

საქართველოს სტანდარტი

არაგაცხელებადი წნევის ჭურჭელი - ნაწილი 3: პროექტირება

საქართველოს სტანდარტებისა და მეტროლოგიის
ეროვნული სააგენტო
თბილისი

საინფორმაციო მონაცემები

1 დამტკიცებულია და შემოღებულია სამოქმედოდ საქართველოს სტანდარტებისა და მეტროლოგიის ეროვნული სააგენტოს 2015 წლის 1 აპრილის № 24 და 2015 წლის 10 თებერვლის № 9 განკარგულებებით

2 მიღებულია გარეკანის თარგმნის მეთოდით სტანდარტიზაციის ევროპული კომიტეტის სტანდარტი ენ 13445-3:2014 „არაგაცხელებადი წნევის ჭურჭელი- ნაწილი 3: პროექტირება“

3 პირველად

4 რეგისტრირებულია საქართველოს სტანდარტებისა და მეტროლოგიის ეროვნული სააგენტოს რეესტრში: 2015 წლის 1 აპრილი №268-1.3-7110

აკრძალულია ამ სტანდარტის გადაცემა მესამე პირებისათვის ან/და მისი სხვა ფორმით
გავრცელება

EUROPEAN STANDARD

EN 13445-3

NORME EUROPÉENNE

EUROPÄISCHE NORM

September 2014

ICS 23.020.30

Supersedes EN 13445-3:2009

English Version

Unfired pressure vessels - Part 3: Design

Récepteurs sous pression - Partie 3: Conception

Unbefeuerte Druckbehälter - Teil 3: Konstruktion

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.....	6
1 Scope	8
2 Normative references	8
3 Terms and definitions.....	9
4 Symbols and abbreviations	11
5 Basic design criteria.....	13
5.1 General.....	13
5.2 Corrosion, erosion and protection.....	13
5.3 Load cases.....	15
5.4 Design methods	19
5.5 Thickness calculations (DBF).....	20
5.6 Joint coefficient.....	21
5.7 Design requirements of welded joints	22
6 Maximum allowed values of the nominal design stress for pressure parts.....	25
6.1 General.....	25
6.2 Steels (except castings), other than austenitic steels covered by 6.4 and 6.5, with a minimum rupture elongation, as given in the relevant technical specification for the material, below 30 %.....	26
6.3 Alternative route for steels (except castings), other than austenitic steels covered by 6.4 and 6.5, with a minimum rupture elongation, as given in the relevant technical specification for the material, below 30 %	26
6.4 Austenitic steels (except castings) with a minimum elongation after rupture, as given in the relevant technical specification for the material, from 30 % to 35 %.....	27
6.5 Austenitic steels (except castings) with a minimum rupture elongation, as given in the relevant technical specification for the material, from 35 %.....	27
6.6 Cast steels	28
7 Shells under internal pressure	29
7.1 Purpose.....	29
7.2 Specific definitions	29
7.3 Specific symbols and abbreviations.....	29
7.4 Cylindrical and spherical shells	29
7.5 Dished ends.....	30
7.6 Cones and conical ends	35
7.7 Nozzles which encroach into the knuckle region.....	43
8 Shells under external pressure	48
8.1 Purpose.....	48
8.2 Specific definitions	48
8.3 Specific symbols and definitions	48
8.4 General.....	51
8.5 Cylindrical shells.....	52
8.6 Conical shell	73
8.7 Spherical shells.....	81
8.8 Vessel ends	82
9 Openings in shells	83
9.1 Purpose.....	83
9.2 Specific definitions	83
9.3 Specific symbols and abbreviations.....	84
9.4 General.....	87
9.5 Isolated openings.....	99
9.6 Multiple openings.....	115
9.7 Openings close to a shell discontinuity	125

