

Leekkumutusest surveanumad. Osa 4: Valmistamine

- 4:

EVS

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

<div>E E</div> <div>EVS-EN 13445-4:2009 EN 13445-4:2009</div> <div>S</div> <div>EVS</div> <div>E</div> <div>E</div> <div>22 0 2009</div> <div>S S</div> <div>E</div>	<div>E</div> <div>EVS-EN 13445-4:2009</div> <div>E</div> <div>EN 13445-4:2009</div> <div>E</div> <div>S</div> <div>E</div> <div>22 0 2009</div> <div>S</div> <div>E</div>
--	---

EVS-

S 23 020 30

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

E S

10 1031 E 05 5050 - E S :

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

N

E S

10 1031 E 05 5050 - E S :

English Version

Unfired pressure vessels - Part 4: Fabrication

Réceptacles sous pression non soumis à la flamme - Partie 4
: fabrication

Unbefeuerte Druckbehälter - Teil 4: Herstellung

This European Standard was approved by CEN on 30 June 2009.

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

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

CEN members are the national standards bodies of 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 United Kingdom.



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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword.....	4
1 Scope	4
2 Normative references	5
3 Requirements for manufacturing and subcontracting	7
3.1 Manufacturing	7
3.2 Subcontracting.....	7
4 Materials	8
4.1 General.....	8
4.2 Material traceability	8
4.2.1 General.....	8
4.2.2 Identification system	8
4.2.3 Visibility	9
4.2.4 Review of material certification and material identification	9
4.2.5 Transfer of markings	9
5 Manufacturing tolerances	9
5.1 Surface geometry of welds	9
5.2 Middle line alignment	9
5.3 Surface alignment.....	11
5.3.1 Surface misalignment between parts	11
5.3.2 Joining of parts of different thickness	11
5.4 Tolerances for vessels subjected to internal pressure	11
5.4.1 External diameter.....	11
5.4.2 Out of roundness.....	11
5.4.3 Deviation from the longitudinal axis.....	12
5.4.4 Irregularities in profile.....	12
5.4.5 Local thinning	14
5.4.6 Dished ends.....	15
5.5 Tolerances for vessels subjected to external pressure	17
5.6 Structural tolerances	17
6 Weld details	17
6.1 General.....	17
6.2 Vessels or parts made of more than one course	17
6.3 Lapped joints, joggle joints, permanent backing strips	17
7 Welding	17
7.1 General.....	17
7.2 Welding procedure specification (WPS)	18
7.3 Welding procedure qualification record (WPQR).....	18
7.4 Qualification of welders and welding operators.....	19
7.5 Filler metals and auxiliary materials.....	19
7.6 Joint preparation.....	19
7.7 Execution of welded joints	20
7.8 Attachments, supports and stiffeners.....	20
7.9 Preheat.....	21
8 Manufacture and testing of welds — Production test.....	21
8.1 General.....	21
8.2 Reference criteria.....	21
8.3 Extent of testing.....	25
8.4 Performance of tests and acceptance criteria.....	27
8.4.1 General.....	27
8.4.2 Transverse tensile test.....	27

8.4.3	Longitudinal weld tensile test	27
8.4.4	Impact test	27
8.4.5	Bend test.....	27
8.4.6	Macro examination	28
8.4.7	Micro examination	28
8.4.8	Hardness test	28
8.4.9	Retests	28
8.4.10	Test report	29
9	Forming of pressure parts	29
9.1	General.....	29
9.2	Ratio of deformation.....	29
9.2.1	Dished circular products	29
9.2.2	Cylinders and cones made by rolling.....	30
9.2.3	Other product types	31
9.2.4	Tube bends.....	32
9.2.5	Forming of Segments.....	32
9.3	Forming procedures.....	33
9.3.1	Cold forming	33
9.3.2	Hot forming	33
9.4	Heat treatment after forming	36
9.4.1	General.....	36
9.4.2	Heat treatment of flat products after cold forming	36
9.4.3	Heat treatment of tubular products after cold forming.....	38
9.4.4	Heat treatment of clad steels after cold forming	38
9.4.5	Heat treatment after hot forming.....	38
9.4.6	Heat treatment of clad steels after hot forming.....	39
9.5	Sampling of formed test coupons	39
9.5.1	Cold formed products without heat treatment	39
9.5.2	Hot formed or cold formed products with heat treatment.....	39
9.6	Tests.....	40
9.6.1	Base material	40
9.6.2	Butt welds.....	40
9.6.3	Acceptance criteria for formed test coupons	41
9.6.4	Retests of formed coupons	41
9.7	Visual inspection and control of dimension.....	41
9.8	Marking	42
9.9	Documentation.....	42
10	Post weld heat treatment (PWHT)	42
10.1	General.....	42
10.2	Heat treatment conditions	43
10.3	Method of PWHT	45
10.4	PWHT procedure.....	46
10.5	Mechanical properties after heat treatment	46
10.6	Dissimilar ferritic joints.....	47
10.7	Special materials	48
10.8	Heat Treatment for reasons other than welding.....	48
11	Repairs.....	49
11.1	Repairs of surface defects in the parent metal	49
11.2	Repair of weld defects.....	49
12	Finishing operations	49
Annex A (informative)	Structural tolerances	51
Annex B (informative)	Example of a sub-contractors form	55
Annex Y (informative)	History of EN 13445-4	56
Annex ZA (informative)	Relationship between this European Standard and the Essential Requirements of the EU Pressure Equipment Directive 97/23/EC	57
Bibliography	58

Foreword

This document (EN 13445-4:2009) 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 2009*, and conflicting national standards shall be withdrawn at the latest by *December 2009*.

