

DIN EN 13480-3



ICS 23.040.01

Supersedes
 DIN EN 13480-3:2014-12,
 DIN EN 13480-3 Corrigendum
 1:2015-12,
 DIN EN 13480-3 Corrigendum
 2:2016-10 and
 DIN EN 13480-3/A1:2017-11

**Metallic industrial piping –
 Part 3: Design and calculation;
 English version EN 13480-3:2017,
 English translation of DIN EN 13480-3:2017-12**

Metallische industrielle Rohrleitungen –
 Teil 3: Konstruktion und Berechnung;
 Englische Fassung EN 13480-3:2017,
 Englische Übersetzung von DIN EN 13480-3:2017-12

Tuyauteries industrielles métalliques –
 Partie 3: Conception et calcul;
 Version anglaise EN 13480-3:2017,
 Traduction anglaise de DIN EN 13480-3:2017-12

Document comprises 367 pages

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original shall be considered authoritative.

A comma is used as the decimal marker.

National foreword

This document (EN 13480-3:2017) has been prepared by Technical Committee CEN/TC 267 “Industrial piping and pipelines” (Secretariat: AFNOR, France). The responsible German body involved in its preparation was *DIN-Normenausschuss Rohrleitungen und Dampfkesselanlagen* (DIN Standards Committee Piping and Boiler Plant), Working Committee NA 082-00-17 AA “Industrial piping and pipeline; Mirror Committee to CEN/TC 267”.

This part of DIN EN 13480 specifies the design and calculation of industrial piping systems.

Amendments

This standard differs from DIN EN 13480-3:2014-12, DIN EN 13480-3 Corrigendum 1:2015-12, DIN EN 13480-3 Corrigendum 2:2016-10 and DIN EN 13480-3/A1:2017-11 as follows:

- a) normative references have been updated;
- b) Clause 2 “Normative references” has been updated concerning the types of inspection documents for metallic materials and the qualification of welding procedures for metallic materials;
- c) subclause 4.2.3.4 “Other loads to be taken into account” has been revised;
- d) subclause 4.3 “Thickness” has been revised;
- e) subclause 4.6 “Dimensioning of piping components subject to pressure” has been revised;
- f) subclause 5.2 “Time-independent nominal design stress” has been revised;
- g) subclause 5.3 “Time-dependent nominal design stress” has been revised;
- h) subclause 6.2.3 “Required wall thickness” has been revised;
- i) subclause 6.3 “Mitre bends” has been revised;
- j) subclause 6.4.4 “Conical shells” has been revised;
- k) subclause 6.6 “Bolted flange connections” has been revised;
- l) Table 7.2.4-1 “Bolted circular flat ends with gasket entirely within the bolt circle” has been revised;
- m) Clause 8 “Openings and branch connections” has been revised;
- n) subclause 8.3.9 “Forged tee” has been included;
- o) subclause 10.3.2.3 “Determination of allowable number of load cycles” has been revised;
- p) Clause 11 “Integral attachments” has been revised;
- q) subclause 12.1.3 “Allowable stresses” has been revised;
- r) subclause 12.2 “Piping flexibility” has been revised;

- s) subclause 12.3 “Flexibility analysis” has been revised;
- t) subclause 12.3.8 “Alternative method for stress calculation” has been included;
- u) Clause 13 “Pipe Supports” has been revised;
- v) Annex B “More accurate calculation of bends and elbows” has been revised;
- w) Annex C “Expansion joints” has been revised;
- x) Annex D “Flanges” has been revised;
- y) Annex E “Design of branch connections in piping accessories” has been revised;
- z) Annex H “Flexibility characteristics, flexibility and stress intensification factors and section moduli of piping components and geometrical discontinuities” has been revised;
- aa) Annex I “Production testing of spring supports and shock arrestors (shock absorbers)” has been revised;
- bb) Annex K “Attachment of supports to structures” has been revised;
- cc) Annex L “Buckling of linear type supports” has been revised;
- dd) Annex N “Documentation of supports” has been revised;
- ee) Annex O “Alternative method for checking branch connections” has been included;
- ff) Annex P “Recommended gaskets for industrial piping” has been revised;
- gg) Annex Q “Simplified pipe stress analysis” has been revised;
- hh) Annex ZA “Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU aimed to be covered” has been revised;
- ii) the Bibliography has been updated;
- jj) the standard has been editorially revised.

