



BSI Standards Publication

Butt-welding pipe fittings

Part 4: Wrought austenitic and austenitic-ferritic (duplex)
stainless steels with specific inspection requirements

National foreword

This British Standard is the UK implementation of EN 10253-4:2025. It supersedes BS EN 10253-4:2008, which is withdrawn.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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Raccords à souder bout à bout - Partie 4 : Aciers inoxydables austénitiques et austéno-ferritiques (duplex) avec contrôle spécifique

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European foreword

This document (EN 10253-4:2025) has been prepared by Technical Committee CEN/TC 459 “ECISS - European Committee for Iron and Steel Standardization¹”, 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of an identical text or by endorsement, at the latest by January 2026 and conflicting national standards shall be withdrawn at the latest by January 2026.

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 10253-4:2008.

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

- a) Concretization of the scope;
- b) Restructuring of EN 10253-2 and EN 10253-4 and ensuring they align with each other;
- c) Update of technical requirements and dimensions to reflect current market standards;
- d) Correction of identical construction dimensions within the EN 10253 series;
- e) Introduction of additional wall thickness and diameter values;
- f) Introduction of test concept TC2 analogous to pipe standards;
- g) Rewording of some options and new numbering;
- h) Modification of test lot sizes;
- i) Update of contents for ultrasonic testing;
- j) Update to the contents of welding chapters;
- k) Revision of figures;
- l) Update of the terms and definitions;
- m) Update of normative references;
- n) Editorial revision to follow the latest design rules;
- o) Revision of mechanical properties;
- p) Update of metric elbows dimensions table.

¹ Through its sub-committee SC 10 “Steel tubes, and iron and steel fittings”, (secretariat: UNI).

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, 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 organizations 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, Türkiye and the United Kingdom.

Introduction

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

EN 10253-3 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) in categories I to IV.

EN 10253-4 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 the 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 parts. It is the ultimate responsibility of the user to select the appropriate part 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 austenitic and austenitic-ferritic (duplex) stainless 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;
 - 1) type A: butt-welding fittings with reduced pressure factor;
 - 2) 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 10028-7:2016, *Flat products made of steels for pressure purposes — Part 7: Stainless steels*

EN 10088-1:2023, *Stainless steels — Part 1: List of stainless steels*

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 10216-5:2021, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 5: Stainless steel tubes*
- EN 10217-7:2021, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 7: Stainless steel tubes*
- EN 10222-5:2017, *Steel forgings for pressure purposes — Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels*
- EN 10228-4:2016, *Non-destructive testing of steel forgings — Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings*
- EN 10266:2003, *Steel tubes, fittings and structural hollow sections — Symbols and definitions of terms for use in product standards*
- EN 10272:2016, *Stainless steel bars for pressure purposes*
- EN 13480-3:2024, *Metallic industrial piping — Part 3: Design and calculation*
- 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 2566-2:2021, *Steel — Conversion of elongation values — Part 2: Austenitic steels (ISO 2566-2:2021, Corrected version 2022-05)*
- 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 3651-2:1998, *Determination of resistance to intergranular corrosion of stainless steels — Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid (ISO 3651-2:1998)*
- EN ISO 4136:2022, *Destructive tests on welds in metallic materials — Transverse tensile test (ISO 4136:2022)*
- EN ISO 4885:2018, *Ferrous materials — Heat treatments — Vocabulary (ISO 4885:2018)*
- EN ISO 5173:2023, *Destructive tests on welds in metallic materials — Bend tests (ISO 5173:2023)*
- EN ISO 5817:2023, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2023)*
- 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 8492:2013, *Metallic materials — Tube — Flattening test (ISO 8492:2013)*

EN ISO 8493:2004, *Metallic materials — Tube — Drift-expanding test (ISO 8493:1998)*

EN ISO 8495:2013, *Metallic materials — Tube — Ring-expanding test (ISO 8495:2013)*

EN ISO 8496:2013, *Metallic materials — Tube — Ring tensile test (ISO 8496:2013)*

EN ISO 9016:2022, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination (ISO 9016:2022)*

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 9712:2022, *Non-destructive testing — Qualification and certification of NDT personnel (ISO 9712:2021)*

EN ISO 10893-2:2011,² *Non-destructive testing of steel tubes — Part 2: Automated eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections (ISO 10893-2:2011)*

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 10893-6:2019, *Non-destructive testing of steel tubes — Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections (ISO 10893-6:2019)*

EN ISO 10893-7:2019, *Non-destructive testing of steel tubes — Part 7: Digital radiographic testing of the weld seam of welded steel tubes for the detection of imperfections (ISO 10893-7:2019)*

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 14284:2022, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284:2022)*

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)*

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)*

² As impacted by EN ISO 10893-2:2011/A1:2020.

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

⁴ As impacted by EN ISO 10893-10:2011/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 terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp/>
- IEC Electropedia: available at <http://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, reducers and tees

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 or concentric straight or eccentric straight shape of the piece.

Note 3 to entry: For caps the model defines the shape of the piece.

Note 4 to entry: For tees the model defines tee, pulled tee, branch welded tee (v-welded) and branch welded tee (circumferential welded) shape of piece.

3.3

purchaser

person or organization that orders products in accordance with this document

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 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 given in EN 10266:2003 and the following apply.

A	Percentage of elongation after 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 outside diameter in one section, expressed in millimetres
$D_{\min}$	Minimum outside 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 Distance from the centre of one face to the centre of bending of 90° elbow
G	Distance from the axis of the centre line to the face of the branch outlet expressed in millimetres
h	Distance from the face of the branch outlet to the body of the pulled tee, 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_m	Tensile strength, expressed in megapascals
$R_{p0,2}$	Minimum 0,2 % proof strength, plastic extension expressed in megapascals
$R_{p1,0}$	Minimum 1,0 % proof strength, plastic 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
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 10088-1:2023, the steel grades covered in this document are classified according to their structure into:

- austenitic steels;
- austenitic–ferritic (duplex) steels.

For more details, see EN 10088-1:2023.

5.2 Designation of steel grades

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

- number of this document (EN 10253-4:2024);

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 5D, D+100, 3DM or 5DM);
- 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) or concentric straight (con str) or eccentric straight (ecc str));
- 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).

For straight reducers the embodiment shall be noticed.

5.3.4 Tees

Equal and reducing tees are designed by the following parameters:

- a) model (tee, pulled tee, branch welded tee (v-welded), or branch welded tee (circumferential welded));
- b) type (type A or type B);
- c) major diameter (D) and minor diameter (D_1);
- d) 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.

For pulled tees and branch welded tees the embodiment shall be noticed.

5.3.5 Caps and dished ends

Caps and dished ends are designated by the following parameters:

- a) model cap (cap) or dished end (end);
- b) type (type A or type B);
- c) outside diameter (D);
- d) wall-thickness (T).

6 Information to be supplied

6.1 Mandatory information

The following information shall be supplied 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) (see 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 no option has been specified at the time of enquiry and order, the fittings shall be supplied in accordance with the basic specification (see 6.1).

