or pen, provided they are compatible with the material being marked;

b) vibro etching or other etching tool;

c) metal stamps of the low stress type.

6.4.2 Permanent marking

Permanent marks complying with the requirements of 6.2 shall be made by any one or a combination, of the following methods:

a) vibro etching or other etching tools;

b) metal stamps of the low stress type;

c) stamped data plates welded directly to the component using an approved welding procedure specification.

6.4.3 Tube bends

Metal stamping shall not be permitted on the curved area of tube bends.

6.4.4 Location drawings

Location drawings may be provided in the case of welders marks, radiographs, etc.

7 Cutting, forming and fabrication tolerances

7.1 Cutting material

7.1.1 Methods for cutting

Steel shall be cut by thermal means, shearing, sawing, machining or a combination of these methods. Thermal cutting may necessitate the use of preheating, depending on the type of steel and the thickness in question, which shall be applied in accordance with 10.3.3. It is recognized that the cold worked zone resulting from the shearing process need not be eliminated before welding if this zone will be fused during welding.

7.1.2 Post-cutting measures

Any material damaged metallurgically in the process of cutting to size or forming the edge or end preparation shall be removed by machining, grinding, chipping or thermal-cutting back to sound metal.

Surfaces that have been thermally cut shall be cut back by machining or grinding so as to remove all burnt metal, harmful notches, slag and scale, but slight discoloration of machine thermally cut edges on mild steel shall not be regarded as detrimental. If alloy steels are prepared by thermal cutting, the surface shall be dressed back by grinding or machining for a distance of at least 1,5 mm, unless it can be shown that the material has not been damaged by the cutting process.

NOTE These requirements for dressing do not apply to surfaces that are prepared for electro-slag welding, where a thermally cut surface is generally acceptable without further treatment.

After the edges of the material have been prepared for welding, they shall be visually examined for flaws, cracks, laminations, slag inclusions or other defects before further work is carried out. Any weld repairs that are required to materials damaged as a result of thermal cutting shall be to an approved welding procedure specification.

7.2 Forming of drums, headers and ends

7.2.1 General

Drums, headers and ends shall be rolled or pressed from plate, solid forged, drawn or extruded, or made by a combination of these processes. Components made by a forging, drawing or extrusion process shall be produced in accordance with the forgemaster's specification, as agreed with the boiler manufacturer.

Components formed from ferritic steel plate shall be heat treated in accordance with 10.2.2 to 10.2.4 inclusive. The heating associated with forming operations and the heat treatment requirements after forming are given in 10.2.

The forming requirements applicable to austenitic steel plate are the subject of development. In the meantime, the methods used shall be in accordance with the manufacturer's own proven procedure which shall ensure that, by their use, the safety of the boiler is not impaired.

7.2.2 Drum and header shells

Shell plates shall be formed, either hot or cold, to ensure compliance with the tolerances specified in 7.4. Each shell plate shall be formed to the correct contour up to the extreme edges of the plate. The bending or pressing shall be done entirely by machine. The definitions of hot and cold forming are given in 3.1 and 3.2.

Local heating and hammering shall not be employed.

7.2.3 Ends

Dishing and peripheral flanging, either hot or cold, shall be carried out to ensure compliance with the tolerances specified in 7.4. The operations shall be performed by machine. Sectional flanging shall not be employed.

7.2.4 Plates welded prior to hot or cold forming

Where practicable, shells and ends shall be rolled or pressed from one piece of plate. Where this is impracticable, butt welding of plate, prior to forming shall be permitted, provided that the welded joints are non-destructively examined after forming in accordance with the requirements of EN 12952-6:2011, and a welding procedure qualification test has been performed to EN ISO 15614-1:2004 taking into account any heat treatment cycles involved. A production test plate as specified in 10.2.5 shall be provided.

7.2.5 Extruded openings in headers

Extruded openings in headers shall have a fillet with a radius not less than the thickness of the neck of the extrusion.

7.3 Forming of tube bends

7.3.1 General

Tubes which are bent hot or cold shall conform to 7.3.2 to 7.3.12.

This subclause does not apply to fittings in accordance with EN 10253-2:2007 and EN 10253-4:2008.

NOTE Annex A requires procedure tests to be carried out on tube bends. Attention is drawn to the fact that not all the combinations of materials and bending processes permitted, and the associated thermal treatments nominated in Table 7.3-2, will satisfy the requirements for the procedure test given in 7.3.2 to 7.3.13 and Annex A. The manufacturer should ensure that any combination of material, bending process and the chosen bend geometry will produce bends that satisfy the requirements of 7.3. If a chosen bend geometry is found not to comply with the requirements of 7.3, the manufacturer should adjust the design to enable the requirements to be met.

