



BSI Standards Publication

Butt-welding pipe fittings

Part 2: Non alloy and ferritic alloy steels with specific inspection requirements

National foreword

This British Standard is the UK implementation of EN 10253-2:2021. It supersedes BS EN 10253-2:2007, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/110, Steel Tubes, and Iron and Steel Fittings.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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European foreword

This document (EN 10253-2:2021) has been prepared by Technical Committee CEN/TC 459 “ECISS - European Committee for Iron and Steel Standardization”, 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of an identical text or by endorsement, at the latest by February 2022, and conflicting national standards shall be withdrawn at the latest by February 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10253-2:2007.

The main changes compared to the previous edition are listed below:

- a) Document technically and editorially revised;
- b) Updating of Clause 2 “Normative References”;
- c) Revision of chemical composition and steel grades;
- d) Revision of permissible deviations of the product analysis from specified limits on cast analysis;
- e) Revision of mechanical properties;
- f) Revision of minimum proof strength including minimum wall thickness;
- g) Revision of impact properties including minimum requirements;
- h) Revision of fitting dimensions and moving to new Annex A;
- i) Addition of creep rupture strength values;
- j) Revision of inspection and tests;
- k) Revision of pressure factors;
- l) Updating of Annex ZA to follow new EU Directive 2014/68/EU for pressure equipment;
- m) Updating of the Bibliography.

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 2014/68/EU.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

EN 10253 comprises a series of European Standards about *Butt-welding pipe fittings*, namely:

- *Part 1: Wrought carbon steel for general use and without specific inspection requirements;*
- *Part 2: Non alloy and ferritic alloy steels with specific inspection requirements;*
- *Part 3: Wrought austenitic and austenitic-ferritic (duplex) stainless steels without specific inspection requirements;*
- *Part 4: Wrought austenitic and austenitic-ferritic (duplex) stainless steels with specific inspection requirements.*

Any feedback and questions on this document should be directed to the users' national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

In writing this document the competent committee recognized that there are two broad types of products commonly used, and decided to reflect these in the standard by differentiating between two parts.

EN 10253-1 describes fittings without formal reference to the pressure resistance, which are not intended to be used in applications, covered by the Pressure Equipment Directive (2014/68/EU) categories I to IV.

EN 10253-2 defines two types of fittings: Type A fittings have the same wall thickness at the welding ends and at the body of the fitting as a pipe having the same specified wall thickness. Their resistance to internal pressure is, in general, less than that of a straight pipe with the same dimensions. Type B fittings showing increased wall thickness at the body of the fitting are designed to resist the same internal pressure as a straight pipe with same dimensions. These two types of fittings are intended to be used in applications covered by the EU Directive 2014/68/EU. According to this Directive and further interpretation guidelines (e.g. guideline G – 19), seamless fittings are considered as materials whereas welded fittings are considered as components. Therefore, in some areas of this document, provisions for seamless and welded fittings are different.

The selection of steel type and requirement level depend on many factors; the properties of the fluid to be conveyed, the service conditions, the design code and any statutory requirements should all be taken into consideration. Therefore this document gives no detailed guidelines for the application of different fittings. It is the ultimate responsibility of the user to select the appropriate fitting for the intended application.

1 Scope

This document specifies the technical delivery requirements for seamless and welded butt-welding fittings (elbows, concentric and eccentric reducers, equal and reducing tees, caps) made of carbon and alloy steel in two test-categories which are intended for pressure purposes at room temperature, at low temperature or at elevated temperatures, and for the transmission and distribution of fluids and gases.

It specifies:

- a) type of fittings;
 - type A: Butt-welding fittings with reduced pressure factor;
 - type B: Butt-welding fittings for use at full service pressure;
- b) steel grades and their chemical compositions;
- c) mechanical properties;
- d) dimensions and tolerances;
- e) requirements for inspection and testing;
- f) inspection documents;
- g) marking;
- h) protection and packaging.

NOTE The selection of the appropriate fitting (material, thickness) is the ultimate responsibility of the manufacturer of the pressure equipment (see European Legislation for Pressure Equipment). In the case of a harmonized supporting standard for materials, presumption of conformity to the ESRs is limited to technical data of materials in the standard and does not presume adequacy of the material to a specific item of equipment. Consequently, it is essential that the technical data stated in the material standard be assessed against the design requirements of this specific item of equipment to verify that the ESRs of the PED are satisfied.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 10020:2000, *Definition and classification of grades of steel*

EN 10021:2006, *General technical delivery conditions for steel products*

EN 10027-1:2016, *Designation systems for steels - Part 1: Steel names*

EN 10027-2:2015, *Designation systems for steels - Part 2: Numerical system*

EN 10028-2:2017, *Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

EN 10028-3:2017, *Flat products made of steels for pressure purposes - Part 3: Weldable fine grain steels, normalized*

EN 10028-4:2017, *Flat products made of steels for pressure purposes - Part 4: Nickel alloy steels with specified low temperature properties*

EN 10160:1999, *Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflection method)*

EN 10168:2004, *Steel products - Inspection documents - List of information and description*

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 10217-1:2019, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 1: Electric welded and submerged arc welded non-alloy steel tubes with specified room temperature properties*

EN 10217-2:2019, *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 10217-3:2019, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 3: Electric welded and submerged arc welded alloy fine grain steel tubes with specified room, elevated and low temperature properties*

EN 10217-4:2019, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 4: Electric welded non-alloy steel tubes with specified low temperature properties*

EN 10217-5:2019, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 5: Submerged arc welded non-alloy and alloy steel tubes with specified elevated temperature properties*

EN 10217-6:2019, *Welded steel tubes for pressure purposes - Technical delivery conditions - Part 6: Submerged arc welded non-alloy steel tubes with specified low temperature properties*

EN 10220:2002, *Seamless and welded steel tubes - Dimensions and masses per unit length*

EN 10222-2:2017, *Steel forgings for pressure purposes - Part 2: Ferritic and martensitic steels with specified elevated temperatures properties*

EN 10222-3:2017, *Steel forgings for pressure purposes - Part 3: Nickel steels with specified low temperature properties*

EN 10222-4:2017, *Steel forgings for pressure purposes - Part 4: Weldable fine grain steels with high proof strength*

EN 10228-3:2016, *Non-destructive testing of steel forgings - Part 3: Ultrasonic testing of ferritic or martensitic steel forgings*

EN 10266:2003, *Steel tubes, fittings and structural hollow sections - Symbols and definitions of terms for use in product standards*

EN 10273:2016, *Hot rolled weldable steel bars for pressure purposes with specified elevated temperature properties*

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

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

EN 13480-5:2017, *Metallic industrial piping - Part 5: Inspection and testing*

EN ISO 148-1:2016, *Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2016)*

EN ISO 377:2017, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:2017)*

EN ISO 2566-1:1999, *Steel - Conversion of elongation values - Part 1: Carbon and low alloy steels (ISO 2566-1:1984)*

EN ISO 3166-1:2020, *Codes for the representation of names of countries and their subdivisions — Part 1: Country code (ISO 3166-1:2020)*

EN ISO 3183:2019, *Petroleum and natural gas industries - Steel pipe for pipeline transportation systems (ISO 3183:2019)*

EN ISO 4136:2012, *Destructive tests on welds in metallic materials - Transverse tensile test (ISO 4136:2012)*

EN ISO 4885:2018, *Ferrous materials - Heat treatments - Vocabulary (ISO 4885:2018)*

EN ISO 5173:2010,¹ *Destructive tests on welds in metallic materials - Bend tests (ISO 5173:2009)*

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 6506-1:2014, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:2014)*

EN ISO 6892-1:2019, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2019)*

EN ISO 6892-2:2018, *Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature (ISO 6892-2:2018)*

EN ISO 9016:2012, *Destructive tests on welds in metallic materials - Impact tests - Test specimen location, notch orientation and examination (ISO 9016:2012)*

EN ISO 9606-1:2017, *Qualification testing of welders - Fusion welding - Part 1: Steels (ISO 9606-1:2012 including Cor 1:2012 and Cor 2:2013)*

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

EN ISO 10893-3:2011,² *Non-destructive testing of steel tubes - Part 3: Automated full peripheral flux leakage testing of seamless and welded (except submerged arc-welded) ferromagnetic steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-3:2011)*

¹ As impacted by EN ISO 5173:2010/A1:2011.

² As impacted by EN ISO 10893-3:2011/A1:2019 and EN ISO 10893-3:2011/A2:2020.