Previous editions

DIN 2413: 1927-01, 1936-09, 1954-05, 1966-06, 1972-06
DIN 2413-1: 1993-10
DIN 2413-2: 1993-10
DIN EN 13480-3: 2002-08, 2012-11, 2013-11, 2014-12
DIN EN 13480-3/A1: 2005-11, 2017-11
DIN EN 13480-3 Corrigendum 1: 2005-12, 2015-12
DIN EN 13480-3 Corrigendum 2: 2006-06, 2016-10
DIN EN 13480-3/A2: 2007-02
DIN EN 13480-3 Corrigendum 3: 2007-05
DIN EN 13480-3/A3: 2009-11
DIN EN 13480-3/A4: 2010-10

— This page is intentionally blank —

English Version

Metallic industrial piping - Part 3: Design and calculation

Tuyauteries industrielles métalliques - Partie 3:
Conception et calcul

Industrielle metallische Rohrleitungen - Teil 3:
Konstruktion und Berechnung

This European Standard was approved by CEN on 21 June 2017.

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, Serbia, 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
European foreword.....	10
1 Scope	12
2 Normative references	12
3 Terms, definitions, symbols and units	13
3.1 Terms and definitions	13
3.2 Symbols and units	13
4 Basic design criteria.....	15
4.1 General.....	15
4.2 Loadings	15
4.2.1 General.....	15
4.2.2 Combination of loads	16
4.2.3 Loads for dimensioning	16
4.2.4 Other loads to be taken into account	18
4.2.5 Design conditions.....	19
4.3 Thickness	22
4.4 Tolerances	25
4.5 Joint coefficient.....	25
4.6 Dimensioning of piping components subject to pressure.....	26
5 Design stresses.....	26
5.1 General.....	26
5.2 Time-independent nominal design stress	27
5.2.1 Steels other than austenitic steels	27
5.2.2 Austenitic steels.....	27
5.2.3 Nickel and / or chromium alloy steels.....	28
5.2.4 Steels castings.....	28
5.2.5 Additional requirements for steels with no specific control.....	28
5.3 Time-dependent nominal design stress	29
5.3.1 General.....	29
5.3.2 Steels.....	29
5.3.3 Nickel and/or chromium alloy steels.....	30
6 Design of piping components under internal pressure	30
6.1 Straight pipes.....	30
6.2 Pipe bends and elbows.....	30
6.2.1 General.....	30
6.2.2 Symbols.....	31
6.2.3 Required wall thicknesses.....	31
6.3 Mitre bends.....	32
6.3.1 General.....	32
6.3.2 Symbols.....	32
6.3.3 Effective radius of mitre bend	33
6.3.4 Multiple mitre bends	33
6.3.5 Single mitre bends	34

6.3.6	Adjacent straight pipe sections of mitre bends	34
6.4	Reducers	34
6.4.1	Conditions of applicability	34
6.4.2	Specific definitions	35
6.4.3	Specific symbols and abbreviations.....	35
6.4.4	Conical shells.....	36
6.4.5	Junctions - general.....	37
6.4.6	Junction between the large end of a cone and a cylinder without a knuckle.....	37
6.4.7	Junction between the large end of a cone and a cylinder with a knuckle	40
6.4.8	Junction between the small end of a cone and a cylinder	41
6.4.9	Offset reducers	43
6.4.10	Special forged reducers	43
6.5	Flexible piping components.....	44
6.5.1	General	44
6.5.2	Expansion joints.....	44
6.5.3	Corrugated metal hose assemblies	46
6.6	Bolted flange connections	47
6.6.1	General	47
6.6.2	Symbols	47
6.6.3	Standard flange	47
6.6.4	Non-standard flange	48
7	Design of ends under internal pressure	48
7.1	Dished ends.....	48
7.1.1	Symbols	48
7.1.2	Hemispherical ends	49
7.1.3	Torispherical ends	50
7.1.4	Ellipsoidal ends	51
7.1.5	Calculation of β	52
7.2	Circular flat ends.....	56
7.2.1	General	56
7.2.2	Symbols	56
7.2.3	Unstayed flat circular ends welded to cylindrical shells/pipes.....	58
7.2.4	Unstayed flat circular bolted ends.....	65
7.2.5	Reinforcements of openings in unstayed flat ends	71
8	Openings and branch connections	74
8.1	General	74
8.2	Symbols	74
8.3	Limitations	75
8.3.1	Thickness ratio	75
8.3.2	Openings in the vicinity of discontinuities	77
8.3.3	Types of reinforcement	79
8.3.4	Calculation method.....	80
8.3.5	Elliptical openings and oblique branch connections.....	80
8.3.6	Reinforcing pads	82
8.3.7	Dissimilar material of shell and reinforcements	82
8.3.8	Extruded outlets.....	82
8.3.9	Forged tee.....	82
8.3.10	Branches in bends or elbows.....	83
8.3.11	Screwed-in branches	83
8.4	Isolated openings.....	84
8.4.1	General	84
8.4.2	Unreinforced openings.....	87