- 1) Method of manufacture of the fitting (see 8.2.1);
- 2) starting product form and/or delivery condition (see 8.2.1);

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

- 3) reporting of method of manufacture (see 8.2.1);
- 4) starting materials when manufacturing seamless fittings (see 8.2.1);
- 5) deviations from finished weld requirement (see 8.2.2.3);
- 6) heat treatment to be applied (see 8.2.3.1);
- 7) other steel grades in accordance with harmonized material standards (see 9.1);
- 8) product analysis (see 9.2.2 and Table 10);
- 9) verification of impact properties at room temperature (see 9.3.1 and Table 10);
- 10) agreed mechanical properties for wall thicknesses (see 9.3.1 and Table 10);
- 11) verification of tensile properties at elevated temperature (see 9.3.2 and Table 10);
- 12) verification of impact properties at low temperature (see 9.3.3 and Table 10);
- 13) intergranular corrosion test (see 9.5 and Table 10);
- 14) pickling (see 10.2);
- 15) shot blasting or bright annealing (see 10.2);
- 16) pickling and passivation (see 10.2);
- 17) tolerance on diameter to inside (see 11.2.1.1);
- 18) special tolerances (see 11.2.1.2);
- 19) plus tolerances on the body of the fitting (see 11.2.3);
- 20) special ends preparation (see 11.3);
- 21) type of inspection document other than the standard document (see 12.2.1);
- 22) tensile test transverse to the weld at room temperature (see Table 10 and 14.3);
- 23) bend test transverse to the weld (see Table 10 and 14.5);
- 24) impact test of the heat affected zone (see Table 10 and 14.6.1);
- 25) liquid penetrant testing of weld and weld ends (see Table 10 and 14.9.2);
- 26) liquid penetrant testing of surfaces (see Table 10 and 14.9.2);
- 27) NDT for the detection of laminar imperfections (see Table 10 and 14.9.4);
- 28) NDT of bars and forgings (see Table 10 and 14.9.7);
- 29) positive material identification (PMI) (see Table 10 and 14.10);
- 30) registration records of the temperatures (see 13.1.1);

- 31) test unit size – Table 13 (see 13.1.1);
- 32) test unit size – purchase order (see 13.1.1);
- 33) verification of impact properties transverse to the weld (see 13.2.6);
- 34) additional marking (see Clause 15);
- 35) special packaging (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 of 114,3 mm and a wall thickness of 3,2 mm, made of steel grade 1.4436 and test category TC1.

1000 elbows — EN 10253-4 — type A — model 3D — 90° — 114,3 × 3,2 — 1.4436 — TC1

6.3.2 Example 2

500 tees in accordance with this document of type B, having an outside diameter of 114,3 mm with a wall thickness of 6,3 mm, a branch outside diameter of 88,9 mm with a branch wall thickness of 4,0 mm, made of steel grade X2CrNi19-11 and test category TC2.

500 tees — EN 10253-4 — type B — 114,3 × 6,3 — 88,9 × 4,0 — X2CrNi19-11 — TC2

6.3.3 Example 3

100 concentric (con) reducers in accordance with this document of type B, having an outside diameter of 168,3 mm with a wall thickness of 7,1 mm and a reduced outside diameter of 114,3 mm with a wall thickness of 6,3 mm, made of steel grade 1.4301 and test category TC1.

100 reducers con — EN 10253-4 — type B — 168,3 × 7,1 — 114,3 × 6,3 — 1.4301 — TC1

6.3.4 Example 4

100 eccentric (ecc) seamless (s) reducers in accordance with this document of type A, having an outside diameter of 168,3 mm with a wall thickness of 7,1 mm and a reduced outside diameter of 114,3 mm with a wall thickness of 6,3 mm, made of steel grade 1.4301 and test category TC1.

**100 reducers ecc — EN 10253-4 — type A — 168,3 × 7,1 — 114,3 × 6,3 — 1.4301 — TC1—
Option 2: seamless (s)**

6.3.5 Example 5

20 caps (model cap) in accordance with this document of type A, having an outside diameter of 273,0 mm with a wall thickness of 4 mm and made of steel grade 1.4301.

20 caps cap — EN 10253-4 — type A — 273,0 × 4,0 — 1.4301

6.3.6 Example 6

500 tees in accordance with this document of type A, having an outside diameter of 114,3 mm with a wall thickness of 3,6 mm, a branch outside diameter of 88,9 mm with a branch wall thickness of 3,2 mm, made of steel grade 1.4571 with option 11 (tensile test at elevated temperature of 350 °C), option 20 (bevel according EN 10253-4) and option 29 (PMI-Test).

500 tees — EN 10253-4 — type A — 114,3 × 3,6 — 88,9 × 3,2 — 1.4571 — opt<11:350°C/20/29>

6.3.7 Example 7

1 000 elbows in accordance with this document of metric elbows (Table A.2), with an angle 90° having an outside diameter of subject to an agreement in consideration of the range of dimensions given in Table A.2 model 3DM, thickness 3,2 mm, made of steel grade 1.4436 and test category TC1.

**1000 elbows — EN 10253-4 — type A — model 3DM — R XX — 90° — 114,3 × 3,2 —
1.4436 — TC1**

7 Resistance to internal pressure

7.1 General

The European Legislation for Pressure Equipment imposes that the design for adequate strength 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 13480-3:2024.

For some fittings (elbows METRIC, pulled tees ISO/METRIC, branch welded tees ISO/METRIC, concentric and eccentric reducers straight ISO/METRIC and dished ends ISO/METRIC) there is no determination of pressure factors and wall-thickness available. These fittings are of type A.

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.

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 10217-7:2021 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 8.2.2.2.4.

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

- only plate/strip according to EN 10028-7:2016 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 10272:2016 and EN 10222-5:2017 shall be used.

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

Process	Hot deformation			Cold deformation		Machining from round bars ($DN \leq 50$) ^c
	Bending ^a	Pressed in die ^b	Rolled, forged followed by machining	Bending	Pressed in die ^b	
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	3 ^d	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.						
^d Applicable for straight reducers only.						

Option 1: *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 2: *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 3: *The method of manufacture shall be reported.*

Option 4: *When manufacturing seamless fittings, starting materials according to EN 10216-5:2021, EN 10028-7:2016, EN 10222-5:2017 or EN 10272:2016 shall be used.*

8.2.2 Welding

8.2.2.1 General

When fittings are produced from welded pipes, the requirements in EN 10217-7:2021 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

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

- a) welding process/procedures shall be qualified in accordance with EN ISO 15614-1:2017;
- b) 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 routes of EN ISO 9606-1:2017, 9.3 c) and of EN ISO 14732:2013, 5.3 c) shall not be applied.

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

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

8.2.2.2.4 Local repair of weld seam which have been made with or without 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.

8.2.2.2.5 All joints welded with filler metal shall be finished in accordance with the requirements in 8.2.2.1 and 8.2.2.2.

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 13480-3:2024) 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 welding shall be performed in order to meet the requirements of quality level C according to EN ISO 5817:2023.

Option 5: *Other quality levels shall be agreed between customer and purchaser.*

8.2.2.4 Post weld heat treatment (PWHT)

Heat treatment after welding is not necessary unless specified by the customer.

8.2.3 Heat treatment condition

8.2.3.1 Cold forming

Fittings, produced from solution annealed and quenched or stabilised annealed materials using cold forming as manufacturing method, do not require heat treatment afterwards, if in the case of austenitic steels with required minimum values for elongation $A > 30\%$, a 15 % level of cold deformation is not exceeded on the base material or if evidence is supplied that there is a minimum post-cold-forming residual elongation A of 15 %. In any case, the post-cold-forming residual elongation shall be at least 14 %. In all other cases material shall be solution annealed after forming operations.