EN ISO 10893-4:2011, *Non-destructive testing of steel tubes - Part 4: Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections (ISO 10893-4:2011)*

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 10893-8:2011,³ *Non-destructive testing of steel tubes - Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections (ISO 10893-8:2011)*

EN ISO 10893-10:2011,⁴ *Non-destructive testing of steel tubes - Part 10: Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-10:2011)*

EN ISO 10893-11:2011,⁵ *Non-destructive testing of steel tubes - Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections (ISO 10893-11:2011)*

EN ISO 14284:2002, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

EN ISO 14732:2013, *Welding personnel - Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials (ISO 14732:2013)*

CEN ISO/TR 15608:2017, *Welding - Guidelines for a metallic materials grouping system (ISO/TR 15608:2017)*

EN ISO 15614-1:2017, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2017, Corrected version 2017-10-01)*

EN ISO 17640:2018, *Non-destructive testing of welds - Ultrasonic testing - Techniques, testing levels, and assessment (ISO 17640:2018)*

EN ISO 18265:2013, *Metallic materials - Conversion of hardness values (ISO 18265:2013)*

³ As impacted by EN ISO 10893-8:2011/A1:2020.

⁴ As impacted by EN ISO 10893-10:2011/A1:2020.

⁵ As impacted by EN ISO 10893-11:2011/A1:2020.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020:2000, EN 10021:2006, EN ISO 377:2017 and EN ISO 4885:2018 and the following apply

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

employer

organization for which a person works on a regular basis

Note 1 to entry: The employer may be either the fitting manufacturer or supplier or a third party organization providing a service, e.g. NDT.

3.2

model

designation for elbows, return bends and reducers

Note 1 to entry: For elbows and return bends the model defines the bending diameter of the piece.

Note 2 to entry: For reducers the model defines concentric or eccentric shape of the piece.

3.3

purchaser

person or organization that orders products in accordance with this European Standard

Note 1 to entry: The purchaser is not necessarily, but may be, a manufacturer of pressure equipment in accordance with the EU Directive listed in Annex ZA.

Note 2 to entry: Where a purchaser has responsibilities under this EU Directive, this standard will provide a presumption of conformity with the essential requirements of the EU Directive so identified in Annex ZA.

3.4

weld during manufacture

weld made for obtaining a fitting

Note 1 to entry: This term does not include the tube welds when a tube is used as starting material.

3.5

seamless fitting

fitting manufactured without welding from starting material which is not welded

3.6

welded fitting

fitting made from welded starting material or fitting where welding is a part of the manufacturing process

3.7

test category

classification that indicates their extent and level of inspection and testing

4 Symbols and abbreviations

For the purposes of this document, the symbols defined in EN 10266:2003 and the following apply:

A	Percentage of elongation at rupture, with reference to gauge length of $5,65 \sqrt{S_0}$
B	Back to face distance for return bends, expressed in millimetres
C	Centre to centre distance for return bends ($C = 2R$), expressed in millimetres
D	Specified outside diameter for elbows, return bends, equal tees, caps and the major outside diameter for reducers and reducing tees, expressed in millimetres
D_1	Specified minor outside diameter for reducers and reducing tees, expressed in millimetres
$D_{\max}$	Maximum diameter in one section, expressed in millimetres
$D_{\min}$	Minimum diameter in the same section, expressed in millimetres
F	Distance from the axis of the branch outlet to the face of the centre body of tees, expressed in millimetres
G	Distance from the axis of the centre line to the face of the branch outlet expressed in millimetres
ID	Inside diameter at the welding ends of elbows, return bends, equal tees and at the major welding end of reducers and reducing tees ($ID = D - 2T$)
ID_1	Inside diameter at the minor welding end of reducers and reducing tees ($ID_1 = D_1 - 2T_1$)
K	Total height for caps, expressed in millimetres
L	Face to face distance for reducers, expressed in millimetres
P	Tolerance on the form of elbows
R	Bending radius of elbows and return bends, expressed in millimetres
R_1	Inside spherical radius of cap
R_2	Inside knuckle radius of cap
R_{eh}	Upper yield strength or proof strength
R_m	Tensile strength, expressed in megapascals
$R_{p0,2}$	Minimum 0,2 % proof strength, plastic extension expressed in megapascals
$R_{t0,5}$	Minimum 0,5 % proof strength, total extension expressed in megapascals
T	Specified wall thickness at the welding ends for elbows, return bends, equal tees and bends or on the D end for reducers and reducing tees, expressed in millimetres
T_1	Specified wall thickness on the D_1 welding end of reducers and reducing tees, expressed in millimetres
TC	Test category
W	Distance from the extrados to the centre of a 90° elbow at the welding ends
X	Tolerance on the form of fittings
Z	Distance from the extrados to the centre of a 45° elbow at the welding ends

5 Classification and designation

5.1 Classification of grades

In accordance with the classification system in EN 10020:2000, the steel grades P235TR2, P265TR2, P235GH, P265GH, P215NL, P265NL and L290NE, L360NE and L360QE are non-alloy quality steels, P355N, P355NH and P355NL1 alloy quality steels and the other steel grades are classified as alloy special steels.

The steel grades P235GH, P265GH, P355N, P355NH, P355NL1 and P215NL can be provided in accordance with test category TC1 or TC2. Any other steel grade given in Table 2 shall be provided only in accordance with TC2.

5.2 Designation of steel grades

For the fittings covered by this document the steel designation consists of:

— the number of this document (EN 10253-2),

plus either

— steel name in accordance with EN 10027-1:2016,

or

— steel number allocated in accordance with EN 10027-2:2015.

5.3 Designation of fittings

5.3.1 General

Fittings are designated by their name and the following parameters.

5.3.2 Elbows and return bends

Elbows and return bends are designated by the following parameters:

- a) model (2D, 3D or 5D);
- b) type (type A or type B);
- c) angle;
- d) outside diameter (D);
- e) wall thickness (T).

5.3.3 Reducers

Reducers are designated by the following parameters:

- a) model [concentric (con) or eccentric (ecc)];
- b) type (type A or type B);
- c) major diameter (D) and wall thickness (T);
- d) minor diameter (D_1) and wall thickness (T_1).

5.3.4 Tees

Equal and reducing tees are designed by the following parameters:

- a) type (type A or type B);
- b) major diameter (D) and minor diameter (D_1);
- c) wall thickness (T) and wall thickness (T_1).

NOTE If only one pair of dimension ($D \times T$) is given, an equal tee is meant.

5.3.5 Caps

Caps are designated by the following parameters:

- a) type (type A or type B),
- b) outside diameter (D)
- c) wall thickness (T).

6 Information to be supplied by the purchaser

6.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) quantity required (number of pieces);
- b) reference to this document;
- c) designation of fittings (see 5.3);
- d) designation of the steel grade (see 5.2);
- e) test category 1 or 2 (TC1/TC2) for quality steels (see 5.1 and 12.3)
- f) options, if any (see 6.2).

6.2 Options

A number of options are specified in this document and these are listed below. In the event that the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the fittings shall be supplied in accordance with the basic specification (see 6.1).

- 1) Steelmaking process (see 8.1);
- 2) Method of manufacture of the fitting (see 8.2.1);
- 3) Starting product form and/or delivery condition (see 8.2.1)

NOTE Use for ordering seamless (S) or welded (W) fittings.;

- 4) Reporting of method of manufacture (see 8.2.1);
- 5) Deviations from the quality level for the weld (see 8.2.2.2);

- 6) Type of heat treatment (see 8.2.3);
- 7) Other grades specified in the purchase order (see 9.2.1);
- 8) Product analysis (see 9.2.2, 14.1 and 12.3, Table 14); option 8 is equal to option 15;
- 9) Verification of the proof strength at elevated temperature (see 9.3);
- 10) Tolerance on diameter – inside (see 11.2.1.1);
- 11) Special tolerances (see 11.2.1.2);
- 12) Plus tolerances on the body of the fitting (see 11.2.3);
- 13) End finishing (see 11.3);
- 14) Inspection document (see 12.2.1);
- 15) Product analysis (see 9.2.2, 14.1 and 12.3, Table 14); option 15 is equal to option 8;
- 16) Tensile test at elevated temperature (see 12.3, Table 14);
- 17) Hardness test (see 14.4 and 12.3, Table 14);
- 18) Impact test (see 12.3, Table 14);
- 19) Impact test of the heat affected zone (see 12.3, Table 14);
- 20) Bend test transverse to the weld (see 12.3, Table 14);
- 21) NDT for the detection of laminar imperfections (see 14.9.4 and 12.3, Table 14);
- 22) NDT for the detection of transverse imperfections (see 14.9.6 and 12.3, Table 14);
- 23) NDT for bars and forgings (see 14.9.7 and 12.3, Table 14);
- 24) Positive material identification (see 14.10 and 12.3, Table 14);
- 25) Registration records of the heat treatment temperatures (see 13.1.1);
- 26) Test unit size – Table 16 (see 13.1.1 and Table 16);
- 27) Test unit size – purchase order (see 13.1.1);
- 28) Impact test of the heat affected zone (see 13.2.6);
- 29) Additional marking and methods of marking (see Clause 15);
- 30) Special packaging, coating or end plugs (see Clause 16).

