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Metallic industrial piping

Part 5: Inspection and testing

National foreword

This British Standard is the UK implementation of EN 13480-5:2017. It supersedes BS EN 13480-5:2012+A2:2017, which is withdrawn.

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Contents

European foreword

This document (EN 13480-5:2017) has been prepared by Technical Committee CEN/TC 267 “Industrial piping and pipelines”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by December 2017, and conflicting national standards shall be withdrawn at the latest by December 2017.

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 EN 13480 for metallic industrial piping consists of eight interdependent and not dissociable Parts which are:

— *Part 1: General;*

— *Part 2: Materials;*

— *Part 3: Design and calculation;*

— *Part 4: Fabrication and installation;*

— *Part 5: Inspection and testing;*

— *Part 6: Additional requirements for buried piping;*

— *CEN/TR 13480-7, Guidance on the use of conformity assessment procedures;*

— *Part 8: Additional requirements for aluminium and aluminium alloy piping.*

Although these Parts may be obtained separately, it should be recognised that the Parts are inter-dependant. As such the manufacture of metallic industrial piping requires the application of all the relevant Parts in order for the requirements of the Standard to be satisfactorily fulfilled.

This European Standard will be maintained by a Maintenance MHD working group whose scope of working is limited to corrections and interpretations related to EN 13480.

The contact to submit queries can be found at http://www.unm.fr (en13480@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 13480-5:2012. 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.

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 Part of this European Standard specifies the requirements for inspection and testing of industrial piping as defined in EN 13480-1:2017 to be performed on individual spools or piping systems, including supports, designed in accordance with EN 13480-3:2017 and EN 13480-6:2017 (if applicable), and fabricated and installed in accordance with EN 13480-4:2017.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13480-1:2017, *Metallic industrial piping — Part 1: General*

EN 13480-2:2017, *Metallic industrial piping — Part 2: Materials*

EN 13480-3:2017, *Metallic industrial piping — Part 3: Design and calculation*

EN 13480-4:2017, *Metallic industrial piping — Part 4: Fabrication and installation*

EN 13480-6:2017, *Metallic industrial piping — Part 6: Additional requirements for buried piping*

EN 14917:2009+A1:2012, *Metal bellows expansion joints for pressure applications*

EN ISO 5817:2014, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2014)*

EN ISO 9712:2012, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712:2012)*

EN ISO 10893-5:2011, *Non-destructive testing of steel tubes — Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections (ISO 10893-5:2011)*

EN ISO 17635:2016, *Non-destructive testing of welds — General rules for metallic materials (ISO 17635:2016)*

EN ISO 17640:2010, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment (ISO 17640:2010)*

ISO 3057:1998, *Non-destructive testing — Metallographic replica techniques of surface examination*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13480-1 shall apply.

4 Symbols and abbreviations

For the purposes of this Part of this European Standard, the symbols given in EN 13480-1 apply together with the following abbreviations:

— NDT Non-destructive testing

— MT Magnetic particle testing

— PT Penetrant testing

— RT Radiographic testing

— UT Ultrasonic testing

— VT Visual testing

— PWHT Post-weld heat treatment

— PEDPressure Equipment Directive.

5 Determination of inspection and testing requirements

5.1 General

The manufacturer shall be responsible for the fabrication and the installation, even if this work will be sub-contracted to other fabricators and/or installers.

The fabricator and/or installer shall be responsible for carrying out the inspection and testing including subcontracted NDT (if any) specified in this European Standard, for all piping.

NOTE For guidance on the use of conformity assessment procedures see CEN/TR 13480-7.

5.2 Classification of piping

Industrial piping shall be classified in accordance with EN 13480-1:2017, Table 5.1-1.

NOTE Categories I to III are identical to categories I to III of the Pressure Equipment Directive.

6 Design review

Before fabrication/installation commences, a review of the piping design and its supports shall be performed.

Where design and fabrication are carried out by separate organisations, the piping designer shall prepare a confirmation for the manufacturer that the design is in compliance with the requirements of this European Standard.

A list of the relevant drawings shall be attached to the confirmation.

Where the design of parts has already been reviewed in accordance with this European Standard, and where an appropriate confirmation is available, a further design review shall not be required.

NOTE For guidance on the use of conformity assessment procedures see CEN/TR 13480-7.

7 In-process inspection and testing

7.1 General

Testing and inspection shall be carried out by personnel qualified for the method used. European Standards, specifications or written procedures (if necessary) shall be available to all testing personnel and inspectors prior to the testing/inspection.

Reports on NDT specified in 7.2.4 and Clause 8 and reports on destructive testing specified in 7.2.5 shall be prepared to demonstrate that all required testing has been carried out and that the results are acceptable.

7.2 Materials and formed pressure retaining parts

7.2.1 General

The testing and inspection specified below shall be restricted to parts formed during the fabrication process, especially induction bending. Formed bought out standardized parts and components shall not be a part of this requirement.

Formed parts shall be subject to appropriate testing in accordance with the fabricators/installers test programme.

7.2.2 Verification of material

A verification shall be performed that materials are in accordance with the specified material standard or purchase order.

7.2.3 Verification of formed pressure retaining parts

It shall be verified that all formed pressure retaining parts comply with the specified shape and dimensional requirements, and have received the specified finish or heat treatment.

7.2.4 Non-destructive testing of formed parts

7.2.4.1 General

All formed parts shall be subject to non-destructive testing. Depending on material, dimensions and type of forming process testing may include:

a) visual testing;

b) wall thickness measurements;

c) dimensional checks (ovality, angle of bend etc.) and tolerances (see EN 13480-4);

d) hardness tests;

e) testing for surface imperfections (magnetic particle or penetrant testing);

on formed parts of each component or batch of identical components.

