

SVENSK STANDARD

SS-EN 13445-4:2014+C5:2018



Fastställt/Approved: 2018-09-14
Utgåva/Edition: 1
Språk/Language: engelska/English
ICS: 23.020.30; 23.020.60

Tryckkärl (ej eldberörda) – Del 4: Tillverkning

Unfired pressure vessels – Part 4: Fabrication

This preview is downloaded from www.sis.se. Buy the entire standard via <https://www.sis.se/std-80006655>

Standarder får världen att fungera

SIS (Swedish Standards Institute) är en fristående ideell förening med medlemmar från både privat och offentlig sektor. Vi är en del av det europeiska och globala nätverk som utarbetar internationella standarder. Standarder är dokumenterad kunskap utvecklad av framstående aktörer inom industri, näringsliv och samhälle och befrämjar handel över gränser, bidrar till att processer och produkter blir säkrare samt effektiviserar din verksamhet.

Delta och påverka

Som medlem i SIS har du möjlighet att påverka framtida standarder inom ditt område på nationell, europeisk och global nivå. Du får samtidigt tillgång till tidig information om utvecklingen inom din bransch.

Ta del av det färdiga arbetet

Vi erbjuder våra kunder allt som rör standarder och deras tillämpning. Hos oss kan du köpa alla publikationer du behöver – allt från enskilda standarder, tekniska rapporter och standardpaket till handböcker och onlinetjänster. Genom vår webbtjänst e-nav får du tillgång till ett lättnavigerat bibliotek där alla standarder som är aktuella för ditt företag finns tillgängliga. Standarder och handböcker är källor till kunskap. Vi säljer dem.

Utveckla din kompetens och lyckas bättre i ditt arbete

Hos SIS kan du gå öppna eller företagsinterna utbildningar kring innehåll och tillämpning av standarder. Genom vår närhet till den internationella utvecklingen och ISO får du rätt kunskap i rätt tid, direkt från källan. Med vår kunskap om standarders möjligheter hjälper vi våra kunder att skapa verklig nytta och lönsamhet i sina verksamheter.

Vill du veta mer om SIS eller hur standarder kan effektivisera din verksamhet är du välkommen in på www.sis.se eller ta kontakt med oss på tel 08-555 523 00.



Standards make the world go round

SIS (Swedish Standards Institute) is an independent non-profit organisation with members from both the private and public sectors. We are part of the European and global network that draws up international standards. Standards consist of documented knowledge developed by prominent actors within the industry, business world and society. They promote cross-border trade, they help to make processes and products safer and they streamline your organisation.

Take part and have influence

As a member of SIS you will have the possibility to participate in standardization activities on national, European and global level. The membership in SIS will give you the opportunity to influence future standards and gain access to early stage information about developments within your field.

Get to know the finished work

We offer our customers everything in connection with standards and their application. You can purchase all the publications you need from us - everything from individual standards, technical reports and standard packages through to manuals and online services. Our web service e-nav gives you access to an easy-to-navigate library where all standards that are relevant to your company are available. Standards and manuals are sources of knowledge. We sell them.

Increase understanding and improve perception

With SIS you can undergo either shared or in-house training in the content and application of standards. Thanks to our proximity to international development and ISO you receive the right knowledge at the right time, direct from the source. With our knowledge about the potential of standards, we assist our customers in creating tangible benefit and profitability in their organisations.

If you want to know more about SIS, or how standards can streamline your organisation, please visit www.sis.se or contact us on phone +46 (0)8-555 523 00



Europastandarden EN 13445-4:2014 Issue 5 (2018-07) gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 13445-4:2014 Issue 5 (2018-07).

Denna standard ersätter SS-EN 13445-4:2014+C4:2017 utgåva 1.

The European Standard EN 13445-4:2014 Issue 5 (2018-07) has the status of a Swedish Standard. This document contains the official version of EN 13445-4:2014 Issue 5 (2018-07).

This standard supersedes the Swedish Standard SS-EN 13445-4:2014+C4:2017 edition 1.

© Copyright/Upphovsrätten till denna produkt tillhör SIS, Swedish Standards Institute, Stockholm, Sverige. Användningen av denna produkt regleras av slutanvändarlicensen som återfinns i denna produkt, se standardens sista sidor.