If heat treatment still will be demanded, this shall be agreed at the time of enquiry and order.

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

8.2.3.2 Hot forming

Fittings shall be solution annealed after forming operations.

9 Technical requirements

9.1 General

Fittings supplied and inspected in accordance with Clause 8, Clause 11 and Clause 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 starting material of the seamless fittings are left at the discretion of the manufacturer provided the requirements defined in Clause 8 and Clause 9 are fulfilled unless option 4 is specified.

Option 7: *Other steel grades in accordance with harmonized material standards can be agreed in the purchase order. Table 10 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.*

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 2 for austenitic steels and of Table 3 for austenitic-ferritic steels.

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 2 and Table 3.

Table 2 — Chemical composition (cast analysis) of austenitic stainless steels, in % by mass

Steel grade	Steel name	Steel number	C max. ^b	Si max.	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
X2CrNi18-9		1.4307	0,030	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	17,5-19,5	—	—	—	8,0-10,5	—	—
X2CrNi19-11		1.4306	0,030	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	18,0-20,0	—	—	—	10,0-12,0	—	—
X2CrNi18-10		1.4311	0,030	1,00	2,00	0,045 ^a	0,015 ^a	0,12-0,22	17,0-19,5	—	—	—	8,5-11,5	—	—
X5CrNi18-10		1.4301	0,07	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	17,0-19,5	—	—	—	8,0-10,5	—	—
X6CrNiTi18-10		1.4541	0,08	1,00	2,00	0,045 ^a	0,015 ^a	—	17,0-19,0	—	—	—	9,0-12,0	5×C-0,70	—
X6CrNiNb18-10		1.4550	0,08	1,00	2,00	0,045 ^a	0,015 ^a	—	17,0-19,0	—	—	10×C-1,00	9,0-12,0	—	—
X1CrNi25-21		1.4335	0,020	0,25	2,00	0,025	0,010	≤ 0,10	24,0-26,0	—	≤ 0,20	—	20,0-22,0	—	—
X2CrNiMo17-12-2		1.4404	0,030	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	16,5-18,5	—	2,00-2,50	—	10,0-13,0	—	—
X5CrNiMo17-12-2		1.4401	0,07	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	16,5-18,5	—	2,00-2,50	—	10,0-13,0	—	—
X6CrNiMoTi17-12-2		1.4571	0,08	1,00	2,00	0,045 ^a	0,015 ^a	—	16,5-18,5	—	2,00-2,50	—	10,5-13,5	5×C-0,70	—
X2CrNiMo17-12-3		1.4432	0,030	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,11	16,5-18,5	—	2,50-3,0	—	10,5-13,0	—	—
X2CrNiMoN17-13-3		1.4429	0,030	1,00	2,00	0,045 ^a	0,015 ^a	0,12-0,22	16,5-18,5	—	2,50-3,0	—	11,0-14,0	—	—
X3CrNiMo17-13-3		1.4436	0,05	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	16,5-18,5	—	2,50-3,0	—	10,5-13,0	—	—
X2CrNiMo18-14-3		1.4435	0,030	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	17,0-19,0	—	2,50-3,0	—	12,5-15,0	—	—
X2CrNiMoN17-13-5		1.4439	0,030	1,00	2,00	0,045 ^a	0,015 ^a	0,12-0,22	16,5-18,5	—	4,0-5,0	—	12,5-14,5	—	—
X2CrNiMo18-15-4		1.4438	0,030	1,00	2,00	0,045 ^a	0,015 ^a	≤ 0,10	17,5-19,5	—	3,0-4,0	—	13,0-16,0	—	—
X1NiCrMoCu31-27-4		1.4563	0,020	0,70	2,00	0,030	0,010	≤ 0,10	26,0-28,0	0,70-1,50	3,0-4,0	—	30,0-32,0	—	—
X1NiCrMoCu25-20-5		1.4539	0,020	0,70	2,00	0,030	0,010	≤ 0,15	19,0-21,0	1,20-2,00	4,0-5,0	—	24,0-26,0	—	—
X1CrNiMoCuN20-18-7		1.4547	0,020	0,70	1,00	0,030	0,010	0,18-0,25	19,5-20,5	0,50-1,00	6,0-7,0	—	17,5-18,5	—	—
X1NiCrMoCuN25-20-7		1.4529	0,020	0,50	1,00	0,030	0,010	0,15-0,25	19,0-21,0	0,50-1,50	6,0-7,0	—	24,0-26,0	—	—

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 fittings welded without filler material the sum of sulphur and phosphorus shall be maximum 0,040 %.

^b If the manufacturer's starting material is plate or strip, then carbon content can be limited to two decimal places, see EN 10028-7:2016.

Table 3 — Chemical composition (cast analysis) of austenitic-ferritic stainless steels, in % by mass

Steel grade		C	Si	Mn	P	S	N	Cr	Cu	Mo	Ni	Others
Steel name	Steel number	max.	max.	max.	max.	max.						
X2CrNiMoN22-5-3	1.4462	0,030	1,00	2,00	0,035	0,015	0,10-0,22	21,0-23,0	—	2,50-3,5	4,5-6,5	—
X2CrNiN23-4	1.4362	0,030	1,00	2,00	0,035	0,015	0,05-0,20	22,0-24,0	0,10-0,60	0,10-0,60	3,5-5,5	—
X2CrNiMoN25-7-4 ^a	1.4410 ^a	0,030	1,00	2,00	0,035	0,015	0,20-0,35	24,0-26,0	—	3,0-4,5	6,0-8,0	—
X2CrNiMoCuWN25-7-4	1.4501	0,030	1,00	1,00	0,035	0,015	0,20-0,30	24,0-26,0	0,50-1,00	3,0-4,0	6,0-8,0	W: 0,50-1,00
X2CrNiMoCuN25-6-3	1.4507	0,030	0,70	2,00	0,035	0,015	0,15-0,30	24,0-26,0	1,00-2,50	2,7-4,0	5,5-8,0	—
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 Patented steel grade.												

Table 4 — Permissible deviations of the product analysis from specified limits on cast analysis given in Table 2 and Table 3

Element	Limiting value for the cast analysis in accordance with Table 2 and Table 3 % by mass	Permissible deviation of the product analysis ^a % by mass
C	$\leq 0,030$	+0,005
	$> 0,030 \leq 0,08$	+0,01
Si	$\leq 1,00$	+0,05
Mn	$\leq 1,00$	+0,03
	$> 1,00 \leq 2,00$	+0,04
P	$\leq 0,030$	+0,003
	$> 0,030$ to $\leq 0,045$	+0,005
S	$\leq 0,015$	+0,003
N	$\leq 0,35$	$\pm 0,01$
Cr	$> 16,50 \leq 20,00$	$\pm 0,20$
	$> 20,00 \leq 28,00$	$\pm 0,25$
Cu	$\leq 1,00$	$\pm 0,07$
	$> 1,00 \leq 2,50$	$\pm 0,10$
Mo	$\leq 0,60$	$\pm 0,03$
	$> 0,60 \leq 1,75$	$\pm 0,05$
	$> 1,75 \leq 7,00$	$\pm 0,10$
Nb	$\leq 1,00$	$\pm 0,05$
Ni	$\leq 1,00$	$\pm 0,03$
	$> 1,00 \leq 5,00$	$\pm 0,07$
	$> 5,00 \leq 10,00$	$\pm 0,10$
	$> 10,00 \leq 20,00$	$\pm 0,15$
	$> 20,00 \leq 32,00$	$\pm 0,20$
Ti	$\leq 0,70$	$\pm 0,05$
W	$\leq 1,00$	$\pm 0,05$
The plus tolerance applies to the maximum values shown in Table 2 and Table 3. The minus tolerance applies to minimum values shown in Table 2 and Table 3.		
^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.		

