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Neogrevane tlačne posode - 5. del: Pregled in preskušanje

Unfired pressure vessels - Part 5: Inspection and testing

Unbefeuerte Druckbehälter - Teil 5: Inspektion und Prüfung

Récipients sous pression non soumis à la flamme - Partie 5 : inspection et contrôles

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Unbefeuerte Druckbehälter - Teil 5: Inspektion und Prüfung

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Foreword

This document (EN 13445-5:2014) has been prepared by Technical Committee CEN/TC 54 “Unfired pressure vessels”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by December 2014, and conflicting national standards shall be withdrawn at the latest by December 2014.

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

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

This European Standard consists of the following Parts:

— Part 1: *General.*

— Part 2: *Materials*.

— Part 3: *Design*.

— Part 4: *Fabrication*.

— Part 5: *Inspection and testing*.

— Part 6: *Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron.*

— CR 13445-7, *Unfired pressure vessels — Part 7: Guidance on the use of conformity assessment procedures.*

— Part 8: *Additional requirements for pressure vessels of aluminium and aluminium alloys.*

— CEN/TR 13445-9, *Unfired pressure vessels — Part 9: Conformance of EN 13445 series to ISO 16528*

Although these Parts may be obtained separately, it should be recognised that the Parts are inter-dependant. As such the manufacture of unfired pressure vessels requires the application of all the relevant Parts in order for the requirements of the Standard to be satisfactorily fulfilled.

Corrections to the standard interpretations where several options seem possible are conducted through the Migration Help Desk (MHD). Information related to the Help Desk can be found at http://www.unm.fr (en13445@unm.fr). A form for submitting questions can be downloaded from the link to the MHD website. After subject experts have agreed an answer, the answer will be communicated to the questioner. Corrected pages will be given specific issue number and issued by CEN according to CEN Rules. Interpretation sheets will be posted on the website of the MHD.

This document supersedes EN 13445-5:2009. This new edition incorporates the Amendments which have been approved previously by CEN members, and the corrected pages up to Issue 5 without any further technical change. Annex Y provides details of significant technical changes between this European Standard and the previous edition.

Amendments to this new edition may be issued from time to time and then used immediately as alternatives to rules contained herein. It is intended to deliver a new Issue of EN 13445:2014 each year, starting with the present document as Issue 1, consolidating these Amendments and including other identified corrections.

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

1 Scope

This Part of this European Standard specifies the inspection and testing of individual and serially produced pressure vessels made of steels in accordance with EN 13445-2:2014.

Special provisions for cyclic operation are given in Annex G of this Part.

Special provisions for vessels or vessel parts working in the creep range are given in Annex F and Annex I of this Part.

NOTE The responsibilities of parties involved in the conformity assessment procedures are given in Directive 97/23/EC. Guidance on this can be found in CR 13445-7.

2 Normative references

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

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

CEN/TR 764-6:2012, *Pressure equipment — Part 6: Structure and content of operating instructions*

EN 1779:1999, EN 1779:1999/A1:2003, *Non-destructive testing — Leak testing — Criteria for method and technique selection*

EN 13445-1:2014, *Unfired pressure vessels — Part 1: General*

EN 13445-2:2014, *Unfired pressure vessels — Part 2: Materials*

EN 13445-3:2014, *Unfired pressure vessels — Part 3: Design*

EN 13445-4:2014, *Unfired pressure vessels — Part 4: Fabrication*

EN ISO 4063:2010, *Welding and allied processes — Nomenclature of processes and reference numbers* (ISO 4063:2009, Corrected version 2010-03-01)

EN ISO 4136:2012, *Destructive tests on welds in metallic materials — Transverse tensile test* (ISO 4136:2012)

EN ISO 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections* (ISO 5817:2014)

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

EN ISO 9712:2012, *Non-destructive testing — Qualification and certification of NDT personnel* (ISO 9712:2012)

EN ISO 14732:2013, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials* (ISO 14732:2013)

EN ISO 17635:2010, *Non-destructive testing of welds — General rules for metallic materials* (ISO 17635:2010)

1) EN ISO 9606-1 has been published in 2013 replaces EN 287-1. CEN has decided to have a transition period for EN 287-1. As a consequence, EN 287-1 is valid until October 2015.

3 Terms and definitions

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

3.1
design review
procedure by which a manufacturer ascertains and declares that the design meets the requirements of this standard

3.2
design approval
procedure by which a responsible authority ascertains that the design meets the requirements of this standard

3.3
testing group
grouping which determines the appropriate level of non-destructive testing (NDT) on a welded joint

Note 1 to entry: There are four testing groups.

3.4
inspection
survey activity which assesses the compliance of the pressure vessel to the technical specification

Note 1 to entry: It is a major activity, undertaken mainly by the manufacturer during design, manufacture and testing of equipment. It can be complemented by inspection by other parties. Inspection includes the assessment of testing activities.