Material, heat treatment conditions, heat treatment lot, degree of deformation shall be considered in the definition of the batch.

Replicas of the surface structure in the tension zone may be required in case of lifetime monitoring for creep range application.

Ultrasonic testing may be performed if specified. Specification shall include area, extent, method and acceptance criteria.

NOTE A customary interpretation of a heat treatment lot is the entire content of a furnace of a single heat treatment.

7.2.4.2 Induction bending

Material surfaces shall be suitable for induction bending. EN ISO 10893-5 specifies surface qualities and acceptance levels. The acceptance levels shall be agreed, considering material, dimensions and service (creep, fatigue).

Induction bends shall be tested according to Table 7.2.4.2-1.

Heat treatment shall be done if required by EN 13480-4. Subsequent hardness testing shall be performed on the straight length and within bending zone to verify the homogeneity of annealing.

If no heat treatment is required after forming, hardness testing is required in the bending zone only if specified for service reasons.

Dimensional checks shall include ovality, angle of bend, wall thickness and tolerances (see EN 13480-4).

MT/PT testing shall be performed to verify that the outside surface in the bended zone is free of cracks.

If specified for the component or by Table 7.2.4.2-1, replicas of the surface structure in the tension zone shall be taken on each component or batch of identical components. Replicas shall be made in accordance with ISO 3057.

The material grade, the heat treatment conditions of the material, the heat treatment lot after bending and the forming conditions shall be considered in the definition of the batch.

Table 7.2.4.2-1 — NDT for induction bends

Material Group (see EN 13480–2)	VT	Dimensional check	Hardness testing	MT/PT	Replicas
1.1, 1.2, 1.3, 8, 9	c	c	—	b5e	—
1.4, 3, 5.3, 5.4, 6	c	c	c	cf	—
2	c	c	c	b5e	—
4	c	c	c	ce	—
5.1, 5.2	c	c	b10e	b10e	—
10	c	c	—	cf	yes

NOTE
b5e – 5 % of batch on extrados
c – testing per component
cf – component forming area
b10e – 10 % of batch on extrados
ce – testing per component extrados

7.2.4.3 Cold formed pipes

Cold formed pipes shall be tested according to Table 7.2.4.3-1.

Heat treatment shall be done if required by EN 13480-4. Subsequent hardness testing shall be performed on the straight length and within bending zone to verify the homogeneity of annealing.

If no heat treatment is required after forming, hardness testing is required in the bending zone only if specified by the purchaser for service reasons.

Dimensional checks shall be performed after tooling of the bending machine and start of production to the same extent as specified for MT/PT (see Table 7.2.4.2-1) and shall include ovality, angle of bend and tolerances (see EN 13480-4).

Wall thickness measurement at the extrados is required for all cold formed pipes with $r_m \leq 1{,}3\ d_o$.

MT/PT testing shall be performed to verify that the outside surface in the bended zone is free of cracks.

Table 7.2.4.3-1 — NDT after cold forming of pipes

Material group (see EN 13480–2)	Category	VT %	Surface testing (MT/PT) %			Hardness testing
			$r_m \leq 1{,}3\ d_o$	$1{,}3\ d_o < r_m < 2{,}5\ d_o$	$2{,}5\ d_o \leq r_m$	$r_m \leq 1{,}3\ d_o$
1.1, 1.2, 1.3, 8.1, 8.2, 9.1	I	100	0	0	0	0
	II					
	III		b5e			
2.1, 2.2, 4.1, 4.2, 5.1, 5.2, 7.1, 8.3, 9.2, 9.3	I	100	0	0	0	c (only for material groups 2.1, 2.2, 4.1, 4,2)
	II		b5e	0	0	
	III			b5e	0	
1.4, 3.1, 3.2, 3.3, 5.3, 5.4, 6.1, 6.2, 6.3, 6.4, 7.2, 7.3, 10.1, 10.2	I	100	b5f	b5f	b5f	c (only for material groups 3.1, 3.2, 3.3, 5.3, 5,4, 6.1, 6.2, 6.3, 6.4)
	II		b25f			
	III			b10f		

NOTE
b5e – 5 % of batch on extrados
b5f – 5 % of batch on forming area
b10f – 10 % of batch on forming area
b25f – 25 % of batch on forming area
c - testing per component

7.2.5 Destructive testing of formed parts

Testing shall be performed to verify the heat treatment of the formed parts (induction bends with or without subsequent heat treatment, cold formed parts with subsequent heat treatment, hot formed parts with or without subsequent heat treatment) and shall include:

a) tensile test at room temperature;

b) impact test;

c) other tests specified in European Standards for base materials.

Testing shall be performed as specified in the European Standards for the base materials.

The tests shall be performed on test pieces from the end of the component itself, or from test pieces placed together with the components in the heat treatment furnaces.

Production test coupons for destructive testing shall be representative for one heat treatment lot defined by the same dimension, material heat and similar forming conditions.

Low alloyed steels (up to 5 % total alloying content) may be representatively tested by a single production test coupon, representative for several furnace loads if:

1) comparable furnace parameters are applied and

2) the heat treatment parameters are recorded for each furnace load by a thermocouple attached to the component.

7.3 Welding

7.3.1 Review of welding documents

Prior to carrying out any welding activity, the fabricator shall verify that the welding procedures and the welding personnel are qualified for the relevant work. This shall be reviewed by the manufacturer.