9.3 Mechanical properties

9.3.1 At room temperature

The mechanical properties at room temperature of the fittings of this document shall conform to the requirements given in Table 5 and Table 6.

Option 9: *Impact properties shall be verified at room temperature (see Table 5 and Table 6). For fittings manufactured from welded tubes the location of the test pieces, from the weld or opposite to the weld, shall be agreed at the time of enquiry and order.*

Option 10: *Mechanical properties from Table 5 shall apply for wall thicknesses greater than 60 mm.*

9.3.2 At elevated temperature

The minimum proof strength $R_{p0,2}$ and $R_{p1,0}$ values at elevated temperature are specified in the relevant standard for the starting material dependent on the delivery form being used.

Option 11: *Proof strength $R_{p0,2}$ or $R_{p1,0}$ shall be verified at elevated temperature for austenitic steels. Proof strength $R_{p0,2}$ shall be verified at elevated temperature for austenitic-ferritic steels. The temperature for tensile testing shall be agreed at the time of enquiry and order.*

9.3.3 At low temperature

Impact energy values at specified low temperature shall conform to the requirements in Table 5 and Table 6.

Option 12: *Impact properties shall be verified at low temperature (see Table 5 and Table 6). For fittings manufactured from welded tubes the location of the test pieces, from the weld or opposite to the weld, shall be agreed at the time of enquiry and order.*

Table 5 — Mechanical properties for wall thicknesses up to 60 mm at room temperature and impact properties at room temperature and at –196 °C of austenitic stainless steels in the solution annealed condition (+AT)^b, heat treatment and information about resistance to intergranular corrosion

Steel grade		Hardness ^h		Tensile properties at room temperature ^a				Impact properties ^a			Reference heat treatment conditions		Resistance to intergranular corrosion		Limit temp.	
				Proof strength		Tensile strength ^b		Elongation		Minimum average absorbed energy						
Steel name	Steel number	HB	max.	Rp0,2	Rp1,0	Rm	A	at RT		KV	Solution temperature ^c	Cooling in ^d	e	Method of EN ISO 3651-2: 1998	°C ^g	
				MPa	min.	min.	%	min.	min.	at −196 °C						J
								l	t							
X2CrNi18-9	1.4307	215		180 ⁱ	215 ⁱ	460 to 700	40	35	100	60	60	1 000 to 1 100	w, a, o	yes	A	350
X2CrNi19-11	1.4306	215		180	215	460 to 700	40	35	100	60	60	1 000 to 1 100	w, a, o	yes	A	350
X2CrNiN18-10	1.4311	230		270	305	550 to 760	35	30	100	60	60	1 000 to 1 100	w, a, o	yes	A	400
X5CrNi18-10	1.4301	215		195 ⁱ	230 ⁱ	500 to 750	40	35	100	60	60	1 000 to 1 100	w, a, o	yes ^f	A	300
X6CrNiTi18-10	1.4541	215		180	215	460 to 730	35	30	100	60	60	1 020 to 1 120	w, a, o	yes	A	400
X6CrNiNb18-10	1.4550	230		205 ^j	240	510 to 740 ^j	35	30	100	60	40	1 020 to 1 120	w, a, o	yes	A	400
X1CrNi25-21	1.4335	200		180	210	470 to 670	35	30	100	60	60	1 030 to 1 110	w, a, o	yes	A	400
X2CrNiMo17-12-2	1.4404	215		190	225	490 to 700	40	30	100	60	60	1 020 to 1 120	w, a, o	yes	A	400

Steel grade		Hardness ^h		Tensile properties at room temperature ^a				Impact properties ^a			Reference heat treatment conditions		Resistance to intergranular corrosion		Limit temp.	
Steel name	Steel number	HB	max.	Proof strength		Tensile strength ^b	Elongation		Minimum average absorbed energy			Solution temperature ^c	Cooling in ^d	e	Method of EN ISO 3651-2: 1998	°C ^g
				Rp0,2 MPa	Rp1,0 MPa	Rm MPa	A %	at RT	at -196 °C	l	t					
X5CrNiMo17-12-2	1.4401	215		205 ⁱ	240 ⁱ	510 to 710 ⁱ	40	30	100	60	60	1 020 to 1 120	w, a, o	yes ^f	A	300
X6CrNiMoTi17-12-2	1.4571	215		190	225	490 to 730	35	30	100	60	60	1 020 to 1 120	w, a, o	yes	A	400
X2CrNiMo 17-12-3	1.4432	215		190	225	490 to 700	40	30	100	60	60	1 020 to 1 120	w, a, o	yes	A	400
X2CrNiMoN17-13-3	1.4429	250		295 ^{i, j, k}	330 ^{i, j, k}	580 to 800	35	30	100	60	60	1 020 to 1 120	w, a, o	yes	A	400
X3CrNiMo17-13-3	1.4436	215		205 ⁱ	240 ⁱ	510 to 730 ⁱ	40	30	100	60	60	1 020 to 1 120	w, a, o	yes ^f	A	300
X2CrNiMo18-14-3	1.4435	215		190	225	490 to 700	40	30	100	60	60	1 020 to 1 120	w, a, o	yes	A	400
X2CrNiMoN17-13-5	1.4439	250		285 ^{i, j}	315 ^j	580 to 800	35	30	100	60	42	1 100 to 1 140	w, a, o	yes	C	400
X2CrNiMo18-15-4	1.4438	200		220	250	490 to 700	35	30	100	60	60	1 100 to 1 160	w, a, o	yes	C	400
X1CrMoCu31-27-4	1.4563	230		215	245	500 to 750	35	30	100	60	60	1070 to 1 160	w, a, o	yes	C	400
X1NiCrMoCu25-20-5	1.4539	230		220	250	520 to 730	35	30	100	60	60	1 060 to 1 150	w, a, o	yes	C	400

Steel grade		Hardness ^h	Tensile properties at room temperature ^a			Impact properties ^a			Reference heat treatment conditions	Resistance to intergranular corrosion	Limit temp.		
Steel name	Steel number		Proof strength		Tensile strength ^b	Elongation	Minimum average absorbed energy						
			Rp0,2	Rp1,0			KV	Solution temperature ^c				Cooling in ^d	Method of EN ISO 3651-2: 1998
			MPa	MPa									
		HB			A								
		max.	min.	min.	min.	min.	at RT	at -196 °C			°C ^g		
					<i>l</i>	<i>t</i>	<i>l</i>	<i>t</i>					
X1CrNiMoCuN20-18-7	1.4547	260	300	340	650 to 850	35	100	60	1 140 to 1 230	w, a, o	C	400	
X1NiCrMoCuN25-20-7	1.4529	250	270	310	600 to 850	35	100	60	1 120 to 1 180	w, a, o	C	400	

For wall thicknesses greater than 60 mm the mechanical properties are subject to agreement at the time of enquiry and order (see option 10).