© Copyright SIS, Swedish Standards Institute, Stockholm, Sweden. All rights reserved. The use of this product is governed by the end-user licence for this product. You will find the licence in the end of this document.

Uppllysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS som även lämnar allmänna uppllysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för Konstruktion, tillverkning och kontroll av tryckbärande anordningar, SIS / TK 298.

Har du synpunkter på innehållet i den här standarden, vill du delta i ett kommande revideringsarbete eller vara med och ta fram andra standarder inom området? Gå in på www.sis.se - där hittar du mer information.

EUROPEAN STANDARD

EN 13445-4

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2014

ICS 23.020.30

Supersedes EN 13445-4:2009

English Version

Unfired pressure vessels - Part 4: Fabrication

Réceptifs sous pression non soumis à la flamme - Partie 4:
Fabrication

Unbefeuerte Druckbehälter - Teil 4: Herstellung

This European Standard was approved by CEN on 19 August 2014.

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

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Contents

Page

Foreword.....	5
1 Scope	7
2 Normative references	7
3 Requirements for manufacturing and subcontracting	9
3.1 Manufacturing	9
3.2 Subcontracting.....	9
4 Materials	10
4.1 General.....	10
4.2 Material traceability	10
4.2.1 General.....	10
4.2.2 Identification system	10
4.2.3 Visibility	11
4.2.4 Review of material certification and material identification	11
4.2.5 Transfer of markings	11
5 Manufacturing tolerances	11
5.1 Surface geometry of welds	11
5.2 Middle line alignment	11
5.3 Surface alignment.....	13
5.3.1 Surface misalignment between parts	13
5.3.2 Joining of parts of different thickness	13
5.4 Tolerances for vessels subjected to internal pressure	13
5.4.1 External diameter.....	13
5.4.2 Out of roundness.....	13
5.4.3 Deviation from the longitudinal axis.....	14
5.4.4 Irregularities in profile.....	14
5.4.5 Local thinning	16
5.4.6 Dished ends.....	17
5.5 Tolerances for vessels subjected to external pressure	19
5.6 Structural tolerances	19
6 Weld details	19
6.1 General.....	19
6.2 Vessels or parts made of more than one course	19
6.3 Lapped joints, joggle joints, permanent backing strips	19
7 Welding	19
7.1 General.....	19
7.2 Welding procedure specification (WPS)	20
7.3 Welding procedure qualification record (WPQR).....	20
7.4 Qualification of welders and welding operators.....	21
7.5 Filler metals and auxiliary materials	21
7.6 Joint preparation.....	22
7.7 Execution of welded joints	22
7.8 Attachments, supports and stiffeners.....	22
7.9 Preheat.....	23
7.10 Permanent joints other than welding.....	23
7.10.1 General.....	23
7.10.2 Mechanical roller expansion.....	23
7.10.3 Brazing.....	23
8 Manufacture and testing of welds — Production test.....	23
8.1 General.....	23
8.2 Reference criteria.....	24
8.3 Extent of testing.....	27