7.3.2 Inspection before welding

Prior to carrying out any welding, each joint preparation shall be visually inspected. The inspection shall verify compliance with the drawing and WPS, by ensuring the following:

a) the correct materials are used;

b) dimensions are within tolerance, including position, alignment, and orientation of branches, nozzles, attachments and anchors, etc.;

c) cleanliness and freedom from imperfections which may give rise to defects in the completed joint;

d) nozzles, branches etc., properly fit the curvature of the pipe;

e) tack welds that are to be incorporated into the final weld are free from cracks or other defects.

7.3.3 Testing and inspection during welding

The following testing and inspection shall be carried out, where appropriate, at suitable stages during the welding operation to verify that the specified WPS is being followed for:

a) correct preheat;

b) correct welding process;

c) correct welding consumables;

d) correct electrical characteristics;

e) correct interpass temperature and cleaning;

f) other requirements of the WPS;

g) all tack welds and temporary attachments are welded in accordance with an approved WPS.

7.3.4 Inspection after welding

The following inspection shall be carried out on completion of welding:

a) verification for compliance with drawings;

b) verification that welds are correctly identified and traceable to the welder/operator;

c) verification that temporary attachments have been properly removed.

7.3.5 Inspection of built up pipe ends

All built up pipe ends shall be subject to 100 % non-destructive testing of internal and surface imperfections.

7.4 Heat treatment

For post-forming and post-weld heat treatment (PWHT), where applicable, it shall be verified by a review of the heat treatment reports that the heat treatment carried out complies with the heat treatment procedure.

If additional examinations (e.g. replica, hardness) after post-forming and post-weld heat treatment are required, this testing shall be reported and the reports shall be reviewed.

8 Non-destructive testing of welds

8.1 Application of NDT

8.1.1 General

8.1.1.1 The following shall be applicable to all welded joints:

a) welded joints shall be visually examined before any other NDT is performed;

b) the area to be examined shall include the weld metal and the heat affected zones;

c) surface examination stipulated in Table 8.2-1 shall be performed on the outer surface;

d) where a welded joint is to be subsequently formed or heat treated, the required NDT shall be carried out on the weld in the final condition. If a weld will not be accessible for examination after heat treatment or forming, a suitable alternative shall be agreed;

e) NDT-methods used and acceptance criteria for all NDT shall be in accordance with 8.4.5;

f) weld imperfections, which have been assessed as weld defects, shall be repaired in accordance with EN 13480-4 and inspected again after repair.

8.1.1.2 Arc strikes and contact points with fused material shall be ground smooth and subjected to surface examination appropriate to the material used.

8.1.2 Examination of weld quality by sample inspection

Where the required extent of non-destructive testing is less than 100 %, the specified NDT techniques shall be employed at the earliest stage practicable in the fabrication process to ensure that sound welds are achieved. The timing shall be agreed. Sample welds to be examined shall be:

a) randomly selected;

b) representative of a batch of welds.

At least one complete sample weld shall be examined over the whole length.

Where the number of sample welds required is small, combinations of thicker sections and smaller diameters or thinner sections and greater diameters shall be given preference. All welders and welding operators shall be covered.

A batch of welds is a quantity of welds, welded by one welder or welding operator, in accordance with a specific welding procedure specification.

8.1.3 Imperfections revealed by sample inspection

When sample inspection reveals imperfections in one weld which are not acceptable to this European Standard, the following shall apply for each defective weld:

a) Two additional welds of the same batch shall be examined by the same method(s);

b) If these additional welds are acceptable, the initial weld shall be repaired or replaced and re-examined by the original method(s);

c) If any one of these additional welds required by a) reveal an unacceptable imperfection, two further additional welds of the same batch shall be examined by the same method(s).

d) If the two additional welds required by c) are acceptable, the initial weld and the weld(s) examined under c) with unacceptable imperfections shall be repaired or replaced and re-examined by the original method(s).

e) If any one of the two additional welds required by c) reveal an unacceptable imperfection, all welds in that batch represented by the sample inspection shall be examined and, as necessary, repaired or replaced and re-examined.

When defining the represented sample inspection one may distinguish between:

1) piping installation at construction sites; or

2) piping manufacturing (series or mass production) in workshops.

1) is normally used if 2) is not applicable. For this piping, a group of welds represented by the same sample inspection may be defined per piping system or per line number.

2) is normally used for piping integrated in packaged units such as machinery. For this piping a group of welds represented by the same sample inspection may be defined as per 1) above or per production lot or any other sample inspection system as long as the minimum extent of NDT of this standard is kept.

8.2 Circumferential butt, branch, fillet and seal welds

8.2.1 Extent of testing

The type of NDT required and its extent shall be determined in accordance with Table 8.2-1, taking into account the category the piping is classified to and also wall thicknesses and material grouping.

For piping where creep or fatigue is the controlling factor in design:

a) additional extent of NDT is required by Table 8.2-1, Note f, critical areas shall be included in the test;

b) the quality level given in Table 8.4.2-1 for these service conditions shall be met.

For piping of pipe category 0, piping operating at or below 0,5 bar and piping of category I the following special rules apply:

1) for piping of pipe category 0 and piping operating at or below 0,5 bar, the amount of NDT shall be suitable to assure weld quality. For volumetric testing a minimum amount of 2% is recommended;

2) when agreed in the purchase order, for piping of category I made of material of material group 1.1, 1.2 and 8.1 an amount of 2% volumetric testing may be sufficient, if satisfactory experience exists;

when pneumatic testing is used, the extent of testing according to Table 8.2-1, Note g (test P_t according to 9.3.3 f)) and Table 9.3.3-1 applies.