For wall thicknesses greater than 60 mm the mechanical properties are subject to agreement at the time of enquiry and order (see option 10).

^a *l* = longitudinal, *t* = transverse

^b For all cold-formed fittings which are not finally solution annealed (i.e. not annealed after forming and welding) *R_m* can be exceeded by 70 MPa. See also 8.2.3.1.

^c The maximum temperatures are for guidance only.

^d w = water ; a = air ; o = other; cooling sufficiently rapid

^e When tested in accordance with EN ISO 3651-2:1998 (appropriate method A or B or C shall be as indicated) up to the limit temperatures indicated in the last column of this table.

^f In delivery condition (normally not fulfilled in the sensitized condition).

^g Up to these temperatures, the material should, within 100 000 h, not have changed so as to show susceptibility of intergranular corrosion, when tested in conformity with EN ISO 3651-2:1998.

^h According to pre material standards e.g. EN 10272:2016.

ⁱ When using bars according to EN 10272 as starting material, a lower value according to EN 10272:2016 is permissible by agreement between purchaser and manufacturer.

^j When using flat products according to EN 10028-7 as starting material, a lower value according to EN 10028-7:2016 is permissible by agreement between purchaser and manufacturer.

^k When using forgings according to EN 10222-5 as starting material, a lower value according to EN 10222-5:2017 is permissible by agreement between purchaser and manufacturer.

Table 6 — Mechanical properties for wall thicknesses up to 30 mm at room temperature and impact properties at room temperature and at -40 °C of austenitic-ferritic stainless steels in the solution annealed condition (+AT)^b, heat treatment and information about resistance to intergranular corrosion

Steel grade		Hardness ^g	Tensile properties at room temperature ^a		Impact properties ^a			Reference heat treatment conditions		Resistance to intergranular corrosion	Limit temp. ^f																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
			Proof strength	Tensile strength ^b								Elongation																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
Steel name		Steel number	HB	R _{p0.2} MPa min.	R _m MPa	A %	Minimum average absorbed energy	Solution temperature ^c	Cooling in ^d	Method in EN ISO 3651-2:1998	°C																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				

^a *l* = longitudinal, *t* = transverse

^b For all cold-formed fittings which are not finally solution annealed (i.e. not annealed after forming and welding) *R*_m can be exceeded by 70 MPa. See also 8.2.3.1.

^c The maximum temperatures are for guidance only.

^d w = water ; a = air ; o = other; cooling sufficiently rapid.

^e When tested in accordance with EN ISO 3651-2:1998 (appropriate method A or B or C shall be as indicated) up to 250 °C.

^f Up to these temperatures, the material should, within 100 000 h, not have changed so as to show susceptibility of intergranular corrosion, when tested in conformity with EN ISO 3651-2:1998.

^g According to pre-material standards, e.g. EN 10216-5:2021, EN 10217-7:2021, EN 10222-5:2017 and EN 10272:2016.

^h When using flat products as per to EN 10028-7 as starting material, a lower value according to EN 10028-7:2016 is permissible by agreement between purchaser and manufacturer.

ⁱ When using bars as per to EN 10272 as starting material, a lower value according to EN 10272:2016 is permissible by agreement between purchaser and manufacturer.

^j When using forgings as per to EN 10222-5 as starting material, a lower value according to EN 10222-5:2017 is permissible by agreement between purchaser and manufacturer.

9.4 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

9.5 Corrosion resistance

The information given in Table 5 and Table 6 refer to the resistance of the steels to intergranular corrosion when tested according to EN ISO 3651-2:1998 to the indicated method A or method B or method C.

Guideline values for the limit temperature for susceptibility to intergranular corrosion are indicated in Table 5 and Table 6.

Option 13: *A test for the resistance to intergranular corrosion shall be carried out.*

If other specific corrosion tests are required, they shall be agreed at the time of enquiry and order.

10 Appearance and internal soundness (delivery conditions)

10.1 Definition of surface imperfections

Surface imperfections and their definitions are given in Table 7.

Table 7 — Definition 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	—	Concentration of nonmetallic 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."

Imperfection	Figure	Definition
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 internal and external surface finish 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) Cracks, surface inclusions, slag, porosity are not acceptable.
- f) 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 or less 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.
- g) 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.
- h) If surface imperfections acceptable under f) 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.
- i) Repairs to fittings shall only be carried out by grinding or machining, welding is not acceptable except in the weld seam as described in 8.2.2.1. Hammering is permitted but not in the weld and HAZ areas. Hammering shall be done in such a way that no significant local strain or work hardening occurs, which would lead to a change of the mechanical properties.
- j) The surface of the fittings shall be metallically clean by a method suitable to stainless steels (by pickling, or bright annealing, shot blasting or similar procedures) indicated by manufacturer.

Option 14: *Pickling shall be specified at the time of enquiry and order.*

Option 15: *Shot blasting or bright annealing shall be specified at the time of enquiry and order.*

Option 16: *Pickling and passivation shall be specified at the time of enquiry and order.*

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 the Tables in Annex A and Annex D may be agreed upon.

11.1.2 Elbows

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

Diameter, radius and thickness shall be agreed between purchaser and manufacturer where ranges are shown in Table A.2.

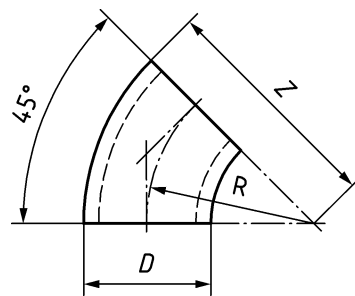


Figure 1 — 45° elbow

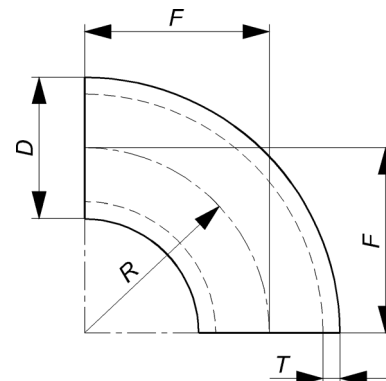


Figure 2 — 90° elbow

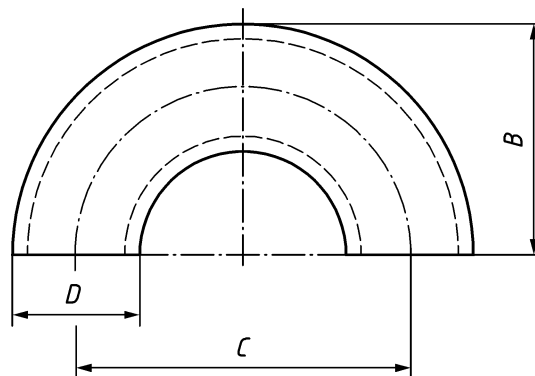


Figure 3 — 180° elbow (return bend)

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.3 (see A.3.1).

Pulled tees are produced in accordance with Figure 6, Branch welded tees in accordance with Figure 7 or Figure 8.