10	Flat ends	133
10.1	Purpose.....	133
10.2	Specific definitions	133
10.3	Specific symbols and abbreviations.....	133
10.4	Unpierced circular flat ends welded to cylindrical shells.....	135
10.5	Unpierced bolted circular flat ends.....	142
10.6	Pierced circular flat ends	146
10.7	Flat ends of non-circular or annular shape.....	150
11	Flanges.....	154
11.1	Purpose.....	154
11.2	Specific definitions	154
11.3	Specific symbols and abbreviations.....	154
11.4	General	157
11.5	Narrow face gasketed flanges	161
11.6	Full face flanges with soft ring type gaskets	176
11.7	Seal welded flanges	179
11.8	Reverse narrow face flanges	179
11.9	Reverse full face flanges	182
11.10	Full face flanges with metal to metal contact	186
12	Bolted domed ends.....	189
12.1	Purpose.....	189
12.2	Specific definitions	189
12.3	Specific symbols and abbreviations.....	189
12.4	General.....	189
12.5	Bolted domed ends with narrow face gaskets.....	189
12.6	Bolted domed ends with full face joints	191
13	Heat Exchanger Tubesheets.....	193
13.1	Purpose.....	193
13.2	Specific definitions	193
13.3	Specific symbols and abbreviations.....	193
13.4	U-tube tubesheet heat exchangers	196
13.5	Fixed tubesheet heat exchangers	210
13.6	Floating tubesheet heat exchangers.....	238
13.7	Tubesheet characteristics.....	255
13.8	Maximum permissible tube to tubesheet joint stress	262
13.9	Maximum permissible longitudinal compressive stress for tubes.....	263
13.10	Design of tubesheet flange extension with a narrow face gasket	266
13.11	Design of tubesheet flange extension with a full face gasket.....	269
13.12	Special tube-to-tubesheet welded joints	272
14	Expansion bellows.....	275
14.1	Purpose.....	275
14.2	Specific definitions	275
14.3	Specific symbols and abbreviations.....	277
14.4	Conditions of applicability	279
14.5	U-shaped unreinforced bellows	281
14.6	U-shaped reinforced bellows	295
14.7	Toroidal bellows.....	303
14.8	Fabrication	310
14.9	Inspection and testing	312
14.10	Bellows subjected to axial, lateral or angular displacements.....	314
15	Pressure vessels of rectangular section.....	319
15.1	Purpose.....	319
15.2	Specific definitions	319
15.3	Specific symbols and abbreviations.....	319
15.4	General.....	320

15.5	Unreinforced vessels	320
15.6	Reinforced vessels	326
15.7	Openings.....	333
16	Additional non-pressure loads	335
16.1	Purpose	335
16.2	Specific definitions	335
16.3	Specific symbols and abbreviations.....	336
16.4	Local loads on nozzles in spherical shells	337
16.5	Local loads on nozzles in cylindrical shells	347
16.6	Line loads	355
16.7	Lifting lugs.....	361
16.8	Horizontal vessels on saddle supports	365
16.9	Horizontal vessels on ring supports.....	379
16.10	Vertical vessels on bracket supports	384
16.11	Vertical vessels with supporting legs.....	389
16.12	Vertical vessels with skirts	391
16.13	Vertical vessels with ring supports.....	422
16.14	Global loads.....	433
17	Simplified assessment of fatigue life.....	438
17.1	Purpose	438
17.2	Specific definitions	438
17.3	Specific symbols and abbreviations.....	440
17.4	Conditions of applicability	441
17.5	General.....	442
17.6	Determination of allowable number of pressure cycles	447
17.7	Assessment rule	472
17.8	Design and manufacture	472
17.9	Testing	473
18	Detailed assessment of fatigue life	474
18.1	Purpose	474
18.2	Specific definitions	474
18.3	Specific symbols and abbreviations.....	477
18.4	Limitations	479
18.5	General.....	481
18.6	Welded material.....	483
18.7	Unwelded components and bolts.....	488
18.8	Elastic-plastic conditions.....	491
18.9	Fatigue action	493
18.10	Fatigue strength of welded components	496
18.11	Fatigue strength of unwelded components	517
18.12	Fatigue strength of steel bolts.....	522
19	Creep design	525
19.1	Purpose	525
19.2	Specific definitions	525
19.3	Specific symbols and abbreviations.....	525
19.4	Design in the creep range	526
19.5	Nominal Design stress in the creep range	526
19.6	Weld joint factor in the creep range	531
19.7	Pressure loading of predominantly non-cyclic nature in the creep range	531
19.8	Design procedures for DBF	531
20	Design rules for reinforced flat walls	535
20.1	General	535
20.2	Stayed flat walls	535
20.3	Specific definitions for stayed flat walls.....	535
20.4	Required thickness of stayed flat walls.....	535
20.5	Required dimensions and layout of staybolts and stays	535
20.6	Requirements for threaded staybolts	536
20.7	Requirements for welded-in staybolts and welded stays.....	536
20.8	Tables for stayed flat walls	537
20.9	Figures for Stayed Flat Walls.....	538