3.5
testing
procedure used to verify vessel compliance with the technical requirements of this standard by one or more tests

3.6
technical specification
document stating requirements for a product or a procedure

3.7
repair
action or series of actions of rectifying a condition in either base material or weld to establish compliance with this standard

3.8
serial production
manufacture of identical vessels or parts which subsequently are joined to form a complete vessel and which are manufactured to a single model acceptance, using the same manufacturing procedure involving a continuous fabrication process

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.9
continuous fabrication process
process where the welding of the main seams and branch welds is essentially continuous, that means there are no stoppages or fabrication break-downs requiring resetting of the welding machine and/or NDT equipment

Note 1 to entry: Adjustments to the welding machine within the welding procedure limitations do not qualify as resetting the welding machine.

Note 2 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.10
model acceptance
procedure which ascertains that a representative sample of the production (a prototype vessel/part) meets the requirements of this standard in respect of design, manufacturing and testing

Note 1 to entry: Model acceptance is conducted by the manufacturer or the responsible authority depending on the conformity assessment module chosen.

Note 2 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.11
prototype vessel/part
first or representative sample of a series of pressure vessels/parts covered by a single model acceptance

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.12
batch of vessels
part of a series where the welding of the main weld joints and branch welds has been essentially continuously produced by the same welding procedures

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.13
shift
period of time per day during which the welders and welding operators remain the same

Note 1 to entry: The definitions 3.8 to 3.13 relate to serially produced pressure vessels as described in Annex A.

3.14
joint batch
several joints made by the same welder or welding operator using a single welding procedure specification

4 Performance of inspection and testing

4.1 General

Each individual vessel shall be inspected during construction and upon completion. Inspections shall be made to ensure that in all respects the design, materials, manufacturing, and testing comply with the requirements of this standard. Documented evidence shall be prepared to verify implementation of this requirement.

4.2 Inspection

Inspection shall be carried out by the manufacturer to verify that all requirements of this standard have been met. The level of non-destructive testing (NDT) shall be dependent on the testing group as described in 4.3.

All inspections shall be carried out by qualified personnel.

4.3 Non-destructive testing (NDT)

The type and amount of non-destructive testing of a pressure vessel shall be based upon the testing group or combination of testing groups when permitted in 6.6.1.2 (see Table 6.6.1-1: testing groups for steel pressure vessels and Table 6.6.2-1: extent of non-destructive testing).

5 Technical documentation

5.1 General

The vessel manufacturer shall document those items listed in 5.2, which shall be reviewed in accordance with 5.3, prior to manufacture commencing.

The manufacturer shall state which vessels are covered by the same design.

5.2 Information to be contained in the technical documentation

5.2.1 General

For the purposes of this standard the following types of documents shall be considered necessary as technical documentation.

5.2.2 General description of the pressure vessel

a) Name of vessel manufacturer and subcontractors, if applicable;

b) Location/s of vessel manufacturer and sub-contractors, if applicable;

c) Document describing design data and special consideration which covers:

1) maximum and minimum allowable pressures, design pressures and test pressures in bar for each compartment (vacuum with minus sign);

2) capacity in litres for each compartment;

3) maximum and minimum design temperatures;

4) nature and location of marking of the pressure vessel, nameplate or stamp;

5) the fluid group.

6) if the vessel is designed for cyclic operation the allowed numbers of cycles, the range of action (as defined in EN 13445-3:2014, 5.3.1) during the cycle and the locations where the cumulative fatigue damage index D (as defined in EN 13445-3:2014, Clauses 17 and 18) is greater than 0,8. The maximum permissible peaking shall also be given.

7) If the vessel is working in the creep range, the following additional information:

— the design life (e.g. 100 000 h) and expected life for each load case

— the parts of the vessel which are subjected to creep

— the value of the weld creep strength reduction factor which has been used for each weld joint subjected to creep

— whether lifetime monitoring, as defined in Clause 19 of EN 13445-3:2014, is being applied or not.

5.2.3 Design and construction drawings

The manufacturer analysis of hazards identifying those which apply to the pressure vessel on account of action (as defined in EN 13445-3:2014, 5.3.1) shall be documented and be of sufficient detail.

Details of the design including the design methods adopted, performance criteria and construction drawings shall be provided. Guidance about the detailed dimensional information that shall be provided is given in Annex B. Process diagrams, sub-assemblies or other data relevant to design shall also be maintained.

5.2.4 Descriptions and explanations necessary for an understanding of the drawings and diagrams and the operation of the pressure vessel

a) operating instructions;

b) special checks to be carried out e.g. tests envisaged on closures, bellows, clamping bolts, etc.

c) operational position if this is significant with regard to the safety evaluation.