Specific dimensions are listed in Table A.4 to Table A.8 (see A.3.2 and A.3.3).

NOTE Design rules are not given for pulled and branch-welded tees in this document. Therefore, no calculation is available. This is the responsibility of the user (see European foreword).

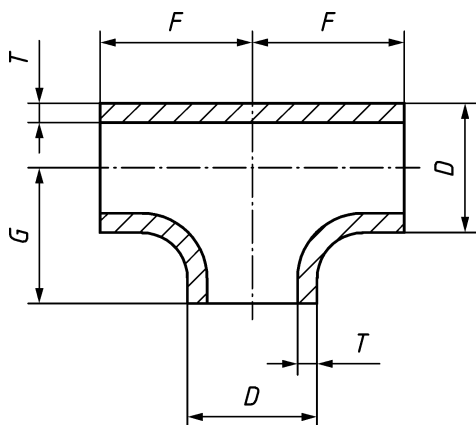


Figure 4 — Equal tee

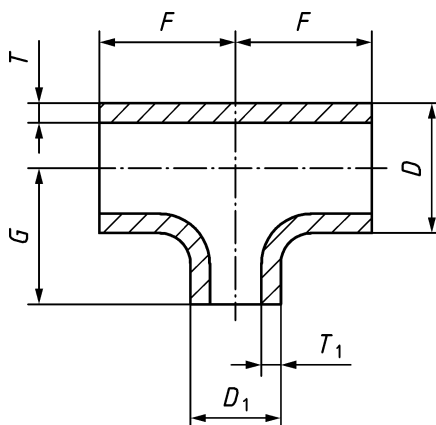


Figure 5 — Reducing tee

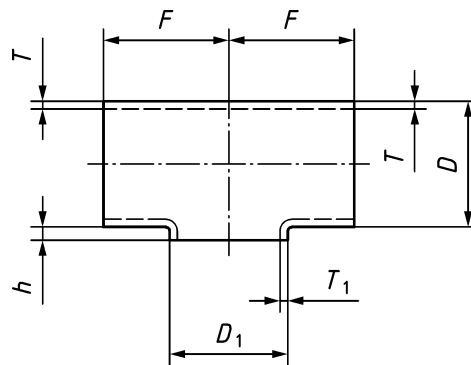


Figure 6 — Pulled tee

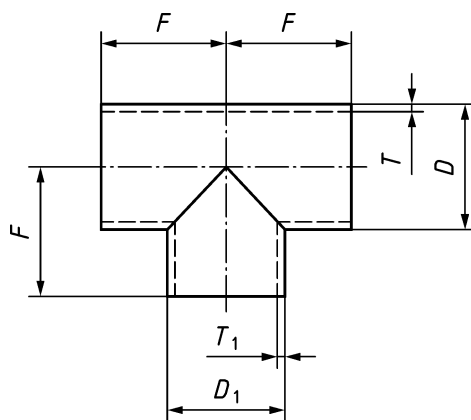


Figure 7 — Branch welded tee (v-welded)

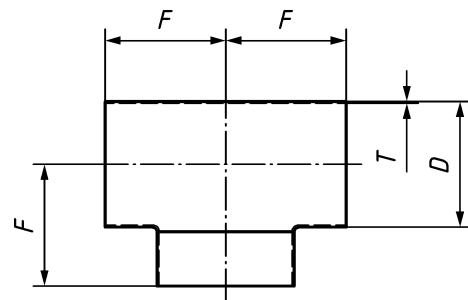


Figure 8 — Branch welded tee (circumferential welded)

11.1.4 Reducers

Concentric (con) and eccentric (ecc) reducers are produced in accordance with Figure 9 and Figure 10. Specific dimensions are listed in Table A.9 (see A.4.1).

Concentric (straight) and eccentric reducers (straight) are produced in accordance with Figure 11 and Figure 12. Specific dimensions are listed in Table A.10 and Table A.11 (see A.4.2).

NOTE Design rules are not given for straight reducers in this document. Therefore, no calculation is available. This is the responsibility of the user (see European foreword).

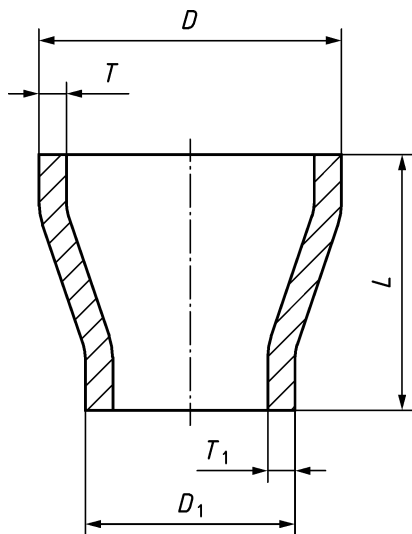


Figure 9 — Concentric (con) reducer

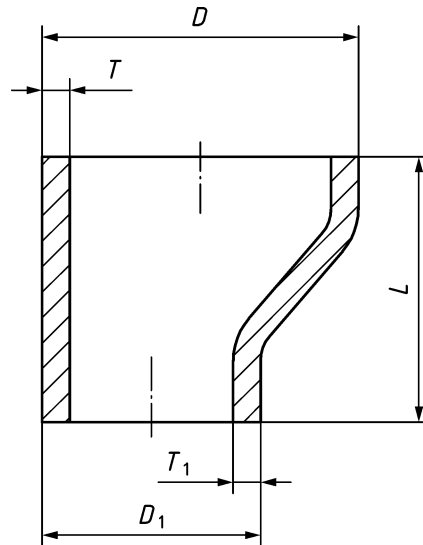


Figure 10 — Eccentric (ecc) reducer

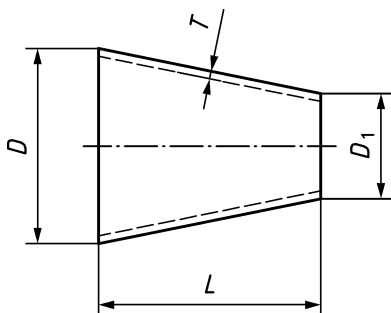


Figure 11 — Concentric straight (con str) reducer

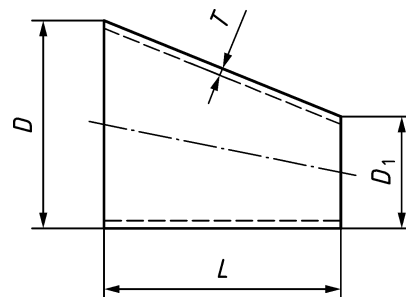


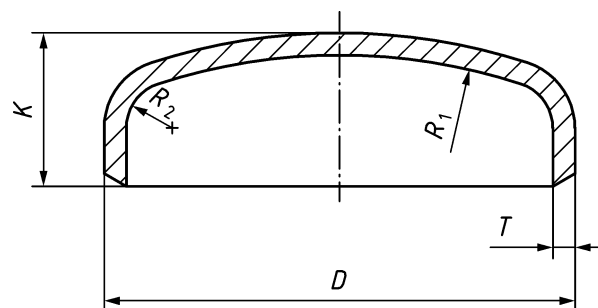
Figure 12 — Eccentric straight (ecc str) reducer

11.1.5 Caps and dished ends

Caps and dished ends are produced in accordance with Figure 13 and Figure 14. Specific dimensions are listed in Table A.12, Table A.13 and Table A.14 (see A.5).