6.3 Examples of an order

6.3.1 Example 1

1 000 elbows in accordance with this document of type A and model 3D, with an angle 90° having an outside diameter 114,3 mm and a wall thickness 6,3 mm, made of steel grade P265GH and test category TC1.

1 000 elbows — EN 10253-2 — type A - model 3D — 90° — 114,3 × 6,3 — P265GH — TC1

6.3.2 Example 2

500 tees in accordance with this document of type B, having an outside diameter 114,3 mm with a wall thickness 6,3 mm and a branch outside diameter 88,9 mm with a branch wall thickness 4,0 mm and made of steel grade P235GH and test category TC2.

500 tees — EN 10253-2 — type B — 114,3 × 6,3 — 88,9 × 4,0 — P235GH — TC2

6.3.3 Example 3

100 concentric (con) reducers in accordance with this document of type B, having an outside diameter 168,3 mm with a wall thickness of 7,1 mm and a reduced outside diameter 114,3 mm with a wall thickness of 6,3 mm, made of steel grade 16Mo3.

100 reducers con — EN 10253-2 — type B — 168,3 × 7,1 — 114,3 × 6,3 — 16Mo3

100 eccentric (ecc) seamless (s) reducers in accordance with this document of type A, having an outside diameter 168,3 mm with a wall thickness of 7,1 mm and a reduced outside diameter 114,3 mm with a wall thickness of 6,3 mm, made of steel grade 16Mo3.

**100 reducers ecc — EN 10253-2 — type A — 168,3 × 7,1 — 114,3 × 6,3 — 16Mo3 — Option 3:
seamless (s)**

6.3.4 Example 4

20 caps in accordance with this document of type A, having an outside diameter 273,0 mm with a wall thickness of 16,0 mm, made of steel grade P355N.

20 caps — EN 10253-2 — type A — 273,0 × 16,0 — P355N

6.3.5 Example 5

500 reducing tees in accordance with this document of type B, having an outside diameter 114,3 mm with a wall thickness 6,3 mm and a branch outside diameter 88,9 mm with a branch wall thickness 4,0 mm, made of steel grade 16Mo3, with option 16 (tensile test at elevated temperature of 400 °C), option 13 (bevel according ISO 9692-1:2013, Reference number 1.5 with c = 2 mm) and option 24 (PMI-Test)

**500 tees — EN 10253-2 — type B — 114,3 × 6,3 — 88,9 × 4,0 — 16Mo3 —
opt<16:400°C/13:ISO 9692-1_1.5_c = 2/24>**

7 Resistance to internal pressure

7.1 General

The European Legislation for Pressure Equipment imposes that the design for adequate strength shall be based on a calculation method or, with restrictions, on an experimental method.

The resistance to internal pressure of a fitting conforming to this document shall be determined according to the relevant design rules laid down in EN 13480-3:2017.

7.2 Fittings of type A

Type A fittings have the same wall thickness at the welding ends and at the body of the fitting as a pipe having the same specified wall thickness. Their resistance to internal pressure is less than that of a pipe with the same specified diameter, wall thickness and of the same steel grade. The determination of the reducing pressure factor is given in Annex B and tables of pressure factors are given in Annex C.

For reducers the wall thickness at the conical section shall be the specified wall thickness at the major end.

7.3 Fittings of type B

Fittings of type B have increased wall thickness at the body of the fitting. They will, in general, withstand the same pressure as a pipe having the same specified diameter, wall thickness and the same steel grade.

Wall thickness requirements for this type of fittings are defined by the calculation procedures given in Annex B. For some preferred, specified wall thicknesses the resulting wall thicknesses at the body of the fitting are listed in the tables given in Annex D.

8 Manufacturing process

8.1 Steelmaking process

The steelmaking process is left at the discretion of the manufacturer and shall be reported. The steels shall be fully killed.

Option 1: *The steelmaking process shall be as specified on the purchase order.*

8.2 Product making process for fittings and heat treatment

8.2.1 Product making process

The different allowed processes and the relevant starting product forms are listed in Table 1. Differing starting materials and production routes are associated with variations in the types of controls applied. The method of manufacturing is left at the discretion of the manufacturer. When choosing the method the manufacturer shall take suitable precautions to prevent the occurrence of ageing problems in the final product form.

Where tubes are used as starting material, following conditions shall apply:

- unless otherwise specified, the choice of the tubes (seamless or welded) is left at the discretion of the manufacturer;
- when manufacturing fittings from welded tubes, only tubes according to EN 10217-1:2019 to EN 10217-6:2019 and EN ISO 3183:2019 shall be used;
- helical welded tubes (SAWH) are not permitted;

- after forming, repair of the pipe weld seam is only permitted for weld seams made with filler metal. These repairs shall be carried out as described in 8.2.2.

Where plate or strip is used as starting material for welded fittings, the following condition shall apply:

- only plate or strip according to EN 10028-2:2017, EN 10028-3:2017 and EN 10028-4:2017 shall be used.

Where bars are used as starting material for welded or machined fittings, the following condition shall apply:

- only bars according to EN 10273:2016 and EN 10222-2:2017, EN 10222-3:2017 and EN 10222-4:2017 shall be used.

Table 1 — Product making process – Product form of starting material

Process	Hot deformation			Cold deformation		Machining from round bars (DN ≤ 50) ^c
	Bending ^a	Pressed in die ^b	Rolled, forged followed by machining	Bending	Pressed in die	
Elbows	1, 2, 4, 5	1, 2, 3, 4, 5	—	1, 2, 4, 5	1, 2, 3, 4, 5	—
Tees	—	1, 2, 3, 4, 5	4, 5	—	1, 2, 3, 4, 5	—
Reducers	—	1, 2, 3, 4, 5	4, 5	—	1, 2, 3, 4, 5	5
Caps	—	1, 2, 3, 4, 5	4, 5	—	1, 2, 3, 4, 5	5
NOTE Starting material: 1 seamless pipe; 2 welded pipe; 3 plate and strip; 4 forging; 5 bar						
^a When producing elbows from welded pipe, the position of the weld is at the discretion of the manufacturer.						
^b For these processes welding with or without filler metal may be used (see 8.2.2.1). When filler metal is used it shall be compatible with the parent metal.						
^c The method of manufacture shall be reported.						

Option 2: *The method of manufacturing and/or details of the manufacturing process, e.g. welding operations or position of the weld before forming shall be as specified on the purchase order.*

Option 3: *The starting product form to be used and/or its delivery condition shall be as specified on the purchase order.*

NOTE Use for ordering seamless (S) or welded (W) fittings.

Option 4: *The method of manufacture shall be reported.*

8.2.2 Welding

8.2.2.1 General

When fittings are produced from welded pipes, the requirements in EN 10217-1:2019 to EN 10217-4:2019 or EN ISO 3183:2019 for welding apply. When welding is performed during the manufacturing of the fittings, paragraphs 8.2.2.2 to 8.2.2.4 apply.

8.2.2.2 Welding as part of the manufacturing process of the fitting

When producing fittings from plate or strip, welding is considered being a part of the manufacturing of fittings, and:

- welding process/procedures shall be qualified in accordance with EN ISO 15614-1:2017;
- welders and/or welding operators shall be qualified in accordance with EN ISO 9606-1:2017 and/or EN ISO 14732:2013. The re-validation route of EN ISO 14732:2013, 5.3.c) shall not be applied.

The documentation of qualification shall be kept available at the manufacturer's site and shall be accessible.

All welds carried out during the manufacture of the fitting shall be fusion weld type. All welds shall have full penetration.

Local repair of weld seam which have been made with filler metal is permitted provided that the repair procedure/welders are qualified in accordance with the relevant part of the above mentioned standards and the repaired area is heat treated and non-destructively tested in the same way as the original weld.

NOTE When taking into account the conditions specified for the manufacture of fittings and for the testing of the welds, a weld efficiency factor of 1,0 can be used in design calculations (see EN 13480-3:2017) with the exception of other than circumferential weld joints under creep conditions, which have to be evaluated in detail by the designer.