Table 8.2-1 — Extent of testing for circumferential, branch, fillet and seal welds

Material group [a]	Category	All welds	Circumferential welds			Branch welds						Socket/fillet welds		Seal welds	
			Surface testing		Volumetric testing [b]	Surface testing			Volumetric testing [b,k]			Surface testing		Surface testing	
		VT %	e_n mm	MT/PT [c] %	RT/UT %	Branch diameter	e_n [h] mm	MT/PT [c] %	Branch diameter [i]	e_n [h] mm	RT/UT %	e_n mm	MT/PT %	e_n mm	MT/PT %
1.1, 1.2, 8.1	I	100	0 (5) [f,g]		5 (10) [g]	All		0 (5) [f,g]	All		0	All	0	All	0
	II														
	III				10			10	> DN 100	> 15	10		10		10
1.3, 1.4, 1.5, 2.1, 2.2, 4.1, 4.2, 5.1, 5.2, 8.2, 8.3, 9.1, 9.2, 9.3, 10.1, 10.2	I	100	≤ 30	5	10	All [e]		10 (25) [g]	All		0	All [e]	10	All [e]	5
			> 30	10	10										
	II		≤ 30	5	10										
			> 30	10	10										
	III		≤ 30	5	10 (25 [d]) [f,g]	All			> DN 100	> 15	10	All	25	All	25
			> 30	10	10 (25 [d]) [f,g]										
3.1, 3.2, 3.3, 5.3, 5.4, 6.1, 6.2, 6.3, 6.4, 7.1, 7.2	I	100	≤ 30	10	25	All		25	> DN 100	> 15	25	All	25	All	10
			> 30	25	25										
	II		≤ 30	25	25										
			> 30	25	25 (25 [d]) [f,g]										
	III		≤ 30	100	25 (100) [f,g]			100			100		100		100
			> 30	100	25 (100 [d]) [f,g]										

a Material group, see CEN ISO/TR 15608.
b For the selection of the appropriate NDT-method for volumetric testing, see 8.4.4.3.
c See 8.4.4.2.
d Additional testing for transverse defects from weld surface (see EN ISO 17640:2010, testing level C).
e Only if PWHT has been carried out.
f Value in brackets applies to piping where creep or fatigue is the controlling factor in design.
g Value in brackets applies to piping with pneumatic pressure test with 1,1 times the maximum allowable pressure.
h e_n is the nominal thickness of the branch pipe at the weld (see W3, W3.1 and W6 in EN 13480-4:2017, Figure 9.14.4-1 and Figure 9.14.4-2).
i For parts without DN designation d_i > 120 mm may be used instead of DN > 100.
k Volumetric testing is required if both criteria (branch diameter and nominal thickness) are satisfied.

8.2.2 Dissimilar metal joints

The test methods and extent of testing for welds between different materials (e.g. austenitic, nickel-based alloys) shall be according to the material group with the higher extent of testing which is applicable to the base materials.

8.2.3 Transverse cracks

For material groups 5.3, 5.4 and 6 with wall thicknesses above 30 mm testing for transverse defects from weld surface (see EN ISO 17640:2010, testing level C) is required. For extent of testing see Table 8.2-1.

8.3 Longitudinal welds

Longitudinal welds, except those in components made to material specifications acceptable to this European Standard (e.g. longitudinal welded steel tubes for pressure purposes acc. EN 10217 series), shall be subject to the level of NDT appropriate to the joint coefficient required (see Table 8.3-1).

Table 8.3-1 — Extent of NDT for longitudinal welds

Joint coefficient z	VT %	MT or PT [a] %	RT or UT [b] %
$z \leq 0,7$	100	0	0
$0,7 < z \leq 0,85$	100	10	10
$0,85 < z \leq 1,0$	100	100	100
[a] See 8.4.4.2 [b] See 8.4.4.3			

8.4 Testing methods

8.4.1 General

The testing methods specified in the following clauses shall be performed in accordance with written procedures, and, where appropriate, with instructions.

8.4.2 Quality level

The quality level shall be in accordance with Table 8.4.2-1.

Table 8.4.2-1 — Quality level according to EN ISO 5817:2014 depending on service conditions and test methods

Service conditions	Surface Imperfections and Imperfections in joint geometry		Internal Imperfections
	Visual testing VT	Surface testing	Volumetric testing
Standard level	C	C	C
Fatigue	B	B	C
Creep	B	B	B

8.4.3 Personnel qualification

Testing shall be carried out by an individual certified to at least EN ISO 9712:2012, level 1, under the supervision of personnel certified to level 2 or level 3 who shall also be responsible for the evaluation of the results.

Visual testing shall be performed and evaluated by an individual with sufficient knowledge and experience with the relevant standards and specifications. Certifications in accordance with EN ISO 9712 are not required.

Ultrasonic testing shall be performed and evaluated by an individual certified to at least EN ISO 9712:2012, level 2.

Prior to carrying out any testing activity, the fabricator shall verify that the personnel are qualified for the relevant work. This shall be reviewed by the manufacturer.

NOTE Qualifications and certifications according to EN 473 remain valid until their expiring date.

8.4.4 Selection of NDT methods and testing techniques

8.4.4.1 Visual inspection and testing

The term “visual inspection and testing” shall be understood to mean observation of the portion of components, joints, and other piping elements and supports that are or can be exposed to view before, during, or after manufacture, fabrication, assembly or installation.

NOTE This inspection may include verification of dimensions, weld edge, joint preparation, alignment, joining (welding, bonding, brazing, or other methods of joining) supports, assembly and installation.

Visual testing of welds shall be in accordance to EN ISO 17635:2016, Table A.1 (VT).

8.4.4.2 Surface testing

Methods shall be MT or PT according to EN ISO 17635:2016, Table 2.