NOTE 1 Some of the listed dimensions don't comply with all technical regulations, e.g. according to EN 13480-3. Nevertheless, they are standard on the market. In these cases, it is essential that the dimensions are agreed.

NOTE 2 Design rules are not given for dished ends in this document. Therefore, no calculation is available. This is the responsibility of the user (see European foreword).

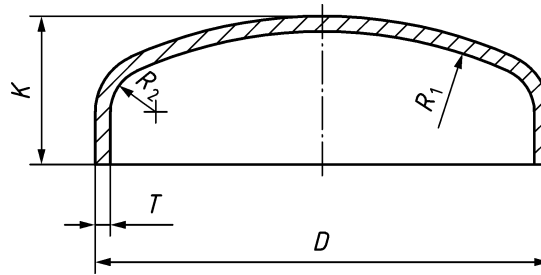


Key

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

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

Figure 13 — Cap (cap)

**Key**

R_1 approximately equal to D

R_2 approximately equal to $0,1 D$

Figure 14 —Dished end (end)

11.1.6 Preferred diameters and wall thicknesses

Preferred diameters and wall thicknesses have been selected in accordance with EN ISO 1127 with the additional preferred wall thickness dimensions 1,5 mm and 3 mm in order to match with tube dimensions.

Preferred wall thickness dimensions 1,5 mm and 3 mm are not described in EN ISO 1127. Dimensions which are different from those in EN ISO 1127 may be agreed.

11.2 Dimensional tolerances

11.2.1 Diameter

11.2.1.1 The relevant outside diameters ($D-D_1$) shall be measured at the welding ends of the fittings. The tolerance is as follows:

— $\pm 1 \%$ or $\pm 0,5 \text{ mm}$, whichever is the greater, but maximum $\pm 5 \text{ mm}$.

Option 17: *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 and dished ends) shall be above 80 % (for tees 70 %) of the inside diameter ID at the welding ends.

Option 18: *Special tolerances may be agreed.*

11.2.2 Out of roundness

The tolerances for out of roundness are:

At the welding ends:

- $D \leq 406,4$ included in the diameter tolerance;
- $D > 406,4$ and $D/T \leq 100$ then $O_v \leq 2\%$;

For fittings with a D/T ratio > 100 the values for out-of-roundness shall be agreed at the time of enquiry and order.

On the body for elbows and return bends: $\leq 4 \%$.

The out of roundness shall be calculated as follows:

- $O_v = 100 (D_{\max} - D_{\min})/D$ in %.

11.2.3 Wall thickness tolerances

Wall thickness tolerances at the welding ends are indicated in Table 8.

The minus tolerances shown in Table 8 apply also for the body of the fitting. Wall thickness in any point of fitting type A shall not go under the minimum wall thickness given for welding ends. For fittings type B, the minus tolerances apply also for the other values of the wall thickness as defined in Annex B and Annex D.

NOTE There is no plus tolerance at the body of the fitting defined.

Option 19: *Plus tolerances on the body of the fitting shall be as specified on the purchase order.*

Table 8 — Wall thickness tolerances at the welding ends

Diameter <i>D</i> mm	Wall thickness <i>T</i> mm	Wall thickness tolerance	
		minus	plus
≤ 610	all	−12,5 %	+20 %
> 610	seamless	−12,5 %	+20 %
	welded		
	≤ 10	−0,35 mm	+20 %
	> 10	−0,5 mm	

11.2.4 Tolerances on specific dimensions and form

For the dimensions specific to fittings, the tolerances given in Table 9 including the tolerances on the form for elbows shall apply.

Table 9 — Tolerances on specific dimensions and form

Dimensions in millimetres

<i>D</i>	<i>F-G-L</i>	<i>B-Z</i>	<i>C</i>	<i>K</i>	<i>P</i>
≤ 114,3	±2	±7	±7	±4	2
114,3 < <i>D</i> ≤ 219,1	±2	±7	±7	±7	4
219,1 < <i>D</i> ≤ 406,4	±5	±7	±10	±7	6
406,4 < <i>D</i> ≤ 762	±5	±10	±10	±7	7
762 < <i>D</i>	±10	±12	±10	±10	9

The tolerances on the form of every type of fitting (out-of-squareness, alignment) are the following:

- $X \leq 1\%$ of the outside diameter at the point measured or 1 mm, whichever is the greater (see Figure 15).

For *P*, the tolerance is given in Table 9.

All tolerances on the form shall be verified with the fitting remaining in the same position as shown in Figure 15.