8.2.2.3 Finished weld requirement

The evaluation of internal and exterior irregularities of the weld shall be in accordance with EN ISO 5817:2014 quality level B.

Option 5: *Deviations from applicable quality level can be agreed upon.*

The finished weld criteria for the fittings made from welded pipe without filler metal shall be governed by the standard defining the starting material.

8.2.2.4 Heat treatment after welding

The sort and need of a heat treatment after welding is based on the material group and the welded wall thickness in dependency of applied standards (EN 13480-2:2017 and EN 13480-5:2017). Applicable heat treatment conditions are an integral part of the approval of processes. The heat treatment condition of base materials shall be in accordance with Table 2.

8.2.3 Heat treatment condition

The fittings shall be delivered in one of the final heat-treated conditions given in Table 2. Recommended heat treatment temperatures are given in Annex E, for welded fittings 8.2.2.3 applies.

In case of hot deformation fittings of steel grade P235TR2, P265TR2, P235GH, P265GH, P355N, P355NH and 16Mo3 may be delivered without additional heat treatment, if hot deformation produces a technically equivalent metallurgical structure with the corresponding mechanical characteristics.

This condition is regarded as satisfied when the final forming operation is completed at a temperature between 750 °C and 980 °C.

Option 6: *The heat treatment to be applied shall be as specified on the purchase order.*

Table 2 — Steel grades – Heat treatment conditions

Steel grade	Steel number	Heat treatment condition ^a	Material group ^c
P235TR2	1.0255	N	1.1
P265TR2	1.0259	N	1.1
P235GH	1.0345	N	1.1
P265GH	1.0425	N	1.1
16Mo3	1.5415	N	1.2
10CrMo5-5	1.7338	NT ^b	5.1
13CrMo4-5	1.7335	NT ^b	5.1
10CrMo9-10	1.7380	NT ^b	5.2
X11CrMo5	1.7362	I or NT	5.3
X11CrMo9-1	1.7386	I or NT	5.4
X10CrMoVNb9-1	1.4903	NT ^b	6.4
X10CrWMoVNb9-2	1.4901	NT ^b	6.4
P355N	1.0562	N	1.2
P355NH	1.0565	N	1.2
P355NL1	1.0566	N	1.2
P215NL	1.0451	N	1.1
P265NL	1.0453	N	1.1
12Ni14	1.5637	NT or QT	9.2
X10Ni9	1.5682	NT or QT	9.3
L290NE	1.0484	N	1.2
L360NE	1.0582	N	1.2
L360QE	1.8948	QT	3.1
L415NE	1.8972	N	1.3
L415QE	1.8947	QT	3.1
L450QE	1.8952	QT	3.1
L485QE	1.8955	QT	3.1

N = Normalized or normalized formed; NT = Normalized and tempered.

QT = Quenched and tempered; I = Isothermal annealing.

^a These heat treatments are identical to those described in the corresponding EN-tube standards.

^b For these steel grades it may be necessary to apply quenching and tempering in order to achieve the intended structure and material properties. The decision shall be left to the discretion of the manufacturer but shall be stated to the customer at the time of enquiry and order. Steel tubes treated in such a way shall be designated by the steel name supplemented by the symbol "+QT".

^c Material group to CEN ISO/TR 15608:2017.

9 Technical requirements

9.1 General

Fittings supplied and inspected in accordance with Clauses 8, 11 and 12 shall comply with the requirements of this document.

In addition to the requirements of this document, the general technical delivery requirements specified in EN 10021:2006 shall apply.

The requirements for the base material of the seamless fittings are left at the discretion of the manufacturer provided the requirements defined in Clauses 8 and 9 are fulfilled.

Option 7: *Other steel grades in accordance with harmonized material standards can be agreed in the purchase order. Table 14 applies to the testing of fittings. For this purpose, the requirements for the chemical composition, mechanical characteristics, heat treatment conditions and wall thicknesses of the products apply in accordance with the specifications given in the referenced material standards.*

The requirements for the steels L290NE to L485QE are based on EN ISO 3183:2019, Annex A (PSL 2 pipe ordered for European onshore natural gas transmission pipelines) for a design factor of 0,625.

9.2 Chemical composition

9.2.1 Cast analysis

The cast analysis reported by the steel manufacturer shall apply and comply with the requirements of Table 3.

9.2.2 Product analysis

Option 8: *A product analysis shall be supplied.*

Table 4 specifies the permissible deviations of the product analysis from the specified cast analysis given in Table 3.

Table 3 — Chemical composition (cast analysis), in % by mass^a

Steel name	Steel number	C	Si	Mn	P	S	Al _{tot}	Cr	Cu	Mo	Nb	Ni	Ti	V	Others	CE _{IIW} ⁱ	CE _{Pcm} ^j
P235TR2	1.0255	0,16	0,35	1,20	0,025	0,015	≥ 0,02 ^c	0,30 ^b	0,30 ^b	0,08 ^b	0,01 ^b	0,30 ^b	0,04 ^b	0,02 ^b	Cr+Cu+Mo+Ni ≤ 0,70 ^b	—	—
P265TR2	1.0259	0,20	0,40	1,40	0,025	0,015	≥ 0,02 ^c	0,30 ^b	0,30 ^b	0,08 ^b	0,01 ^b	0,30 ^b	0,04 ^b	0,02 ^b	Cr+Cu+Mo+Ni ≤ 0,70 ^b	—	—
P235GH	1.0345	0,16	0,35	1,20	0,025	0,010	≥ 0,02 ^d	0,30	0,30	0,08	0,02 ^b	0,30	0,04 ^b	0,02 ^b	Cr+Cu+Mo+Ni ≤ 0,70 ^b	—	—
P265GH	1.0425	0,20	0,40	1,40	0,025	0,010	≥ 0,02 ^d	0,30	0,30	0,08	0,02 ^b	0,30	0,04 ^b	0,02 ^b	Cr+Cu+Mo+Ni ≤ 0,70 ^b	—	—
16Mo3	1.5415	0,12 - 0,20 ^e	0,35	0,40 - 0,90	0,025	0,010	≤ 0,04	0,30	0,30	0,25 - 0,35	—	0,30	—	—	—	—	—
10CrMo5-5	1.7338	0,15	0,50 - 1,00	0,30 - 0,60	0,025	0,010	≤ 0,04	1,00 - 1,50	0,30	0,45 - 0,65	—	0,30	—	—	—	—	—
13CrMo4-5	1.7335	0,10 - 0,17 ^e	0,35	0,40 - 1,00 ^m	0,025	0,010	≤ 0,04	0,70 - 1,15	0,30	0,40 - 0,60	—	0,30	—	—	—	—	—
10CrMo9-10	1.7380	0,08 - 0,14	0,50	0,30 - 0,70	0,020	0,010	≤ 0,04	2,00 - 2,50	0,30	0,90 - 1,10	—	0,30	—	—	—	—	—
X11CrMo5+I X11CrMo5+NT1 X11CrMo5+NT2	1.7362+I 1.7362+NT1 1.7362+NT2	0,08 - 0,15	0,15 - 0,50	0,30 - 0,60	0,025	0,010	≤ 0,04	4,00 - 6,00	0,30	0,45 - 0,65	—	—	—	—	—	—	—
X11CrMo9-1+I X11CrMo9-1+NT	1.7386+I 1.7386+NT	0,08 - 0,15	0,25 - 1,00	0,30 - 0,60	0,025	0,010	≤ 0,04	8,00 - 10,00	0,30	0,90 - 1,10	—	—	—	—	—	—	—
X10CrMoVNb9-1	1.4903	0,08 - 0,12	0,20 - 0,50	0,30 - 0,60	0,020	0,005	≤ 0,02	8,00 - 9,50	0,30	0,85 - 1,05	0,06 - 0,10	0,40	0,01	0,18 - 0,25	N: 0,030 - 0,070 Zr: ≤ 0,01	—	—
X10CrWMoVNb9-2	1.4901	0,07 - 0,13	0,50	0,30 - 0,60	0,020	0,010	≤ 0,02	8,50 - 9,50	—	0,30 - 0,60	0,04 - 0,09	0,40	0,01	0,15 - 0,25	N: 0,030 - 0,070 B: 0,001 - 0,006 W: 1,50 - 2,00 Zr: ≤ 0,01	—	—