Testing techniques shall be in accordance to EN ISO 17635:2016, Table A.2 (PT) and Table A.3 (MT).

For ferritic steels MT is recommended instead of PT. For austenitic-ferritic steels PT is recommended.

8.4.4.3 Volumetric testing

Methods shall be selected according to EN ISO 17635:2016, Table 3.

Testing techniques shall be in accordance to EN ISO 17635:2016, Tables A.5 (RT-F), A.6 (RT-D), (RT-CR) or (DDA), A.7 (UT), A.8 (TOFD) and A.9 (PAUT).

NDT techniques A.7, A.8 and A.9 may be used for other than ferritic materials providing they are proven to satisfy the required quality level given in Table 8.4.2-1.

8.4.5 Testing techniques and acceptance levels

Depending on the quality levels of Table 8.4.2-1 testing techniques and levels and acceptance levels shall be selected according to EN ISO 17635:2016, Annex A.

8.5 Reports

Reports of non-destructive testing shall be drawn up in accordance with the European Standard for the testing method.

8.6 Weld repairs

Welding procedures shall be in accordance with EN 13480-4.

Repaired welds shall be retested with the same NDT methods and testing techniques.

NOTE The evaluation of weld imperfections may require additional inspections during the repair.

Where imperfections are identified but cannot be adequately evaluated, an alternative test shall be performed or the imperfection repaired.

No more than two repairs shall be made in the same area before the weld is cut and re-welded, unless otherwise agreed.

9 Final assessment and documentation

9.1 General

Prior to final certification, the manufacturer shall carry out a final assessment to verify that the piping system has been manufactured in compliance with all specified requirements. The required documentation shall then be compiled.

9.2 Final inspection

9.2.1 General

The final inspection shall consist of the following:

c) a visual inspection before the proof test;

d) a visual inspection after the proof test;

c) review of the manufacturing documents.

9.2.2 Visual inspection before the proof test

A visual inspection shall be carried out prior to completion of the coating. The visual inspection shall verify that:

a) dimensions and orientations comply with design requirements of the piping system;

b) components, supports, assembly and installation comply with the other requirements of this European Standard.

9.2.3 Visual inspection after the proof test

The visual inspection shall verify that there has been no deterioration resulting from the proof test and:

a) all blind flanges, fitted to isolate components not subject to pressure test shall have been removed;

b) all temporary supports etc. shall have been removed;

c) any gauges fitted for the purpose of pressure testing shall have been removed;

d) all components removed for proof testing (control valves, instruments etc.) shall have been re-assembled;

e) safety valves or relief devices required by the design or this standard shall have been correctly installed and are of the specified capacity and type.

9.2.4 Review of the manufacturing documents

The manufacturer shall carry out a review of the manufacturing documents to verify that all applicable examinations and tests specified in clauses 7 to 9 have been satisfactorily performed and reported.

9.3 Proof test

9.3.1 General

All piping constructed in accordance with this European Standard shall be subjected to a proof test to demonstrate the integrity of the finished product. The proof test shall always be carried out, under controlled conditions, with appropriate safety precautions and equipment, and in such a way that the persons responsible for the test are able to make adequate inspections of all pressurised parts.

The proof test shall be a hydrostatic pressure test, except where a hydrostatic pressure test is harmful or impractical. In these instances, a pneumatic pressure test (see 9.3.3) or other tests (see 9.3.4) shall be performed.

9.3.2 Hydrostatic pressure test

9.3.2.1 Basic requirements for hydrostatic pressure tests

9.3.2.1.1 Where practicable, the finished piping system shall be pressure tested after the installation has been completed and all inspections have been performed. If it is not practicable, due to size or mode of manufacture, to pressure test a complete piping system, the test procedure to be followed shall be agreed at the design stage.

9.3.2.1.2 All joints shall be left uninsulated and unlined and exposed for examination during pressure testing, except that joints and tubes previously tested in accordance with this standard may be insulated or covered. A primer for corrosion protection shall be permitted, provided, it does not prevent the clear examination of the joint under test.

9.3.2.1.3 Piping designed for vapour or gas shall be provided with additional temporary supports, if necessary, to support the weight of the test liquid.

9.3.2.1.4 Expansion joints shall generally be pressure tested in both, the manufacturers shop and in place in the piping system. Test pressure shall be in accordance with EN 14917 when tested in the manufacturers shop and be subjected to a test pressure according 9.3.2.2.1 when tested with the piping system.

Expansion joints may be provided with restraints to stabilise the bellows against squirm whilst being tested.

9.3.2.1.5 Equipment which is not to be tested shall be either disconnected from the piping or isolated by blank flanges or other means during the test.

NOTE A valve may be used, provided the valve (including its closure mechanism) is suitable for the test pressure.

9.3.2.1.6 No piping shall be subject to any form of shock loading such as hammer testing when undergoing pressure testing.

9.3.2.1.7 When dial indicating and recording pressure gauges are used, the dial shall be graduated over a range of approximately double the intended maximum pressure, but in no case shall the range be less than 1,5 or more than 4 times that pressure.

9.3.2.1.8 When components are to be pressure tested, the indicating gauges shall be connected to the component, or to the component from a remote location, with the gauges readily visible to the operator controlling the pressure throughout the duration of pressurising, testing and depressurising or venting of the component.

NOTE 1 For large piping systems where more than one gauge is specified or required, a recording type gauge is recommended.

NOTE 2 It is recommended that a small pressure relief valve set to 1,1 times the test pressure is attached to the pressure test system in order to avoid excess pressure being developed.