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*.

This document supersedes EN 13445-4:2002. This new edition incorporates the Amendments which have been approved previously by CEN members, and the corrected pages up to Issue 36 without any further technical change. Annex Y to EN 13445-1:2009 and Annex Y to this Part 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 13445:2009 each year, consolidating these Amendments and including other identified corrections. Issue 5 (2013-07) includes the corrected pages listed in Annex Y.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, 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 document specifies requirements for the manufacture of unfired pressure vessels and their parts, made of steels, including their connections to non-pressure parts. It specifies requirements for material traceability, manufacturing tolerances, welding requirements, production tests, forming requirements, heat treatment, repairs and finishing operations.

2 Normative references

This Europe 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 Europe 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 287-1:2004, EN 287-1:2004/A2:2006, *Approval testing of welders — Fusion welding — Part 1: Steels*

EN 875:1995, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination*

EN 876:1995, *Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints*

EN 895:1995, *Destructive tests on welds in metallic materials — Transverse tensile test*

EN 910:1996, *Destructive tests on welds in metallic materials — Bend tests*

EN 1043-1:1995, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints*

EN 1321:1996, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds*

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 10028-2:2003, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2003, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2003, *Flat products made of steels for pressure purposes — Part 4: Nickel alloy steels with specified low temperature properties*

EN 10216-1:2002, EN 10216-1:2002/A1:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10216-2:2002+A2:2007, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10216-3:2002, EN 10216-3:2002/A1:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes*

EN 10216-4:2002, EN 10216-4:2002/A1:2004, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 4: Non-alloy and alloy steel tubes with specified low temperature properties*

EN 10217-1:2002, EN 10217-1:2002/A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10217-2:2002, EN 10217-2:2002/A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2: Electric welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-3:2002, EN 10217-3:2002/A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes*

EN 10217-4:2002, EN 10217-4:2002/A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 4: Electric welded non-alloy and alloy steel tubes with specified low temperature properties*

EN 10217-5:2002, EN 10217-5:2002/A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-6:2002, EN 10217-6:2002/A1:2005, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 6: Submerged arc welded non-alloy and alloy steel tubes with specified low temperature properties*

EN 10222-2:1999 *Steel forgings for pressure purposes — Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

EN 10222-3:1998 *Steel forgings for pressure purposes — Part 3: Nickel steels with specified low temperatures properties*

EN 10222-4:1998, EN 10222-4:1998/A1:2002, *Steel forgings for pressure purposes — Part 4: Weldable fine grain steels with high proof strength*

EN 13445-1:2009, *Unfired pressure vessels — Part 1: General*

EN 13445-2:2009, *Unfired pressure vessels — Part 2: Materials*

EN 13445-3: 2009 *Unfired pressure vessels — Part 3: Design*

EN 13445-5:2009, *Unfired pressure vessels — Part 5: Inspection and testing*

EN ISO 3834-2:2005, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

EN ISO 3834-3:2005, *Quality requirements for fusion welding of metallic materials - Part 3: Standard quality requirements*

EN ISO 15609-1:2004, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding (ISO 15609-1:2004)*

EN ISO 15611:2003, *Specification and qualification of welding procedures for metallic materials — Qualification based on previous welding experience (ISO 15611:2003)*

EN ISO 15612:2004, *Specification and qualification of welding procedures for metallic materials — Qualification by adoption of a standard welding procedure* (ISO 15612:2004)

EN ISO 15613:2004, *Specification and qualification of welding procedures 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)

3 Requirements for manufacturing and subcontracting

3.1 Manufacturing

The general responsibilities of the pressure vessel manufacturer are stated in EN 13445-1:2009. Additionally to those requirements, the manufacturer shall ensure that:

- a) the organisation for the control of manufacturing operations which includes special processes such as welding, forming and heat treatment shall be clearly defined by the manufacturer;
- b) the manufacturing procedures such as welding, forming and heat treatment are adequate for the purpose and the pressure vessel meets the requirements of this standard. Where specific requirements are associated with materials these shall be taken into account, e.g. EAMs;
- c) the manufacturing equipment is adequate for fabrication;
- d) the staff is adequate for the assigned tasks;

NOTE As far as welding co-ordination is concerned, the qualifications, tasks and responsibilities can be defined by the manufacturer in accordance with EN ISO 14731:2007 [1] in the job assignment.

- e) the quality requirements for welding defined in EN ISO 3834-3:2005 are met as a minimum.

3.2 Subcontracting

The manufacturer may subcontract work, but shall ensure that the subcontractor carries out the work in accordance with the requirements of this European Standard. The manufacturer is responsible for the adequate definition of the subcontracted task and the need for any associated records.

On all occasions that the subcontractor work includes

- a) welding;
- b) forming including associated heat treatment;
- c) post weld heat treatment;
- d) non-destructive testing of welds (see EN 13445-5:2009),

the manufacturer shall obtain a subcontractor form (see Annex B).

Where welding operations are subcontracted, the manufacturer shall also either obtain copies of the welding procedure and welding operator qualification records or take other action to ensure that they comply with this standard.