8.4.3	Reinforced openings with $d_i/D_i < 0,8$	87
8.4.4	Reinforced single openings with $0,8 < d/D \leq 1,0$	93
8.5	Adjacent openings.....	93
8.5.1	Unreinforced openings.....	93
8.5.2	Reinforced openings with $d/D \leq 0,8$	93
8.6	Design of special piping components.....	94
8.6.1	Cylindrical Y-pieces	94
8.6.2	Spherical Y-pieces	95
8.6.3	Triform reinforced branches	96
9	Design of piping components under external pressure.....	97
9.1	General.....	97
9.2	Symbols and elastic stress limits.....	99
9.2.1	Symbols.....	99
9.2.2	Elastic stress limits.....	101
9.3	Cylindrical pipes, elbows and mitre bends.....	101
9.3.1	Determination of lengths	101
9.3.2	Interstiffener collapse	103
9.3.3	Overall collapse of stiffened pipes	105
9.3.4	Stiffener stability.....	106
9.3.5	Heating/cooling channels	109
9.4	Reducers (conical shells)	110
9.5	Dished ends	112
9.5.1	Hemispherical ends.....	112
9.5.2	Torispherical ends.....	113
9.5.3	Ellipsoidal ends.....	113
10	Design for cyclic loading.....	113
10.1	General.....	113
10.2	Exemption from detailed fatigue analysis	113
10.3	Fatigue design for cyclic pressure.....	114
10.3.1	Equivalent full load cycles.....	114
10.3.2	Simplified fatigue analysis.....	114
10.4	Fatigue design for thermal gradients	129
10.4.1	General.....	129
10.4.2	Design guidance.....	129
10.5	Fatigue design for combined loads	130
11	Integral attachments.....	130
11.1	General.....	130
11.2	Allowable stresses	130
11.3	Symbols.....	131
11.4	Hollow circular attachments.....	133
11.4.1	Limitations.....	133
11.4.2	Preliminary calculations	133
11.4.3	Analysis of attachments welded to pipe with a full penetration weld.....	135
11.4.4	Analysis of attachments welded to pipe with fillet or partial penetration weld	136
11.5	Rectangular attachments	136
11.5.1	Limitations.....	136
11.5.2	Preliminary calculations	136
11.5.3	Analysis of attachments welded to pipe with a full penetration weld.....	138
11.5.4	Analysis of attachments welded to pipe with fillet or partial penetration weld	139
11.6	Stress analysis of the run pipe.....	139
11.7	Shear stress analysis in attachment.....	141

11.7.1	Hollow circular attachments	141
11.7.2	Rectangular attachments	141
11.8	Alternative calculation methods	141
12	Flexibility analysis and acceptance criteria	141
12.1	Basic conditions	141
12.1.1	General	141
12.1.2	Loading conditions	142
12.1.3	Allowable stresses	142
12.2	Piping flexibility	144
12.2.1	General	144
12.2.2	Basic conditions	144
12.2.3	Displacement strains	144
12.2.4	Displacement stresses	145
12.2.5	Stress range	146
12.2.6	Cold pull	146
12.2.7	Properties for flexibility analysis	147
12.2.8	Supporting conditions	147
12.2.9	Expansion joints	149
12.2.10	Flexibility analysis	149
12.3	Flexibility analysis	151
12.3.1	General	151
12.3.2	Stress due to sustained loads	152
12.3.3	Stress due to sustained and occasional or exceptional loads	152
12.3.4	Stress range due to thermal expansion and alternating loads	153
12.3.5	Additional conditions for the creep range	154
12.3.6	Stresses due to a single non-repeated support movement	154
12.3.7	Determination of resultant moments	155
12.3.8	Alternative method for stress calculation	157
12.3.9	Reactions	157
12.4	Fatigue analysis	157
12.5	Vibration	157
13	Pipe Supports	158
13.1	General requirements	158
13.1.1	General	158
13.1.2	Classification of supports	158
13.1.3	Additional definitions	159
13.1.4	Boundaries	161
13.1.5	Pipe supports welded to the pipe	163
13.2	Selection of pipe supports	164
13.2.1	General	164
13.2.2	Detail design of pipe supports	165
13.2.3	Support location	166
13.3	Constant hangers/base mounted (pedestal) constant supports	166
13.3.1	General	166
13.3.2	Load deviation from calibrated load	166
13.3.3	Site adjustment of the calibrated load	166
13.3.4	Travel reserve (Overtravel)	166
13.3.5	Blocking	167
13.3.6	Identification Marking/Name plate	167
13.4	Variable load spring hangers and base mounted (pedestal) variable load spring supports	167
13.4.1	General	167