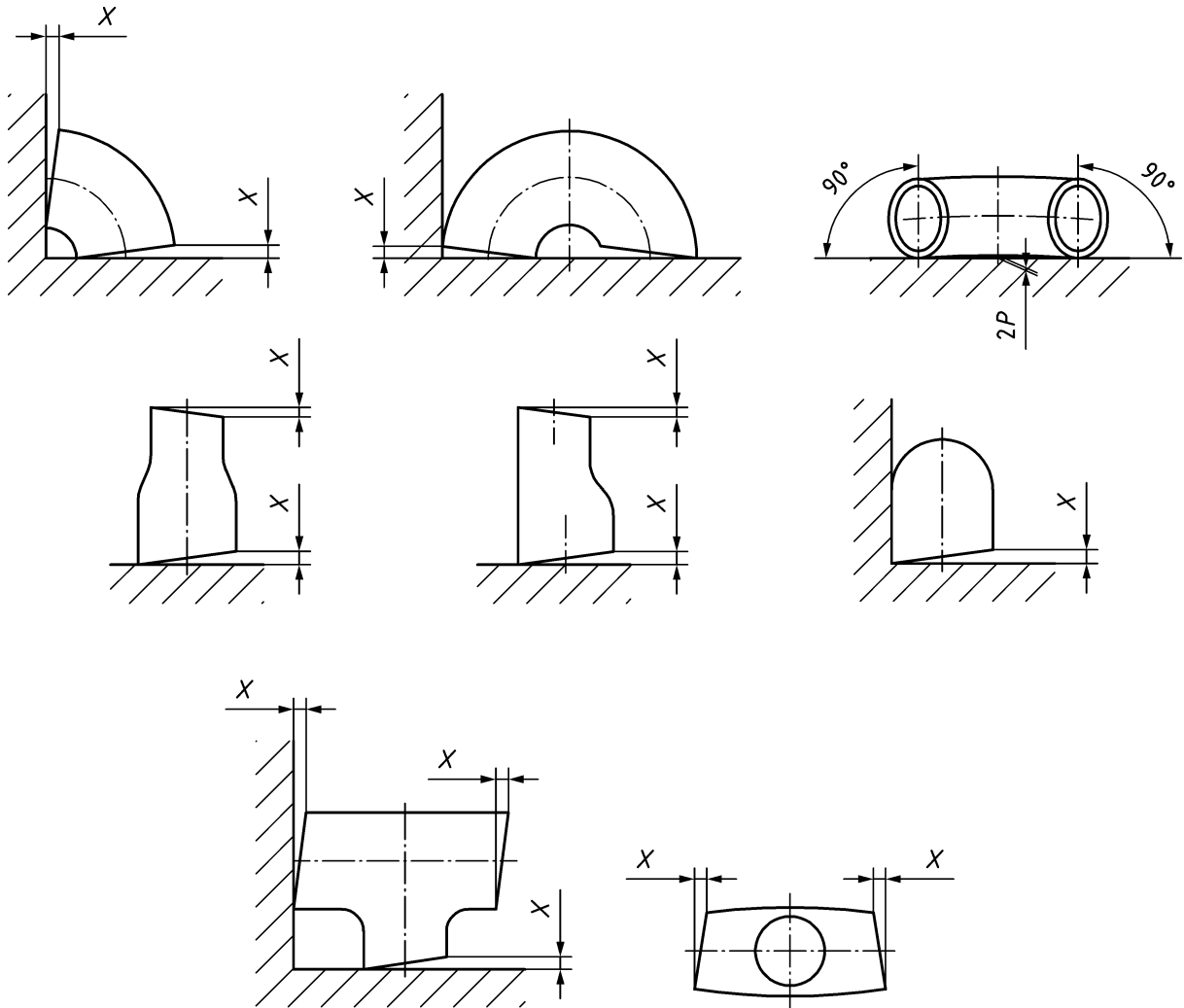


Figure 15 — Determination of the tolerance on the form of fittings

11.2.5 Corrugation

Corrugation (see Figure 16) is permitted within following limits:

a) For elbows and return bends:

- 1) h_m not exceeding 3 % of D or 25 mm, whichever is lesser;
- 2) $LE \geq 15 \cdot h_m$.

b) For tees and reducers:

- 1) h_m not exceeding 3 % of D or 25 mm, whichever is lesser;
- 2) $LE \geq 15 \cdot h_m$;
- 3) there shall be no sharp edges associated with the corrugation.

$$h_m = \frac{d_{a2} + d_{a4}}{2} - d_{a3}$$

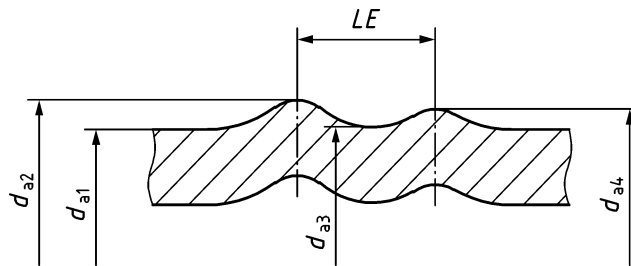


Figure 16 — Determination of corrugation

11.3 Performance of the end bevelling

At the manufacturer's option, for specified wall thicknesses below $T < 3,2$ mm the ends may be square cut.

For nominal wall thicknesses $3,2 \leq T \leq 20,0$ mm the ends shall be bevelled with an angle α of 30^{+5}_0 with a root face C of $1,6 \pm 0,8$ mm.

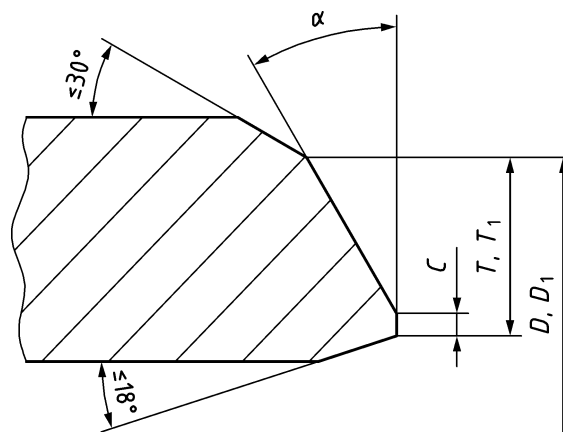


Figure 17 — Fitting end bevel

For wall thicknesses above 20 mm, the type of bevel shall be agreed.

Where machining at the welding ends is necessary, the wall thickness may be reduced by taper boring, the taper being not larger than:

- external: max. 30° ;
- internal: max. 18° .

The fitting ends shall be free from harmful burrs.

Option 20: *The end finishing shall be as specified.*

12 Inspection

12.1 Type of inspection

Conformity to the requirements of the order, for fittings in accordance with this part of EN 10253, shall be checked by specific inspection.

When an inspection certificate 3.1 according to EN 10204:2004 is specified, the manufacturer shall state in the confirmation of the order whether they are operating according to a "quality assurance system", certified by a competent body established within the community, and having undergone a specific assessment for materials and processes relevant to manufacture of fittings, including, if applicable, welding procedure approvals, welder/weld operator approval and NDT operator approval.

12.2 Inspection documents

12.2.1 Type of inspection documents

Unless option 21 is specified, an inspection certificate 3.1 in accordance with EN 10204:2004 shall be issued.

Option 21: *An inspection certificate 3.2 in accordance with EN 10204:2004 shall be issued.*

If an inspection certificate 3.2 is specified, the name and address of the organization or person who is to carry out the inspection and to produce the inspection document shall be notified.

For welded fittings and fittings machined from bars or forgings, the manufacturer shall join to the inspection document the relevant inspection document concerning the starting material (welded tube, plate/strip, bar or forgings).

12.2.2 Content of inspection documents

The content of the inspection certificate shall be in accordance with EN 10168:2004.

In all types of inspection certificates, a statement on the conformity of the products delivered with the requirements of this standard and the order shall be included.

The inspection certificate shall contain the following codes and/or information:

A	commercial transactions and parties involved;
B01 – B13	description of products to which the inspection certificate applies;
B14 – B99	supplementary information, starting material where applicable;
C01 – C03	location of the samples and direction of the test pieces and testing temperature where applicable;
C10 – C13	tensile test where applicable
C40 – C43	impact test where applicable;
C50 – C69	other tests (e.g. weld bend test and ring expanding test);
C70	steelmaking process
C71 – C92	chemical composition on cast analysis (product analysis where applicable);
D01	marking and identification, surface appearance, shape and dimensional properties;
D02 – D99	non-destructive testing, material identification, where applicable;
Z	validation.

When welding is part of the manufacturing process, the inspection document shall also contain:

— reference to welding procedure approval;

- reference to welder and or welding operator approval;
- reference to non-destructive testing operator's approval;
- information on the forming process and the applied heat treatment.

When fittings are produced from welded tubes, the inspection document shall also contain:

- information on the forming process and the applied heat treatment.

In addition, for inspection certificate 3.1, the manufacturer shall state the references to the certificate (see 12.1) of the appropriate "quality assurance system", if applicable.

12.3 Summary of inspection and testing

Inspection and testing to be carried out are summarized in Table 10.

Table 10 — Inspections and tests

Type of inspection and testing		Conditions for realization	Number of tests	Test category (TC)	
				1	2 ^b
Mandatory tests	Cast analysis (14.1)	Base material	1 per cast	×	×
	Tensile test at room temperature (14.2.1)	$D \geq 114,3 \text{ mm}$	1 per test unit	×	×
	Ring expanding test (14.4)	Cold formed fittings without subsequent heat treatment (see 8.2.3.1) $D < 114,3 \text{ mm}$	1 per test unit	×	×
	Dimensional testing (14.7)	—	Manufacturer's procedure	×	×
	Visual testing (VT) (14.8)	—	Manufacturer's procedure	×	×
	NDT of the weld seam (100 %) (14.9.2)	Welded fittings ^a	Each fitting	×	×