



SLOVENSKI STANDARD
SIST EN 13445-5:2002
01-november-2002

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Unfired pressure vessels - Part 5: Inspection and testing

Unbefeuerte Druckbehälter - Teil 5: Inspektion und Prüfung

Réipients sous pression non soumis a la flamme - Partie 5: Inspection et contrôles

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Ta slovenski standard je istoveten z: EN 13445-5:2002

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ICS:

23.020.30

SIST EN 13445-5:2002

en

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English version

Unfired pressure vessels - Part 5: Inspection and testing

Réceptifs sous pression non soumis à la flamme - Partie
5: Inspection et contrôles

Unbefeuerte Druckbehälter - Teil 5: Inspektion und Prüfung

This European Standard was approved by CEN on 23 May 2002.

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

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

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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

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Foreword

This document (EN 13445-5:2002) 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of an identical text or by endorsement, at the latest by November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

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.

In this standard the Annexes A, B, C, F and G are normative and the Annexes D, E and H are informative.

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.*

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

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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 subject to predominantly non_cyclic operation (i.e. vessels operating below 500 full equivalent pressure cycles).

Special provisions for cyclic operation are given in EN 13445-3 and in Annex G of this Part.

This Part does not give inspection and testing provisions for vessels designed using Design by Analysis – Direct Route (DBA) of EN 13445-3:2002? Annex B.

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

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 287-1:1992, *Approval testing of welders — Fusion welding — Part 1: Steels.*

EN 473:2000, *Non-destructive testing — Qualification and certification of NDT personnel — General principles.*

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

prEN 764-6:2002, *Pressure equipment — Part 6: Operating instructions.*

EN 583-4:1999, *Non-destructive testing — Ultrasonic examination — Part 4: Examination for discontinuities perpendicular to the surface*

EN 970:1997, *Non-destructive examination of fusion welds — Visual examination.*

EN 1289:1998:1998, *Non-destructive examination of welds — Penetrant testing of welds — Acceptance levels.*

EN 1290:1998, *Non-destructive examination of welds — Magnetic particle examination of welds.*

EN 1291:1998:1998, *Non-destructive examination of welds — Magnetic particle testing of welds — Acceptance levels.*

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 1435:1997:1997, *Non-destructive examination of welds — Radiographic examination of welded joints.*

EN 1712:1997:1997, *Non-destructive examination of welds — Ultrasonic examination of welded joints — Acceptance levels.*

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EN 1713:1998, *Non-destructive examination of welds — Ultrasonic examination — Characterisation of indications in welds.*

EN 1714:1997:1997, *Non-destructive examination of welds — Ultrasonic examination of welded joints.*

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

EN 12062:1997, *Non-destructive examination of welds — General rules for metallic materials.*

EN 12517:1998, *Non-destructive examination of welds - Radiographic examination of welded joints — Acceptance levels.*

EN 13445-2:2002, *Unfired pressure vessels — Part 2: Materials.*

EN 13445-3:2002, *Unfired pressure vessels — Part 3: Design.*

EN 13445-4:2002, *Unfired pressure vessels — Part 4: Fabrication.*

prEN ISO 5817:2002, *Welding – Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) – Quality levels for imperfections (ISO/DIS 5817:2002).*

EN ISO 6520-1:1998, *Welding and allied processes - Classification of geometric imperfections in metallic materials – Part 1: Fusion welding (ISO 6520-1:1998).*

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 attests that the design meets the requirements of this standard

3.2

design approval

procedure by which a responsible authority ascertains and attests 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 There are four testing groups.

3.4

inspection

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

NOTE 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 attest vessel compliance with the technical requirements of this standard by one or more tests

3.6

technical specification

technical data included in the order or mandatory for pressure vessels and covering such things as regulations and user's specific requirements

3.7

repair

process of rectifying a condition in either base material or weld to ensure compliance with this standard

NOTE The following definitions all relate to serially produced pressure vessels as described in Annex A.

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 approval, using the same manufacturing procedure involving a continuous fabrication process

3.9

continuous fabrication process

process where the welding of the main seams and branch welds is essentially continuous

NOTE Stoppages or break-downs requiring resetting of the welding machine and/or NDT equipment constitute a break in continuity. Adjustments to the welding machine within the welding procedure limitations do not qualify as resetting the welding machine.

3.10

model acceptance

procedure which ascertains and attests 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 Model acceptance is conducted by the manufacturer or the responsible authority depending on the conformity assessment module chosen.

3.11

prototype vessel/part

first or representative example of a series of pressure vessels/parts covered by a single model acceptance.

3.12

batch of vessels

part of a series where the welding of the main weld joints and branch welds has been essentially continuous

NOTE A stoppage in vessel production greater than three consecutive days requires the designation of a new batch.

3.13

shift

period of time per day during which the welding operator or operators remain the same

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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.

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 6.6.1.1.2 (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 documentation.