7.3.2 Tube bending procedure test

It shall be demonstrated by means of a tube bending procedure test (see Annex A) that tubes can be satisfactorily bent to the requirements of 7.3.1. The tests shall be performed to represent combinations of tube sizes, materials and bend radii which demonstrate the adequacy of the bending method chosen. The range and scope of the qualification of tube bends resulting from these procedure tests are also given in Annex A. The results from the bending procedure tests shall be documented and used as a basis for all future tube bends falling within the scope of the combinations tested.

When specific pre-production test bends are manufactured in accordance with Table 7.3-1 and which conform to the requirements of 7.3.1 the resulting documented data shall serve as qualification for subsequent production runs and may be considered to satisfy the requirements of Annex A.

NOTE Documented evidence of previous satisfactory tube bending procedure tests may be accepted as fulfilling these requirements.

7.3.3 Requirements for dimensional testing

Thinning at the bend extrados, thickening at the bend intrados (where required) and departure from circularity limits shall be demonstrated by the methods given in Table 7.3-1.

NOTE This test relates to the forming of tubes for conventional water-tube boilers. For the special case of coiled boilers and coiled superheaters, see Annex D.

Table 7.3-1 — Requirements for dimensional testing of a production run of tube bends

Tube size – Nominal outside diameter d_o mm	Testing during a production run of tube bends
$d_o \leq 80$	a) Measure non-destructively 2 % of the production run, including the first bend, for thinning and departure from circularity u. b) Additionally, where $r_b/d_o < 1,3$, a sample test bend is required before production commences.
$80 < d_o \leq 142$	a) Measure non-destructively 2 % of the production run, including the first bend, for thinning, thickening (where practicable) and the departure from circularity u. b) Additionally, where $r_b/d_o < 1,3$ a sample test bend is required before production commences.
$d_o > 142$	Measure all bends for thinning, thickening and the departure from circularity u.

NOTE 1 A sample test bend consists of the sectioning and measuring of a trial bend to establish the maximum thinning, thickening (where practicable), and the maximum departure from circularity. The measured values are checked against the requirements given in 7.3.4, 7.3.5 and 7.3.7 respectively.

NOTE 2 A production run is defined as a series of tubes of the same size and material being bent on a specific machine within the same machine set-up.

NOTE 3 The departure from circularity u is measured at the apex of the bend.

NOTE 4 The radius of the bend r_b is measured to the centre-line of the tube.

NOTE 5 The outside diameter d_o of the tube is measured on the straight.

NOTE 6 This table does not apply to coil type boilers (see Annex D).

7.3.4 Thinning at the tube bend extrados for tubes of nominal outside diameter 142 mm and below

The thickness at any point after bending shall not be less than that given by equation:

$$e_{ext} = e_{act} \times \frac{2r_b / d_o + 0{,}5}{2r_b / d_o + 1} \quad (7.1)$$

where

e_{ext} is the required minimum thickness at the extrados, in mm;

e_{act} is the nominal thickness of the supplied tube minus the supplier's maximum negative thickness tolerance, in mm;

r_b is the radius of the bend measured to the centre-line of the tube in mm;

d_o is the nominal outside diameter of the tube, in mm.

When the measured value on the tube bend is less than e_{ext} reference shall be made to the minimum calculated thickness given in EN 12952-3:2011, 11.3.

The thinning on the extrados of bends formed in two stages i.e. hot formed after initial hot or cold bending, shall not exceed 30 % of the thickness of the straight tube local to the bend as measured during a procedure test.

7.3.5 Thickening at the tube bend intrados for tubes of nominal outside diameter above 80 mm and including 142 mm

The thickness at any point after bending shall not be less than that given by equation:

$$e_{int} = e_{act} \times \frac{2r_b / d_o - 0{,}5}{2r_b / d_o - 1} \quad (7.2)$$

where

e_{int} is the required minimum thickness at the intrados, in mm;

e_{act} is the nominal thickness of the supplied tube minus the supplier's maximum negative thickness tolerance, in mm;

r_b is the radius of the bend measured to the centre-line of the tube, in mm;

d_o is the nominal outside diameter of the tube, in mm.

When the measured value on the tube bend is less than e_{int} reference shall be made to the minimum calculated thickness given in EN 12952-3:2011, 11.3.

7.3.6 Thinning/thickening at the tube bend extrados/intrados for tubes of nominal outside diameter greater than 142 mm

For tubes above 142 mm diameter comparison shall be made directly with the calculated thickness given in EN 12952-3:2011, 11.3. The calculated thickness shall be stated on the drawing.