9.3.2.1.9 All indicating and recording type gauges used shall be calibrated to the appropriate gauge standard.

9.3.2.1.10 Piping which has been repaired following the hydrostatic pressure test shall be subjected again to the specified pressure test after completion of the repair and any required post-weld heat treatment, unless otherwise agreed.

9.3.2.2 Detailed requirements for the hydrostatic pressure test

9.3.2.2.1 The test pressure shall be not less than the greater of the two values determined by the following:

$$P_t = 1{,}25 \cdot PS \cdot \frac{f_{test}}{f} \qquad (9.3.2\text{-}1)$$

or

$$P_t = 1{,}43 \cdot PS \qquad (9.3.2\text{-}2)$$

where

f is the nominal design stress for design conditions at design temperature, in MPa (N/mm²) (but limited to time-independent values, see paragraph before NOTE 1);

f_{test} is the nominal design stress for design conditions at test temperature, in MPa (N/mm²);

PS is the maximum allowable pressure, in bar;

P_t is the test pressure, in bar.

The ratio f_{test}/f depends on the material of the part under consideration and/or on the variation of the temperature TS along the piping, the value of f_{test}/f to be used for calculation of P_t shall not be less than the smallest ratio obtained considering the different materials and/or the different temperatures TS of the main pressure bearing parts.

In all cases for each component of the piping the test pressure shall be limited to such a level that it does not generate a design stress greater than that given in EN 13480-3 for testing conditions, by reducing, if necessary, the test pressure.

When piping is operated in the creep range, P_t is determined by using the time-independent values for the highest temperature for which time-independent values are available in the harmonised material standards.

NOTE 1 Due to its short duration, the pressure test can confirm the strength of equipment only with respect to the time-independent failure hazards. It cannot provide any indication on its long-term strength, in particular on its strength against the degradation of the material with time when the service temperature lies inside the creep range.

The applied test pressure shall include the amount of any static head acting in testing at the point under consideration.

NOTE 2 However, the static pressure caused by the content of the piping during testing does not need to be taken into account if it does not increase the test pressure by 5 % at any point.

For each test system, the test pressure shall be limited to such a level that it does not generate a design stress greater than that given in EN 13480-3 for the test conditions by reducing, if necessary, the test pressure. For further details, see EN 13480-3.

It shall be ensured that any temporary and/or permanent structures are designed to support the loads created by the hydrostatic test.

Prior to the hydrostatic test, the strength of temporary supports shall be verified.

Air pockets in the piping system shall be avoided. Adequate measures shall be taken to prevent air pockets in pipe sections during testing.

As a general rule, the hydrostatic test shall be performed with water. The quality of the water shall be such as to prevent both corrosion and any residual impurities.

In most cases the hydrostatic test may be performed with general supply water.

For hydrostatic tests of austenitic stainless steel piping systems, the halogen content (chlorides, bromides, iodides) shall not exceed 50 mg/l.

The pressurizing fluid shall have a temperature sufficiently high that the risk of brittle fracture is avoided, see EN 13480-2.

Where a pressurising fluid other than water is used, care shall be taken to identify any additional hazards associated with the fluid. All of the following conditions shall be satisfied: the pressuring medium shall

a) be non-toxic,

b) have a flash-point 60 °C or above (closed cup test) and shall not be utilised within 25 °C of that flash point,

c) have a temperature at least 10 °C below atmospheric boiling temperature and at least 5 °C above solidification point.

For drinking water supply piping, drinking water should be used for the pressure test.

Heavy walled piping shall not be pressurised until the metal temperature is approximately equal to that of the pressurisation medium. If the toughness of the material, or of the component, imposes a limit on the test temperature or on the rate at which the pressure is increased, account shall be taken of this and documented in the test data certificate.

9.3.2.2.2 The pressure of piping under test shall be increased to a value of approximately 50 % of the specified test pressure. Thereafter, the pressure shall be increased in steps of approximately 10 % of the specified test pressure until it is reached. The piping system shall be held at the test pressure for a period of at least 30 minutes. The pressure shall then be reduced to the maximum allowable pressure *PS* and all components and welded joints subjected to a close visual examination of all surfaces and joints. During this examination, the piping shall show no signs of general plastic yielding.

9.3.2.2.3 During the hydrostatic test, the external surface of the piping system shall be kept in such a condition that leaks can be detected.

The hydrostatic test shall be passed if no leakage or visible plastic deformation is observed.

The details of the hydrostatic test shall be documented.

9.3.2.2.4 The pressure shall be relieved before draining. Where vacuum conditions can occur when draining thin wall piping, venting shall be provided to prevent its collapse.

9.3.3 Pneumatic pressure test

Pneumatic tests shall only be permitted in cases where a hydrostatic pressure test is detrimental to the piping system or is not practical, i.e.

— unacceptable presence of residual water for the process (e.g. ice) or the equipment (e.g. corrosion that may be detrimental to the stability/usability of the equipment);

— technical constraints like loads due to the water weight on either pressure equipment, supports or the ground that would possibly cause damage.

Performance of pneumatic pressure test shall be decided during design stage. Adequate safety precautions shall be taken.

NOTE Special national safety rules about pneumatic pressure tests may apply in the European member states.

The requirements of 9.3.1 shall be fulfilled.