5.2 Information to be contained in the technical documentation

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

5.2.1 General description of the pressure vessel

- a) Name of vessel manufacturer and subcontractors, if applicable;
- b) Location/s of vessel manufacturers 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.

5.2.2 Conceptual design and construction drawings

The manufacturer analysis of hazards identifying those which apply to the pressure vessel on account of pressure shall be documented and be of sufficient detail.

Details of the conceptual 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 conceptual design shall also be maintained.

5.2.3 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.

5.2.4 Results of design calculations and examinations carried out

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

Supporting detailed drawings shall be prepared with all dimension notations marked. The drawings shall clearly identify in the case of cyclic loaded vessels, the critical areas. The maximum permissible peaking for cyclically loaded vessels shall also be given in the drawing. At least on the pressure vessel general arrangement drawing, the testing group for each welded joint shall be clearly identified.

5.2.4.2 If calculations are made with the aid of a computer 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.

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

- a) input data;
- b) plotter graphs (original and copy) form;
 - 1) the element subdivision;
 - 2) the stresses, e.g. as line or arrow figures or equal stress curves; stress curves of surfaces;
 - 3) the displacements;
- d) boundary conditions;
- e) the stresses in the most critical areas;
- f) the dividing and classifying of the stresses into different stress categories;
- g) the comparison of stress intensities and the allowable stress values.

5.2.4.4 In specific cases the following information shall be necessary:

- a) type of post weld heat treatment and, where necessary, type and extent of associated material tests;
- b) construction sequence schedule if the structural testing is to be carried out in several partial 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.

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5.2.5 Test reports

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

- a) welding procedure qualification records, certificate of qualification of welding personnel;
- b) material certificates;
- c) an example of the proposed list of the manufacturing records;
- d) values of measured peaking for vessels subject to cyclic loads.

5.2.6 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 structural 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 masonry 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.

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5.3 Design review

5.3.1 General

A design review and documented acceptance shall be conducted in all cases.

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 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;
- f) the adequacy of proposed pressure retaining boundary (thickness, vessel geometry, weld joint geometry etc.) for design conditions against those required by the design requirements of this standard;
- g) the adequacy of the stress analysis method in accordance with 5.2.4.3;
- h) manufacturing and test procedures.

6 Inspection and testing during fabrication

6.1 General

The inspection and testing activities during fabrication, described in this clause, shall be the responsibility of the manufacturer and shall be fully implemented for all pressure vessels.

6.2 Manufacturing procedures and construction drawings

The manufacturer shall ensure that all construction drawings and manufacturing procedures reviewed and approved at the design stage in clause 5, shall be available at the appropriate work area and shall be fully implemented in manufacturing. Inspection records shall document the use of the correct and appropriate procedures, and/or drawings including revision status at the time the inspection is performed.

6.3 Material traceability

6.3.1 General

The vessel manufacturer shall have and maintain an identification system for materials used in fabrication so that all material subject to stress due to pressure and those welded thereto in the completed vessel can be traced to its origin. This includes the use of welding consumable. The identification system used shall satisfy the requirements of EN 13445-4.

Testing of material traceability, including transfer of markings, shall be performed throughout fabrication and records maintained to document the method used from those permitted in EN 13445-4 (i.e. direct markings visible on the completed vessel, a direct coded marking on the vessel or tabulation/as built sketches). Final records shall include all material certification required by this standard.

6.3.2 Special Conditions - Material marking

Where service conditions prohibit die-stamping for material identification (see EN 13445-4) and when so specified by the purchase order, the manufacturer of the base materials shall mark the required data on the materials in a manner which will allow positive identification during inspection upon delivery. The markings shall be recorded so that each item of material will be positively identified in its position in the completed vessel (e.g. material/position list) and shall form part of the final records.

6.4 Preparation for manufacturing processes

6.4.1 General

Preparation for manufacturing processes such as edge preparation, vessel supports for formed parts prior to welding and forming shall be controlled and inspected to ensure that such activities are not detrimental to the completed vessel.

6.4.2 Joint preparation testing

The extent to which edges are dressed prior to testing shall be in accordance with EN 13445-4. All joint preparations shall be subject to visual inspection prior to any welding. Defects such as laminations, cracks and slag inclusion shall be removed prior to welding. In case of an increased probability of occurrence of imperfections or when imperfections have been detected, a visual inspection shall be supplemented by additional non-destructive testing.

All inspections shall be carried out by qualified personnel. The result of joint preparation testing shall be recorded in the NDT inspection schedule.

6.4.3 Inspection of vessel supports

All tack welds associated with bars, jacks, clamps, or other appropriate means used to hold the edges of vessel parts and/or provide support in welding shall be inspected.

- Welds of permanent attachments to pressure parts shall be examined to the extent described in Table 6.6.2-1 (line 21).
- Welds of temporary attachments shall be examined after removal for surface cracks to the extent described in Table 6.6.2-1 (line 22).
- Any repairs necessary following removal of temporary attachments shall be tested as described in 6.5.3.

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