Steel name	Steel number	C	Si	Mn	P	S	Al _{tot}	Cr	Cu	Mo	Nb	Ni	Ti	V	Others	CE _{IIW} ⁱ	CE _{Pcm} ^j
P355N	1.0562	0,20	0,50	0,90 - 1,70	0,025	0,020	≥ 0,02 ^g	0,30 ^f	0,30 ^f	0,08 ^f	0,05	0,50	0,04	0,10	N ≤ 0,020 Nb+Ti+V ≤ 0,12	—	—
P355NH	1.0565	0,20	0,50	0,90 - 1,70	0,025	0,010	≥ 0,02 ^g	0,30 ^f	0,30 ^f	0,08 ^f	0,05	0,50	0,04	0,10	N ≤ 0,020 Nb+Ti+V ≤ 0,12	—	—
P355NL1	1.0566	0,18	0,50	0,90 - 1,70	0,025	0,008	≥ 0,02 ^g	0,30 ^f	0,30 ^f	0,08 ^f	0,05	0,50	0,04	0,10	N ≤ 0,020 Nb+Ti+V ≤ 0,12	—	—
P215NL	1.0451	0,15	0,35	0,40 - 1,20	0,025	0,010	≥ 0,02	0,30	0,30	0,08	0,01	0,30	0,04	0,02	—	—	—
P265NL	1.0453	0,20	0,40	0,60 - 1,40	0,025	0,010	≥ 0,02	0,30	0,30	0,08	0,01	0,30	0,04	0,02	—	—	—
12Ni14	1.5637	0,15	0,15 - 0,35	0,30 - 0,80	0,025	0,005	—	—	0,30	—	—	3,25 - 3,75	—	0,05	—	—	—
X10Ni9	1.5682	0,13	0,15 - 0,35	0,30 - 0,80	0,020	0,005	—	—	0,30	0,10	—	8,50 - 9,50	—	0,05	—	—	—
L290NE	1.0484	0,19 ^h	0,40	1,20 ^h	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10	0,05	0,30	0,04	0,06	N ≤ 0,012 Al/N ≥ 2	0,42	0,25
L360NE	1.0582	0,22 ^h	0,45	1,40 ^h	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10	0,05	0,30	0,04	0,10	N ≤ 0,012 V+Nb+Ti ≤ 0,15 Al/N ≥ 2	0,43	0,25
L360QE	1.8948	0,18 ^h	0,45	1,50 ^h	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10	0,05	0,30	0,04	0,05	N ≤ 0,012 Al/N ≥ 2	0,42	0,25
L415NE	1.8972	0,23 ^h	0,45 ^l	1,40 ^{h,l}	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10 ^k	0,05 ^l	0,30	0,04 ^l	0,10 ^l	N ≤ 0,012 V+Nb+Ti ≤ 0,15 Al/N ≥ 2	as agreed upon	as agreed upon
L415QE	1.8947	0,18 ^h	0,45	1,70 ^h	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10 ^k	0,06	0,30	0,05	0,09	N ≤ 0,012 V+Nb+Ti ≤ 0,15 Al/N ≥ 2	0,43	0,25
L450QE	1.8952	0,18 ^h	0,45	1,70 ^h	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10 ^k	0,06	0,30	0,07	0,10	N ≤ 0,012 V+Nb+Ti ≤ 0,15 Al/N ≥ 2	0,43	0,25

Steel name	Steel number	C	Si	Mn	P	S	Al _{tot}	Cr	Cu	Mo	Nb	Ni	Ti	V	Others	CE _{IIW} ⁱ	CE _{Pcm} ^j
L485QE	1.8955	0,18 ^h	0,45	1,80 ^h	0,025	0,015	0,015 - 0,06	0,30	0,25	0,10 ^k	0,06	0,30	0,07	0,11	N ≤ 0,012 V+Nb+Ti ≤ 0,15 Al/N ≥ 2	0,43	0,25

Elements not listed in this table shall not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

- a For elements where only one value is indicated without further information, this value shall be regarded as a maximum.
- b The content of these elements need not be reported unless intentionally added to the cast.
- c This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements which shall be reported.
- d This requirement is not applicable provided the steel contains a sufficient amount of other nitrogen binding elements which shall be reported. In case titanium is employed, the manufacturer has to prove that $(Al + Ti/2) \geq 0,020$ %.
- e For wall thicknesses greater than 30 mm, the carbon content may be increased by 0,02 % for cast and product analysis.
- f The sum of the percentage by mass of the three elements chromium, copper and molybdenum shall not exceed 0,45 %.
- g Al/N ≥ 2, in case nitrogen is bound with niobium, titanium or vanadium, the determination of Al_{tot} and Al/N is omitted.
- h For each reduction of 0,01 % below the specified maximum of C, an increase of 0,05% above the specified maximum for Mn up to a maximum increase of 0,20% is permissible.
- i For Fittings of test category TC2 with a carbon content > 0,12 % in the product analysis, the carbon equivalent CE_{IIW} shall be determined by applying the following formula (determination only in the product analysis, either of the starting material or of the finished product) $CE_{IIW} = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15}$.
- j For Fittings of test category TC2 with a carbon content ≤ 0,12 % in the product analysis, the carbon equivalent CE_{Pcm} shall be determined by applying the following formula (determination only in the product analysis, either of the starting material or of the finished product) $CE_{Pcm} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$.
- k If agreed, Mo ≤ 0,35%.
- l If not otherwise agreed.
- m Values of base material standard for plates.

Table 4 — Permissible deviations of the product analysis from specified limits on cast analysis given in Table 3

Element	Limiting value for the cast analysis in accordance with Table 3 % by mass	Permissible deviation of the product analysis ^a % by mass
C	≤ 0,23	±0,02
Si	≤ 0,40	±0,05
	> 0,40 to ≤ 1,00	±0,06
Mn	≤ 1,00	±0,05
	> 1,00 to ≤ 1,80	±0,10
P	≤ 0,025	+0,005
S	≤ 0,010	+0,003
	> 0,010 ≤ 0,020	+0,005
Al	≤ 0,060	±0,005
B	≤ 0,006	±0,000 5
Cr	≤ 1,00	±0,05
	> 1,00 to ≤ 10,00	±0,10
Cu	≤ 0,30	+0,05
Mo	≤ 0,35	±0,03
	> 0,35 to ≤ 1,10	±0,04
N	≤ 0,070	±0,01
Nb	≤ 0,10	±0,005
Ni	≤ 0,35	+0,05
	> 0,35 to ≤ 9,50	±0,07
Ti	≤ 0,07	+0,010
V	≤ 0,10	+0,01
	> 0,10 to ≤ 0,25	±0,03
W	≤ 2,00	±0,10

^a If several product analyses are carried out on one cast, and the contents of an individual element determined lie outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum value or to fall short of the permissible minimum value, but not both for one cast. The plus tolerance applies to the maximum values shown in Table 3 and the minus tolerance applies to minimum values shown in Table 3.

9.3 Mechanical properties

The mechanical properties of the finished product shall conform to the requirements given in Tables 5 to 9. For the impact properties in the weld (where applicable), the values of the relevant grade in the transverse direction shall apply.

Option 9: For the grades listed in Table 6, the proof strength at elevated temperature shall be verified. The test temperature shall be specified at the time of enquiry and order.

Table 5 — Mechanical properties – Tensile test at room temperature

Steel grade		Upper yield strength or proof strength R_{eH} or $R_{p0,2}$ min. for wall thicknesses T in mm				Tensile strength R_m for wall thicknesses T in mm				Elongation A min.		Yield ratio
Name	Number	MPa				MPa				%		$R_{t0,5}/R_m$ max.
		$T \leq 16$	$16 < T \leq 40$	$40 < T \leq 60$	$60 < T \leq 100$	$T \leq 16$	$16 < T \leq 60$	$60 < T \leq 100$		Longitudinal	Transverse	
P235TR2	1.0255	235	225	215	—	360-500	360-500	—		25	23	—
P265TR2	1.0259	265	255	245	—	410-570	410-570	—		21	19	—
P235GH	1.0345	235	225	215	—	360-500	360-500	—		25	23	—
P265GH	1.0425	265	255	245	—	410-570	410-570	—		23	21	—
16Mo3	1.5415	280	270	260	—	450-600	450-600	—		22	20	—
10CrMo5-5	1.7338	275	275	265	—	410-560	410-560	—		22	20	—
13CrMo4-5	1.7335	290	290	280	—	440-590	440-590	—		22	20	—
10CrMo9-10	1.7380	280	280	270	—	480-630	480-630	—		22	20	—
X11CrMo5+I	1.7362+I	175	175	175	175	430-580	430-580	430-580		22	20	—
X11CrMo5+NT1	1.7362+NT1	280	280	280	280	480-640	480-640	480-640		20	18	—
X11CrMo5+NT2	1.7362+NT2	390	390	390	390	570-740	570-740	570-740		18	16	—
X11CrMo9-1+I	1.7386+I	210	210	210	—	460-640	460-640	—		20	18	—
X11CrMo9-1+NT	1.7386+NT	390	390	390	—	590-740	590-740	—		18	16	—
X10CrMoVNb9-1	1.4903	450	450	450	450	630-830	630-830	630-830		19	17	—
X10CrWMoVNb9-2	1.4901	440	440	440	440	620-850	620-850	620-850		19	17	—
P355N	1.0562	355	345	325	305	490-650	490-630	450-590		22	20	—
P355NH	1.0565	355	345	325	305	490-650	490-630	450-590		22	20	—
P355NL1	1.0566	355	345	325	305	490-650	490-630	450-590		22	20	—