5.2.5 Results of design calculations and examinations carried out

5.2.5.1 Design calculations shall be provided by the vessel manufacturer to the extent necessary to demonstrate compliance to this standard.

Supporting detailed drawings shall be prepared with all dimension notations marked. At least on the pressure vessel general arrangement drawing, the testing group(s) shall be clearly identified.

5.2.5.2 If calculations are made with the aid of a computer software in order to comply with this standard, then at least the following data shall be presented:

a) explanation of notations;

b) input values;

c) reference number of the standard including edition and reference number of the equation;

d) results of intermediate equations;

e) calculated minimum thickness without additions or the calculated stress and its comparison to the allowable stress;

f) wastage (corrosion) allowance;

g) thickness tolerance (negative thickness tolerance);

h) the chosen thickness.

5.2.5.3 In the event that stress analysis is carried out with the finite element method or other equivalent design methods they shall be documented as follows:

a) input data;

b) graphs which show;

   1) the element subdivision (mesh size);

   2) the stresses, e.g. as line or arrow figures or equal stress curves; stress curves of surfaces;

   3) the displacements;

c) boundary conditions;

d) the stresses in the most critical areas;

e) where appropriate, the dividing and classifying of the stresses into different stress categories;

f) the comparison of stress intensities and the allowable stress values.

5.2.5.4 In specific cases the following information shall be given:

a) type of post weld heat treatment and, where necessary, type and extent of associated material tests;

b) construction sequence schedule if the testing is to be carried out in several steps;

c) fluid(s) being contained and its (their) specific gravity, if this is required for the design of the vessel;

d) pressure testing medium, if the initial or the periodic pressure tests are to be carried out with a medium other than water, the test minimum metal temperature for proof tests (both hydrostatic and pneumatic);

e) position of the vessel in the pressure tests (e.g. horizontal or vertical), if this is significant with regard to the safety evaluation;

f) maximum and minimum liquid levels, if these are required with regard to the safety evaluation;

g) static supplementary forces, e.g. bearing forces, wind and snow loads. An extra calculation shall be presented if the supplementary forces essentially affect the design of the pressure vessel;

h) cyclic and dynamic loading, including seismic loading, where applicable;

i) additional requirements based on other regulations;

j) purchaser's requirements based on the vessel operating conditions in addition to the requirements of this standard;

k) possible corrosion attack, especially in crevices, which shall be taken into account;

l) joint coefficient.

5.2.6 Test reports

These shall consist, as a minimum, of the following:

a) welding procedure qualification records, certificates of qualification of welding personnel;

b) material certificates;

c) the content of the manufacturing records, including measurement of peaking for vessels subject to cyclic loads;

5.2.7 Technical/manufacturing schedule

This shall consist of the following information:

a) the welding processes to be used for the pressure containing parts and welding of any temporary or other attachments to pressure containing parts. The following data are required for the testing:

   1) weld location, shape and preparation and where necessary build up of the layers and treatment of welds;

   2) welding process (in the case of multiple processes, identification of the process against the weld joint);

   3) welding consumables (classification according to the relevant European Standards or trade names);

4) type and extent of production test, number of test plates, non-destructive tests;

If some of the data listed before are not available for the design review, then these shall be completed before finishing the manufacture.

b) special checks to be carried out e.g. the tests envisaged on closures, bellows, clamping, bolts;

c) any pertinent details relative to vessel design and data required in specific cases;

1) additional wall thickness if this is required by the purchaser;

2) operational position if this is significant with regard to the safety evaluation;

3) location and size of inspection and access openings and also closing mechanisms and special locking elements in accordance with Annex C;

4) special equipment to enter the pressure vessel (e.g. spiral stairs, climbing irons);

5) linings, e.g. of refractory and inserts, if significant with regard to the safety evaluation;

6) marking of the welds that will be made on the construction site;

7) proposals on safety;

8) proposals on process requirements such as drainage etc.

5.3 Design review

5.3.1 General

A design review and documented acceptance shall be conducted in all cases. It shall include the year of edition and the number of issue of the standard used, with reference to possible used Amendments.

In particular the review shall include design calculations in accordance with the requirements of this standard, taking into consideration the supporting information of the manufacturer analysis of hazards, and the technical/manufacturing schedule in respect of its intended services. Following the design the pressure vessel shall be manufactured in accordance with the approved manufacturing drawings.

5.3.2 Design review

The design review shall consist of, but not be limited to, the following areas:

a) the suitability of material for intended use;

b) welding processes and consumables;

c) the access to perform the required levels of inspections and tests based on proposed vessel construction geometry;

d) the suitability of openings and closures in meeting the requirements of Annex C of this standard;

e) the provision and adequacy of safety accessories against the requirements of this standard for individual pressure vessels or devices which are contained within the pressure system or assembly. Alternatively the parties responsible for satisfying the provision of safety accessories shall be identified;