21	Circular flat ends with radial reinforcement ribs	541
21.1	Purpose	541
21.2	Specific definitions	541
21.3	Specific symbols and abbreviations	543
21.4	Ends without additional peripheral bending moment	544
21.5	Ends with additional peripheral bending moment	546
21.6	Openings	548
21.7	Welds	548
21.8	Central Ring	548
22	Static analysis of tall vertical vessels on skirts	550
22.1	Purpose	550
22.2	Definitions	550
22.3	Specific symbols and abbreviations	551
22.4	Loads	552
22.5	Load combinations	555
22.6	Stress analysis of pressure vessel shells and skirts	558
22.7	Design of joint between skirt and pressure vessel (at dished end or cylindrical shell)	558
22.8	Design of anchor bolts and base ring assembly	558
22.9	Foundation loads	559
	Annex A (normative) Design requirements for pressure bearing welds	560
	Annex B (normative) Design by Analysis – Direct Route	584
	Annex C (normative) Design by analysis - Method based on stress categories	614
	Annex D (informative) Verification of the shape of vessels subject to external pressure	633
	Annex E (normative) Procedure for calculating the departure from the true circle of cylinders and cones	640
	Annex F (normative) Allowable external pressure for vessels outside circularity tolerance	643
	Annex G (normative) Alternative design rules for flanges and gasketed flange connections	645
	Annex GA (informative) Alternative design rules for flanges and gasketed flange connections	692
	Annex H (informative) Gasket factors m and y	755
	Annex I (informative) Additional information on heat exchanger tubesheet design	758
	Annex J (normative) Alternative method for the design of heat exchanger tubesheets	762
	Annex K (informative) Additional information on expansion bellows design	807
	Annex L (informative) Basis for design rules related to additional non-pressure loads	813
	Annex M (informative) In service monitoring of vessels operating in fatigue or creep	815
	Annex N (informative) Bibliography to Clause 18	818
	Annex O (informative) Physical properties of steels	819
	Annex P (normative) Classification of weld details to be assessed using principal stresses	827
	Annex Q (normative) Simplified procedure for the fatigue assessment of unwelded zones	840
	Annex R (informative) Coefficients for creep-rupture model equations for extrapolation of creep-rupture strength	841
	Annex S (informative) Extrapolation of the nominal design stress based on time-independent behaviour in the creep range	845
	Annex T (normative) Design by experimental methods	851
	Annex Y (informative) History of EN 13445-3	864
	Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of the EU Pressure Equipment Directive 97/23/EC	865

Foreword

This document (EN 13445-3:2014) 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 13445-3:2009. 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.

საინფორმაციო ნაწილი. სრული გექნილი ინტერიერის სანახავის დეკლარაცია დანართის საინფორმაციო ნაწილი. სრული გექნილი ინტერიერის სანახავის დეკლარაცია დანართის საინფორმაციო ნაწილი.