Steel grade		Upper yield strength or proof strength R_{eH} or $R_{p0,2}$ min. for wall thicknesses T in mm				Tensile strength R_m for wall thicknesses T in mm			Elongation A min.		Yield ratio
Name	Number	MPa			MPa	MPa		%	Longitudi- nal	Trans- verse	$R_{t0,5}/R_m$ max.
		$T \leq 16$	$16 < T \leq 40$	$40 < T \leq 60$		$T \leq 16$	$16 < T \leq 60$				
P215NL	1.0451	215 ^a	—	—	—	360-480 ^a	—	—	25	23	—
P265NL	1.0453	265	265 ^b	—	—	410-570	410-570	—	24	22	—
12Ni14	1.5637	345	345	—	—	440-590	440-620 ^f	—	22	20	—
X10Ni9	1.5682	510	510	—	—	690-840	690-840 ^f	—	20	18	—
L290NE	1.0484	290-440 ^c	290-440 ^{c,e}	—	—	415-655	415-655 ^e	—	23	21	0,85
L360NE	1.0582	360-510 ^c	360-510 ^{c,e}	—	—	460-760	460-760 ^e	—	22	20	0,85
L360QE	1.8948	360-510 ^c	360-510 ^{c,e}	—	—	460-760	460-760 ^e	—	22	20	0,88
L415NE	1.8972	415-565 ^c	415-565 ^{c,e}	—	—	520-760	520-760 ^e	—	20	18	0,85
L415QE	1.8947	415-565 ^c	415-565 ^{c,e}	—	—	520-760	520-760 ^e	—	20	18	0,88
L450QE	1.8952	450-570 ^c	450-570 ^{c,e}	—	—	535-760	535-760 ^e	—	20	18	0,90
L485QE	1.8955	485-605 ^c	485-605 ^{c,e}	—	—	570-760	570-760 ^e	—	20	18	0,90

^a For wall thicknesses equal to or smaller than 10 mm.

^b For wall thicknesses equal to or smaller than 25 mm.

^c These values are valid for yield strength $R_{t0,5}$.

^d For wall thicknesses equal to or smaller than 25 mm.

^e For wall thicknesses equal to or smaller than 25 mm. Strength values up to 40 mm are to be agreed.

^f For wall thicknesses equal to or smaller than 40 mm.

Table 6 — Minimum proof strength $R_{p0,2}$ at elevated temperature

Steel grade		Wall thickness T	Minimum proof strength $R_{p0,2}$ [MPa] at a temperature of ($^{\circ}\text{C}$)										
Steel name	Steel number	mm	100	150	200	250	300	350	400	450	500	550	600
P235GH	1.0345	≤ 60	198	187	170	150	132	120	112	108	—	—	—
P265GH	1.0425	≤ 60	226	213	192	171	154	141	134	128	—	—	—
16Mo3	1.5415	≤ 60	243	237	224	205	173	159	156	150	146	—	—
10CrMo5-5	1.7338	≤ 60	240	228	219	208	165	156	148	144	143	—	—
13CrMo4-5	1.7335	≤ 60	264	253	245	236	192	182	174	168	166	—	—
10CrMo9-10	1.7380	≤ 60	249	241	234	224	219	212	207	193	180	—	—
X11CrMo5+I	1.7362+I	≤ 100	156	150	148	147	145	142	137	129	116	—	—
X11CrMo5+NT1	1.7362+NT1	≤ 100	245	237	230	223	216	206	196	181	167	—	—
X11CrMo5+NT2	1.7362+NT2	≤ 100	366	350	334	332	309	299	289	280	265	—	—
X11CrMo9-1+I	1.7386+I	≤ 60	187	186	178	177	175	171	164	153	142	120	—
X11CrMo9-1+NT	1.7386+NT	≤ 60	363	348	334	330	326	322	316	311	290	235	—
X10CrMoVNb9-1	1.4903	≤ 100	410	395	380	370	360	350	340	320	300	270	215
X10CrWMoVNb9-2	1.4901	≤ 100	420	412	405	400	392	382	372	360	340	300	248
P355NH	1.0565	≤ 20	304	284	255	235	216	196	167	—	—	—	—
		> 20 to ≤ 50	294	275	255	235	216	196	167	—	—	—	—
		> 50 to ≤ 65	284	265	245	226	206	186	157	—	—	—	—
		> 65 to ≤ 80	275	255	235	216	196	177	147	—	—	—	—
		> 80 to ≤ 100	265	245	226	206	186	167	137	—	—	—	—

Table 7 — Minimum tensile strength values at elevated temperature for grade P355NH

Temperature °C	R_m [MPa] for wall thickness T in mm			
	$T \leq 30$	$30 < T \leq 50$	$50 < T \leq 80$	$80 < T \leq 100$
100	440	420	400	390
150	430	410	390	380
200	410	390	370	360
250	410	390	370	360
300	410	390	370	360
350	400	380	360	350
400	390	370	350	340

Table 8 — Impact properties

Steel grade		Wall thickness T	Probe direction referred to tube axis	Minimal average impact properties for standard specimen at temperature of (°C) K_V , in J											
Name	Number	mm		-196	-120	-110	-100	-90	-60	-50	-40	-20	-10	0	+20
P235TR2	1.0255	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	40	—
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	27	—
P265TR2	1.0259	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	40	—
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	27	—
P235GH	1.0345	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	40	—
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	27	—
P265GH	1.0425	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	40	—
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	27	—
16Mo3	1.5415	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
10CrMo5-5	1.7338	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
13CrMo4-5	1.7335	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
10CrMo9-10	1.7380	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
X11CrMo5	1.7362	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
X11CrMo9-1	1.7386	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27

Steel grade			Probe direction referred to tube axis	Minimal average impact properties for standard specimen at temperature of (°C) K_V , in J											
Name	Number	Wall thickness T mm		-196	-120	-110	-100	-90	-60	-50	-40	-20	-10	0	+20
X10CrMoVNb9-1	1.4903	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
X10CrWMoVNb9-2	1.4901	—	longitudinal direction	—	—	—	—	—	—	—	—	—	—	—	40
		—	transverse direction	—	—	—	—	—	—	—	—	—	—	—	27
P355N	1.0562	—	longitudinal direction	—	—	—	—	—	—	—	—	40	43	47	55
		—	transverse direction	—	—	—	—	—	—	—	—	27	31	35	39
P355NH	1.0565	—	longitudinal direction	—	—	—	—	—	—	—	—	40	43	47	55
		—	transverse direction	—	—	—	—	—	—	—	—	27	31	35	39
P355NL1	1.0566	—	longitudinal direction	—	—	—	—	—	—	—	40	53	60	65	70
		—	transverse direction	—	—	—	—	—	—	—	27	35	39	43	47
P215NL	1.0451	$T \leq 10$	longitudinal direction	—	—	—	—	—	—	—	40	45	—	—	55
		$T \leq 10$	transverse direction	—	—	—	—	—	—	—	—	—	—	—	—
P265NL	1.0453	$T \leq 25$	longitudinal direction	—	—	—	—	—	—	—	40	45	—	—	50
		$T \leq 25$	transverse direction	—	—	—	—	—	—	—	27	30	—	—	35
12Ni14	1.5637	$T \leq 25$	longitudinal direction	—	—	—	40	45	50	55	55	60	—	—	65
		$T \leq 25$	transverse direction	—	—	—	27	30	35	35	40	45	—	—	45
12Ni14	1.5637	$25 < T \leq 40$	longitudinal direction	—	—	—	—	40	45	50	50	55	—	—	65
		$25 < T \leq 40$	transverse direction	—	—	—	—	27	30	30	35	40	—	—	45
X10Ni9	1.5682	$T \leq 40$	longitudinal direction	40	50	50	60	60	70	70	70	70	—	—	70
		$T \leq 40$	transverse direction	27	35	35	40	40	50	50	50	50	—	—	50