Due to the hazard involved in pressure testing using a compressible medium, a hazard analysis shall be performed by the manufacturer with special consideration to at least the following factors:

a) location of the piping system and its position relative to other buildings, plants, public roads, and areas open to public and all other equipment and structures in the vicinity of the piping system to be tested;

b) maintaining during the test the highest practicable standards of safety and ensuring that only personnel involved in the testing have access to the testing area, that if the testing is not performed in a special room the region in the immediate vicinity of the testing area is sealed off and warning signs used highlighting the danger zone and prohibited area;

c) resistance of the piping system materials to fast fracture and the absolute necessity of avoiding brittle fracture;

d) Attention is drawn to the fact that if the gas pressure is reduced to the piping system under test from high pressure storage, its temperature will fall. Therefore the equipment shall be such that the temperature of the gas entering the piping systems exceeds the minimum temperature indicated, The metal temperature at which shall be at least 25 above the brittle fracture temperature required in EN 13480-2:2017, Annex B for piping systems;

e) the extent of remote monitoring provided during the test.

The test pressure shall be in accordance with 9.3.2.2.

Piping subject to this pressure shall be located in an enclosed and restricted area and adequate measures being taken to prevent parts shooting away in the case of explosion. Alternatively the piping shall be located in an area enough far away from any individuals (public or manufacturers employees) such that in the case of explosion, people will not be affected by the blast (This does not include damage from projectiles).

The pressure shall be gradually increased to a value of 50 % of the required test pressure. Thereafter the pressure shall be increased in steps of approximately 10 % of the required test pressure until this is reached. The pressure shall then be reduced after 10 min to the inspection pressure P_i.

$$P_i = PS \cdot \frac{f_{test}}{f} \qquad (9.3.3\text{-}1)$$

and held during the inspection of the piping.

f) Alternatively a test may be performed at a test pressure of 1,1 times the maximum allowable pressure PS.

Where the alternative 1.1 times the maximum allowable pressure has been used, the pressure shall be dropped to the maximum allowable pressure for inspection of the piping.

Before initial pressure tested, NDT shall be performed as a minimum as shown in Table 9.3.3-1. Extent of testing shall not be less than specified in Table 8.2-1 including Note g.

Table 9.3.3-1 — Extent of NDT in case of pneumatic pressure test according to 9.3.3

Type of weld	Extent of NDT	
Circumferential welds; branch and nozzle welds DN ≥ 100	10 %[a] RT or UT, cross sections with longitudinal welds to be covered	
Branch and nozzle welds DN < 100 and socket welds	Material groups 1.1, 1.2, 8.1 Other Material groups	5 % PT or MT 25 % PT or MT
Longitudinal welds and spiral welds, if not already subject to a NDT or pressure test at the pipe/fitting manufacturer's premises	100 % RT or UT	
[a] Up to DN ≤ 600, 10 % of welds to be tested 100 %, from DN > 600, 10 % of the total length of welds.		

9.3.4 Other tests

In cases where a hydrostatic or pneumatic pressure test of individual welds (connection welds) would be detrimental or impracticable they shall be substituted by an appropriate non-destructive test (100 % RT or UT and 100 % PT or MT). If for specific materials, e.g. glass linings, the calculated stresses in the piping are lowered to less than 70 % of the nominal stress for the design condition of the piping, this may be taken into account when the test pressure and the amount of non-destructive testing is specified.

Consideration shall be given to final testing at an early stage in the design cycle, so that arrangements can be made to ensure that the individual component receive an appropriate test.

9.3.5 Documentation of the proof test

The proof test shall be confirmed in a test report. Where the proof test is not carried out using water, the test medium used shall be recorded.

9.4 Documentation

9.4.1 Final documentation package

The final documentation package shall contain the design and manufacturing documentation package and the operating instructions. The content of the final documentation package shall be as specified in Table 9.4-1.

Table 9.4-1 — Final documentation

No.	Documents	Category				Piping at or below 0,5 bar
		III	II	I	0	
1	Piping and instrumentation diagram (P & I diagram)	x	x	x	x [a]	x [a]
2	Summary of design and operating conditions	x	x	x	x [a]	x [a]
3	Drawings of the layout of the piping and piping supports with dimensions (may include isometric drawings, as built drawings, views, ground layouts).	x	x	x	x [a]	x [a]
4	Parts lists for piping components	x	x	x [a]	x [a]	–
5	Material certificates for base materials and filler material, if required	x	x	x [a]	See EN 13480-2	–
6	Documentation for miscellaneous components, e.g. valves, safety equipment	x	x	x [a]	x [a]	x [a]
7	Welding documents	x	x	x [a]	x [a]	–
8	NDT documents	x	x	x	–	–
9	Heat treatment documents	x	x	x	–	–
10	Pressure test or equivalent test documents	x	x	x	x [a]	–
11	Marking information (see EN 13480-4:2017, Clause 11)	x	x	x	x	x [a]
12	Declaration of design compliance	x	x	x	–	–
13	Declaration of compliance for piping fabrication/installation	x	x	x	–	–
14	Operating instructions [b]	x	x	x	–	–
15	Adequate instructions for use [b]	–	–	–	x	–

"x" means that the document shall be included in the final documentation.
NOTE See Annex VII of the PED for the declaration of conformity which shall be available if piping of Categories I, II and III is placed at a market in a country where the PED applies.

[a] dependent on manufacturer's decision
[b] if not included in the operation instructions of the plant or assembly

9.4.2 Design and manufacturing documentation package

The manufacturer shall compile a design and manufacturing documentation package in such a way that the design and manufacture of the piping may be assessed against the requirements of this standard and the agreed design.

9.4.3 Operating instructions

The manufacturer shall compile operating instructions for the user, containing all necessary information relating to putting into service, operation and proposed maintenance and user in-service-inspections of the piping system.

The operating instructions shall cover the design data and main dimensions of the piping delivered as well as the information contained in the marking. Where appropriate, these instructions shall also include those documents, drawings and diagrams which are necessary for a full understanding of the operation instructions.