13.4.2	Tolerance on spring rate	168
13.4.3	Travel reserve (Overtravel)	168
13.4.4	Blocking	168
13.4.5	Name plate	168
13.5	Rigid struts	169
13.6	Shock arrestors (shock absorber, snubber).....	169
13.7	Sliding supports	170
13.8	Anchors	170
13.9	Documentation of supports	170
13.10	Marking of supports	170
13.11	Manufacturing of pipe supports	170
13.11.1	Material requirements	170
13.11.2	Design temperatures for support components	171
13.11.3	Design details.....	172
13.11.4	Determination of component sizes	173
13.11.5	Welded connections	174
13.11.6	Threaded connections	176
13.11.7	Additional requirements on springs	177
13.11.8	Design details for rigid struts	177
13.11.9	Design details for shock arrestors (shock absorbers, snubbers)	178
13.11.10	Design details for shock arrestors (shock absorbers, snubbers).....	179
Annex A	(informative) Dynamic analysis	180
A.1	General.....	180
A.2	Analysis by calculation.....	180
A.2.1	Seismic events	180
A.2.2	Rapid valve closure	184
A.2.3	Flow induced vibration	187
A.2.4	Safety valve discharge	189
A.2.5	Allowable stresses	192
A.3	Alternative means of design verification.....	192
A.3.1	Comparative studies	192
A.3.2	Full scale testing.....	192
A.3.3	Reduced scale testing	192
Annex B	(normative) More accurate calculation of bends and elbows	193
B.1	General.....	193
B.2	Symbols and units	193
B.3	Required wall thickness	194
B.4	Calculation	195
B.4.1	Calculation of wall thickness.....	195
B.4.2	Stress calculation	197
Annex C	(informative) Expansion joints	201
C.1	Incorporation of expansion joints into piping systems.....	201
C.1.1	General.....	201
C.1.2	Types of expansion joints.....	202
C.1.3	Design of expansion joints.....	202
C.1.4	Designing with expansion joints.....	203
C.1.5	Analyses and calculation	205
C.1.6	Cold pull.....	206
C.2	Maximum spacing for unrestrained axially compensated straight runs.....	206
C.2.1	General.....	206
C.2.2	Calculation rules.....	206

C.2.3	Maximum spacing for defined conditions	207
C.3	Indication for the design of expansion joints	209
C.3.1	General	209
C.3.2	Information for the system analyst.....	209
Annex D	(normative) Flanges.....	210
D.1	Purpose	210
D.2	Specific terms and definitions.....	210
D.3	Specific symbols and abbreviations.....	211
D.4	General	212
D.4.1	Introduction	212
D.4.2	Use of standard flanges without calculation.....	212
D.4.3	Bolting.....	213
D.4.4	Flange construction	215
D.4.5	Machining	215
D.4.6	Gaskets	215
D.5	Narrow face gasketed flanges	216
D.5.1	General	216
D.5.2	Bolt loads and areas.....	219
D.5.3	Flange moments	220
D.5.4	Flange stresses and stress limits.....	220
D.5.5	Narrow face flanges subject to external pressure	226
D.5.6	Lap joints	226
D.5.7	Split ring flanges	229
D.6	Full face flanges with soft ring type gaskets	230
D.6.1	Specific symbols and abbreviations.....	231
D.6.2	Bolt loads and areas.....	231
D.6.3	Flange design.....	232
D.6.4	Full face flanges subject to external pressure	233
D.7	Seal welded flanges.....	233
D.8	Reverse narrow face flanges.....	234
D.8.1	Internal pressure	234
D.8.2	External pressure	236
D.9	Reverse full face flanges.....	236
D.9.1	General	236
D.9.2	Design following method of D.5.....	236
D.9.3	Design following method of D.6.....	238
D.10	Full face flanges with metal to metal contact	240
D.10.1	General	240
D.10.2	Specific symbols and abbreviations.....	240
D.10.3	Design	241
Annex E	(normative) Design of branch connections in piping accessories	243
E.1	Scope	243
E.1.1	General	243
E.2	Reinforcement	245
E.2.1	Angles and areas	245
E.2.2	The following condition shall be satisfied:.....	245
E.3	Flexibility analysis	246
Annex F	(informative) Testing during operation in the case of cyclic loading.....	248
F.1	Testing during operation.....	248
F.2	Measures to be taken when the calculated fatigue life has been reached	248
Annex G	(informative) Physical properties of steels	250