Table 9 — Minimum requirements for the impact properties of pipeline transportation systems steels

Outside diameter <i>D</i> mm	Minimal average impact properties for standard specimen at 0° C <i>K_V</i> , in J ^a				
	L290NE	> L290NE ≤ L360NE (QE)	> L360NE (QE) ≤ L415NE (QE)	> L415NE (QE) ≤ L450QE	> L450QE ≤ L485QE
$D \leq 508$	40 (60)	40 (60)	40 (60)	40 (60)	40 (60)
$508 < D \leq 610$	40 (60)	40 (60)	40 (60)	40 (60)	41 (60)
$610 < D \leq 711$	40 (60)	40 (60)	40 (60)	40 (60)	45 (67)
$711 < D \leq 813$	40 (60)	40 (60)	40 (60)	40 (60)	48 (72)
$813 < D \leq 914$	40 (60)	40 (60)	40 (60)	40 (60)	51 (76)
$914 < D \leq 1\,016$	40 (60)	40 (60)	40 (60)	40 (60)	53 (79)
$1\,016 < D \leq 1\,118$	40 (60)	40 (60)	40 (60)	42 (63)	56 (84)
$1\,118 < D \leq 1\,219$	40 (60)	40 (60)	40 (60)	43 (64)	58 (87)
^a Values in transverse direction, in brackets in longitudinal direction.					

9.4 Creep rupture strength values

See Annex F.

9.5 Weldability

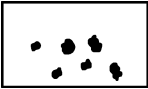
Fittings covered by this document are weldable; however, account should be taken of the fact that the behaviour of the steel during and after welding is dependent not only on the steel, but also essentially on the conditions of preparing and carrying out the welding.

10 Appearance and internal soundness (delivery conditions)

10.1 Definitions of surface imperfections

Surface imperfections and their definitions are given in Table 10.

Table 10 — Definitions of surface imperfections

Imperfection	Figure	Definition
Pit		A small surface void resulting from a localized loss of base material.
Cluster of pits		Two or more pits, the closest distance between each being less than the diameter of any one pit.
Dent		A large, smooth-bottomed depression whose diameter or width is greater than its depth and that will not produce an indication and thickness reduction.
Nick		A surface void anomaly caused by material removal or compression from the surface, whose bottom surface is usually irregular.
Crack		Fracture-type discontinuities characterized by a sharp tip and high ratio of length and width to opening displacement.
Surface inclusion		Particles of foreign material in a metallic matrix. The particles are usually compounds such as oxides, sulfides, or silicates, but may be a substance foreign to and essentially insoluble in the matrix.
Surface residual		A foreign substance that adheres to a surface by chemical reaction, adhesion, adsorption, or ionic bonding (e.g., corrosion, rouging, and staining).
Slag		A concentration of non-metallic impurities (often oxides or nitrides) that forms in the weld pool and solidifies on the underbead or weld top surface. Sometimes referred to as "dross."
Porosity		Cavity-type discontinuities formed by gas entrapment during solidification, defined as pits if it is in surface.
Cluster porosity		Porosity that occurs in clumps or clusters, defined as cluster pits if it is in surface.
Score marks		Score marks are scratches etc. Avoid by the mechanical action.

10.2 Appearance

- a) The fittings shall be free from external and internal surface defects that can be detected by visual testing.
- b) The finish of the internal and external surface of the fittings shall be typical of the manufacturing process and, where applicable, the heat treatment employed. The finish and surface condition shall be such, that any surface imperfections requiring dressing shall be identified.
- c) It shall be permissible to dress only, by grinding or machining, surface imperfections provided that, after doing so, the wall thickness of the fitting in the dressed area is not less than the specified minimum wall thickness.
- d) All dressed areas shall blend smoothly into the contour of the fitting.
- e) Surface imperfection with a depth equal to or less than 0,3 mm are acceptable. Any surface imperfection, which is demonstrated to be deeper than 5 % of the wall thickness T or deeper than 3 mm, whichever is the smaller, shall be dressed. This requirement does not apply to surface imperfection with a depth equal to or less than 0,3 mm. Score marks (linear mechanical scratches) shall not have a depth greater than 1,6 mm or 12,5 % of the nominal wall thickness, whichever is the smaller, provided that the bottom of the marks are rounded and not sharp. Sharp bottom scores shall be considered as defects.
- f) Surface imperfections which encroach on the specified minimum wall thickness shall be considered defects and fittings containing these shall be deemed not to conform to this part of EN 10253.
- g) If surface imperfections acceptable under e) are not scattered and appear over a large area in excess of what is considered to be an acceptable surface condition then fittings shall be rejected or alternatively subjected to dressing as agreed between purchaser and manufacturer.
- h) Repairs to fittings shall only be carried out by grinding or machining, welding is not acceptable except of the weld seam as described in 8.2.2.1. Hammering is not permitted.
- i) Localized or generalised scale up to 0,8 mm thick is permissible provided the scale is tightly adherent to the fitting and does not readily flake off.

10.3 Internal soundness

The weld area shall be free from cracks, lack of fusion and lack of penetration.

11 Dimensions and tolerances

11.1 Dimensions

11.1.1 General

For reducers and tees it is not mandatory that the produced pieces correspond to the exact representation in the figures. Only the dimensions given in the relevant tables shall be respected.

Other shapes of reducers and tees exist on the market. They do not fulfil the appropriate calculation procedures of this standard. Therefore the user himself is responsible for calculation, design and application.

Other specific dimensions than those listed in Annex A and D may be agreed upon.

11.1.2 Elbows

Elbows shall be produced according to Figures 1, 2 and 3 (45°, 90°, 180°). Specific dimensions are listed in Table A.1.

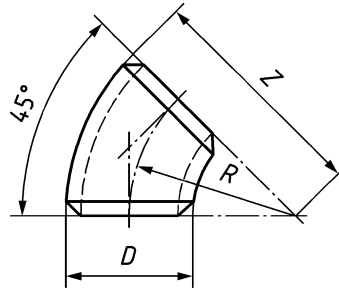


Figure 1 — 45° elbow

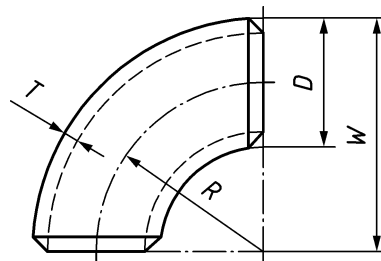


Figure 2 — 90° elbow

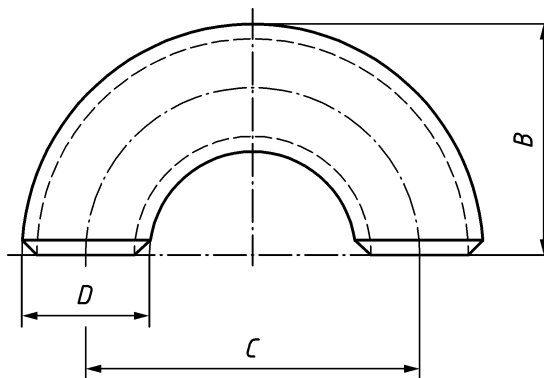


Figure 3 — 180° elbow (return bend)

The values given for W and Z in addition to those for R have been calculated from the values of R and shall be used to verify conformance of the elbow because measurement of R is not possible in practice.

11.1.3 Tees

Equal tees are produced in accordance with Figure 4, reducing tees in accordance with Figure 5. Specific dimensions are listed in Table A.2.

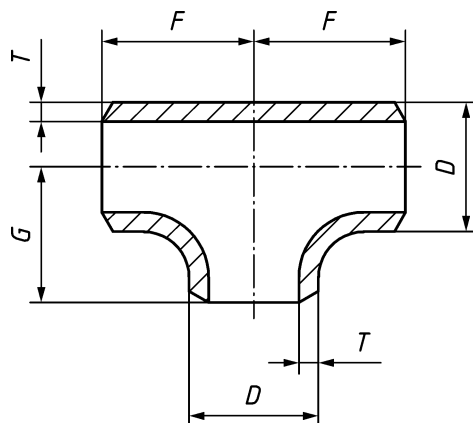


Figure 4 — Equal tee

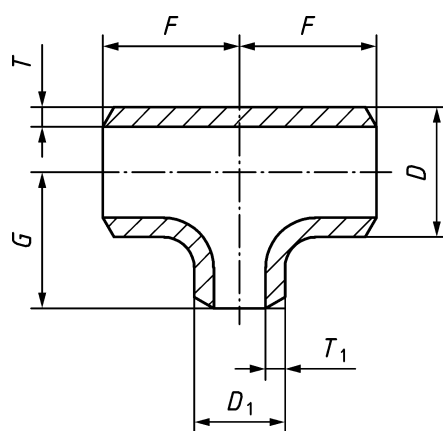


Figure 5 — Reducing tee

11.1.4 Reducers

Concentric (con) and eccentric (ecc) reducers are produced in accordance respectively with Figures 6 and 7. Specific dimensions are listed in Table A.3.