9.4.4 Documentation for the purchaser

A copy of the final documentation package shall be delivered to the purchaser after completion of the contract. In accordance with the agreement between the parties concerned the design and manufacturing documentation package may be delivered in full or parts thereof.

10 Declaration

On completion of final assessment and documentation, the manufacturer shall issue a declaration of compliance with EN 13480 (see Annex A).

NOTE See CEN/TR 13480-7 for guidance on the requirements for EC declaration of conformity.

Annex A
(informative)

Declaration of compliance with EN 13480

A.1 Declaration for design

Figure A.1 provides a form for a declaration for design which may be used whenever the designer is required to declare design compliance with EN 13480 to another party.

DECLARATION OF DESIGN COMPLIANCE
Description of piping
Identification no./drawings no.
designed by *(company)*
for *(plant/purchaser/purpose)*
Design conditions: PS [bar] TS [°C] category
We hereby declare that the above piping has been designed in accordance with EN 13480. Company ____ Place and Date ____ Signature

Figure A.1 — Declaration of design compliance

A.2 Declaration for fabrication, installation and testing

Figure A.2 provides a form for a declaration for fabrication, installation and testing which may be used whenever the fabricator/installer is required to declare fabrication, installation and testing in accordance with EN 13480 to another party.

DECLARATION OF COMPLIANCE FOR PIPING FABRICATION , INSTALLATION AND TESTING
Description of piping
Identification no./drawings no.
installed by *(company)*
for *(plant/purchaser/purpose)*
Design conditions: PS [bar] TS [°C] test pressure [bar] and date test medium design examination declaration no./by
We hereby declare that the above piping has been fabricated, installed, examined and tested in accordance with EN 13480. Company ____ Place and Date ____ Signature

Figure A.2 — Declaration of compliance for piping fabrication and installation

A.3 Declaration for compliance for piping with EN 13480

Figure A.3 provides a form for a declaration for compliance for piping with EN 13480.

DECLARATION OF COMPLIANCE FOR PIPING WITH EN 13480
Description of piping
Identification no./drawings no.
manufactured by *(company)*
for *(plant/purchaser/purpose)*
Design conditions: PS [bar] TS_{max}, TS_{min} [°C] category DECLARATION OF DESIGN COMPLIANCE no. /by DECLARATION of COMPLIANCE for FABRICATION, INSTALLATION AND TESTING no./by
We hereby declare that the above piping conforms with the requirements of EN 13480:…. . Company ____ Place and Date ____ Signature

Figure A.3 — Declaration of compliance of final inspection for piping

Annex Y
(informative)

History of EN 13480-5

Y.1 Differences between EN 13480-5:2012 and EN 13480-5:2017

The 2017 edition of EN 13480-5 contains the 2012 edition of the standard and all Amendment(s) and/or correction(s) issued in the meantime.

Significant technical changes include:

— update of normative references;

— revision of Clause 6 regarding design review;

— revision of sub-clause 7.2.4 regarding non-destructive testing of formed parts;

— revision of sub-clause 7.2.5 regarding destructive testing of formed parts;

— revision in 8.1 of the determination of the extent of NDT;

— addition in 8.1 of requirements for category 0;

— clarification in 8.1 of requirements for NDT for piping in creep and fatigue service;

— addition in 8.1 and in 9.3.3 of requirements for NDT for piping subject to pneumatic pressure testing;

— revision of sub-clause 8.1.3 regarding imperfections revealed by sample inspection;

— revision of Table 8.2-1 regarding the extent of testing for circumferential, branch, fillet and seal welds;

— specification in 8.4 of quality levels depending on service conditions and test methods considering EN ISO 5817;

— revision of sub-clause 8.4.3 regarding personnel qualification;

— specification in 8.4.4 and 8.4.5 of selection of NDT methods and testing techniques based on EN ISO 17635;

— addition in 9.3.2.2.1 of requirements for pressure testing of piping operating in the creep range;

— addition in 9.3.3 of an alternative method for pneumatic pressure testing;

— revision of Table 9.4-1 regarding final documentation;

— replacement in Clause 10 of the reference to CEN/TR 13480-7 regarding the declarations of compliance with a reference to Annex A;

— addition of a new Annex A including new forms for the declaration of design compliance, declaration of compliance for piping fabrication, installation and testing and declaration of compliance for piping with EN 13480;

— revision of the Annexe ZA in relation with the Pressure Equipment Directive 2014/68/UE;

— update of the Bibliography;

— editorial revision of the standard.

NOTE The changes referred include the significant technical changes but is not an exhaustive list of all modifications.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/071 "Mandate to CEN for standardization in the field of Pressure equipment" to provide one voluntary means of conforming to Essential Requirements of the New Approach Pressure Equipment Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 2014/68/EU on Pressure Equipment

Essential Safety Requirements (ERs) of Directive 2014/68/EU on Pressure Equipment, Annex I	Clause(s)/sub-clause(s) of this EN	Qualifying remarks/Notes
3.1	7	Manufacturing procedures
3.1.1	7.3.2	Preparation of component parts
3.1.3	8.4.3	Personnel for non-destructive tests
7.2	8.3	Non-destructive testing
3.2.1	9.2	Final inspection
3.2.2	9.3	Proof test
3.4 a) and b)	9.4.3 and Table 9.4-1	Operating instruction and documentation

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

Bibliography

Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment

EN 473:2008, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

EN 10217 (all parts), *Welded steel tubes for pressure purposes — Technical delivery conditions*

CEN/TR 13480-7, *Metallic industrial piping — Part 7: Guidance on the use of conformity assessment procedures*

CEN ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system (ISO/TR 15608)*

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