8.4	Performance of tests and acceptance criteria.....	29
8.4.1	General.....	29
8.4.2	Transverse tensile test.....	29
8.4.3	Longitudinal weld tensile test.....	29
8.4.4	Impact test.....	29
8.4.5	Bend test.....	29
8.4.6	Macro examination.....	30
8.4.7	Micro examination.....	30
8.4.8	Hardness test.....	30
8.4.9	Retests.....	30
8.4.10	Test report.....	31
9	Forming of pressure parts.....	31
9.1	General.....	31
9.2	Ratio of deformation.....	31
9.2.1	Dished circular products.....	31
9.2.2	Cylinders and cones made by rolling.....	32
9.2.3	Other product types.....	33
9.2.4	Tube bends.....	34
9.2.5	Forming of Segments.....	34
9.3	Forming procedures.....	35
9.3.1	Cold forming.....	35
9.3.2	Hot forming.....	35
9.4	Heat treatment after forming.....	38
9.4.1	General.....	38
9.4.2	Heat treatment of flat products after cold forming.....	38
9.4.3	Heat treatment of tubular products after cold forming.....	40
9.4.4	Heat treatment of clad steels after cold forming.....	40
9.4.5	Heat treatment after hot forming.....	40
9.4.6	Heat treatment of clad steels after hot forming.....	41
9.5	Sampling of formed test coupons.....	41
9.5.1	Cold formed products without heat treatment.....	41
9.5.2	Hot formed or cold formed products with heat treatment.....	41
9.6	Tests.....	42
9.6.1	Base material.....	42
9.6.2	Butt welds.....	42
9.6.3	Acceptance criteria for formed test coupons.....	43
9.6.4	Retests of formed coupons.....	43
9.7	Visual inspection and control of dimension.....	43
9.8	Marking.....	44
9.9	Documentation.....	44
10	Post weld heat treatment (PWHT).....	44
10.1	General.....	44
10.2	Heat treatment conditions.....	45
10.3	Method of PWHT.....	49
10.4	PWHT procedure.....	50
10.5	Mechanical properties after heat treatment.....	50
10.6	Dissimilar ferritic joints.....	51
10.7	Special materials.....	52
10.8	Heat Treatment for reasons other than welding.....	52
11	Repairs.....	53
11.1	Repairs of surface defects in the parent metal.....	53
11.2	Repair of weld defects.....	53
12	Finishing operations.....	53
Annex A (informative) Structural tolerances.....		55
Annex B (informative) Example of a sub-contractors form.....		59
Annex C (normative) Specification and approval of expansion procedures and operators.....		60
C.1	General.....	60
C.1.1	Introduction.....	60

EN 13445-4:2014 (E)
Issue 5 (2018-07)

C.1.2	Responsibility	60
C.1.3	Specification of expansion procedures.....	60
C.1.4	Technical content of expansion procedure specification (EPS)	61
C.1.5	Expansion procedure qualification test (EPQT)	62
C.2	Examination and testing	62
C.2.1	General.....	62
C.2.2	Visual examination	62
C.2.3	Dimensional verification	62
C.2.4	Testing	63
C.3	Range of approval.....	63
C.3.1	General.....	63
C.3.2	Manufacturer	63
C.3.3	Material	63
C.3.4	Tube dimensions	63
C.3.5	Expansion factor.....	63
C.3.6	Joint design.....	64
C.3.7	Tool	64
C.3.8	PWHT	64
C.4	Expansion Procedure Approval Record (EPAR)	64
C.5	Expansion operator approval	64
C.5.1	General.....	64
C.5.2	Validity range of expansion operator qualification	65
C.5.3	Qualification tests.....	65
C.5.4	Examination and testing	65
C.5.5	Period of validity	65
C.5.6	Certification	66
Annex Y (informative)	History of EN 13445-4	67
Y.1	Differences between EN 13445-4:2009 and EN 13445-4:2014	67
Y.2	List of corrected pages of Issue 2 (2015-07).....	67
Y.3	List of corrected pages of Issue 3 (2016-07).....	67
Y.4	List of corrected pages of Issue 4 (2017-07).....	67
Y.5	List of corrected pages of Issue 5 (2018-07).....	67
Annex ZA (informative)	Relationship between this European Standard and the essential requirements of Directive 2014/68/EU aimed to be covered	68
Bibliography	69

Foreword

This document (EN 13445-4:2014) 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.*
- Part 10: *Additional requirements for pressure vessels of nickel and nickel alloys*

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 13445-4:2009. 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.

EN 13445-4:2014 (E)
Issue 5 (2018-07)

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, consolidating these Amendments and including other identified corrections. Issue 5 (2018-07) 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, 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, Serbia, 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, requirements for permanent joints other than welding, production tests, forming requirements, heat treatment, repairs and finishing operations.

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 10028-2:2009, *Flat products made of steels for pressure purposes — Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2009, *Flat products made of steels for pressure purposes — Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2009, *Flat products made of steels for pressure purposes — Part 4: Nickel alloy steels with specified low temperature properties*

EN 10216-1:2013, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 1: Non-alloy steel tubes with specified room temperature properties*

EN 10216-2:2013, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10216-3:2013, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 3: Alloy fine grain steel tubes*

EN 10216-4:2013, *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*