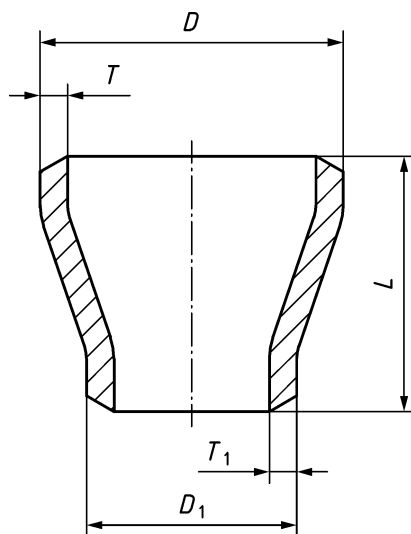


Figure 6 — Concentric (con) reducer

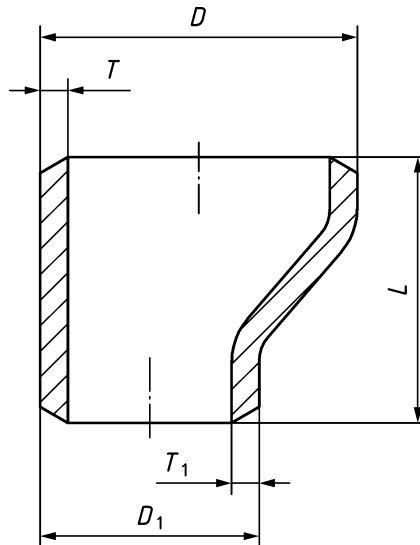
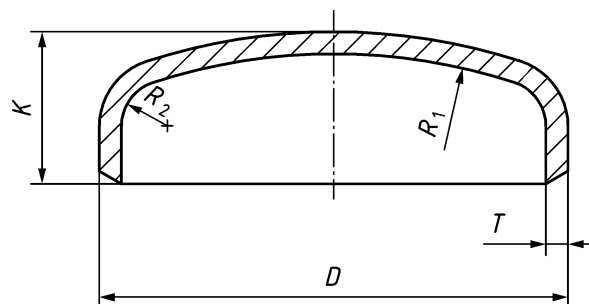


Figure 7 — Eccentric (ecc) reducer

11.1.5 Caps

Caps are produced in accordance with Figure 8. Specific dimensions are listed in Table A.4.



Key

R_1 approximately equal to $0,8 \times D$

R_2 approximately equal to $0,15 \times D$

Figure 8 — Cap

NOTE Some of the listed dimensions don't comply with all technical regulations, e.g. according to EN 13480-3:2017. Nevertheless they are standard on the market. In these cases, it is essential that the dimensions are to be agreed.

11.1.6 Preferred diameters and wall thicknesses

Preferred diameters and wall thicknesses have been selected to match with tube dimensions described in EN 10220:2002 and are listed in Table 11.

Dimensions which are different from those in Table 11 may be agreed.

Table 11 — Preferred diameter and wall thicknesses

Outside Diameter <i>D</i>			Wall thickness series							
Series ^a			1	2	3	4	5	6	7	8
1	2	3	1	2	3	4	5	6	7	8
21,3			—	2,0	2,6	3,2	4,0	—	5,0	7,1
	25,0		—	2,0	2,3	—	—	—	—	—
26,9			—	2,3	2,6	3,2	4,0	4,5	5,6	8,0
	31,8		—	2,6	—	—	—	—	—	—
33,7			—	2,6	3,2	4,0	4,5	5,6	6,3	8,8
	38,0		—	2,6	—	—	—	—	—	—
42,4			—	2,6	3,6	4,0	5,0	6,3	8,0	10,0
48,3			—	2,6	3,6	4,0	5,0	6,3	8,0	10,0
	51,0		—	2,6	—	—	—	—	—	—
	57,0		—	2,9	—	—	—	—	—	—
60,3			—	2,9	3,6	4,0	5,6	7,1	8,8	11,0
	63,5		—	2,9	—	—	—	—	—	—
	70,0		—	2,9	—	—	—	—	—	—
76,1			—	2,9	3,6	5,6	7,1	8,0	10,0	14,2
		82,5	—	3,2	—	—	—	—	—	—
88,9			—	3,2	4,0	5,6	8,0	8,8	11,0	16,0
	101,6		—	3,6	4,0	5,6	8,0	—	—	—
		108,0	—	3,6	—	—	—	—	—	—
114,3			—	3,6	4,5	6,3	8,8	11,0	14,2	17,5
	127,0		—	4,0	—	—	—	—	—	—
	133,0		—	4,0	—	—	—	—	—	—
139,7			—	4,0	5,0	6,3	10,0	12,5	16,0	20,0
		152,4	—	4,5	—	—	—	—	—	—
		159,0	—	4,5	—	—	—	—	—	—
168,3			4,0	4,5	5,6	7,1	11,0	14,2	17,5	22,2
		177,8	—	5,0	—	—	—	—	—	—
		193,7	—	5,6	6,3	7,1	—	—	—	—
219,1			4,5	6,3	7,1	8,0	12,5	16,0	17,5	22,2
		244,5	—	6,3	—	—	—	—	—	—
273,0			5,0	6,3	8,8	10,0	12,5	16,0	22,2	30,0
323,9			5,6	7,1	8,8	10,0	12,5	17,5	25,0	32,0
355,6			5,6	8,0	10,0	12,5	16,0	20,0	28,0	36,0
406,4			6,3	8,8	10,0	12,5	17,5	22,2	30,0	40,0
457,0			6,3	10,0	11,0	12,5	17,5	22,2	32,0	45,0

Outside Diameter <i>D</i> Series ^a			Wall thickness series							
1	2	3	1	2	3	4	5	6	7	8
508,0			6,3	10,0	11,0	12,5	17,5	25,0	36,0	50,0
		559,0	6,3	10,0	—	12,5	20,0	28,0	—	—
610,0			6,3	10,0	12,5	17,5	25,0	30,0	45,0	60,0
		660,0	—	10,0	12,5	17,5	—	—	—	—
711,0			7,1	10,0	12,5	25,0	—	—	—	—
		762,0	—	10,0	12,5	25,0	—	—	—	—
813,0			8,0	10,0	12,5	25,0	—	—	—	—
		864,0	—	10,0	12,5	25,0	—	—	—	—
914,0			10,0	12,5	20,0	25,0	—	—	—	—
1016,0			10,0	12,5	20,0	25,0	—	—	—	—
		1067,0	10,0	12,5	20,0	25,0	—	—	—	—
		1118,0	10,0	12,5	20,0	25,0	—	—	—	—
		1168,0	10,0	12,5	20,0	25,0	—	—	—	—
1219,0			10,0	12,5	20,0	25,0	—	—	—	—

^a Series 1: Diameter for which all the accessories needed for the construction of piping system are standardised.
Series 2: Diameter for which not all the accessories are standardised.
Series 3: Diameter for special application for which very few standardised accessories exist.

11.2 Dimensional tolerances

11.2.1 Diameter

11.2.1.1 The relevant outside diameters ($D-D1$) shall be measured at the welding ends of the fittings. The tolerance is as follows:

$\pm 1\%$ or $\pm 0,5$ mm, whichever is the greater, but maximum ± 5 mm

Option 10: *The tolerance on diameter shall apply to the inside diameter instead to the outside diameter.*

11.2.1.2 In order to guarantee the regular flow of the fluid through the fitting, the inside diameter in any section of the fitting (not applicable to caps) shall be above 80 % (for tees 70 %) of the inside diameter ID at the welding ends.

Option 11: *Special tolerances may be agreed.*

11.2.2 Out of roundness

The tolerances for out of roundness are:

— At the welding ends:

- $D \leq 273,0$ included in the diameter tolerance;
- $273,0 < D \leq 610$ $\leq 2\%$;
- $D > 610$ 1% ;