

ICS

English version

**Butt-welding pipe fittings - Part 4: Wrought austenitic and  
austenitic-ferritic (duplex) stainless steels with specific  
inspection requirements**

Formstücke zum Einschweißen - Teil 4: Austenitische und  
austenitischferritisch nichtrostende Stähle mit besonderen  
Prüfanforderungen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee ECISS/TC 29.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

**Management Centre: rue de Stassart, 36 B-1050 Brussels**

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## Foreword

This document (prEN 10253-4) has been prepared by Technical Committee CEN/TC ECISS/TC 29 "Steel tubes and fittings for steel tubes", the secretariat of which is held by UNI.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this document.

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: Wrought carbon 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*

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

Firstly the committee recognized the need to provide a basic type in which the minimum wall thickness of the fitting is guaranteed without formal reference to the pressure resistance. This type is considered in Part 3 and includes products not intended to be used in applications covered by the Pressure Equipment Directive (97/23/EC).

Secondly the application standards for the Pressure Equipment Directive will require that the fitting is designed to withstand a defined resistance to internal pressure. This approach imposes enhanced requirements that are considered in Part 4.

Annex A (informative) gives information about specific dimensions of fittings and Annex D (informative) indicates preferred inside diameters and wall thicknesses.

For fittings specified in accordance with this EN 10253-4, the resistance to internal pressure of the fitting may be determined by calculation. Annex B (informative) gives information about the calculation.

For some wall thickness series Annex C (informative) lists wall thickness values for the body of the fittings so that the fitting will, in general, withstand the same pressure as a straight pipe with the same nominal dimensions.

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 standard 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

1.1 This Part of EN 10253 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 which are applied for pressure and corrosion resisting purposes at room temperature, at low temperature or at elevated temperatures.

It specifies:

- the type of fittings;
  - type A : Butt-welding fittings with reduced pressure factor;
  - type B : Butt-welding fittings for use at full service pressure;
- the steel grades;
- the mechanical properties;
- the dimensions and tolerances;
- the requirements for inspection and testing;
- the inspection documents;
- the marking;
- the handling and packaging.

1.2 Unless otherwise specified in this Part of EN 10253 the general technical delivery requirements in EN 10021 apply.

## 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 287-1, *Approval testing of welders – Fusion welding – Part 1 : Steels.*

EN 288-1, *Specification and qualification of welding procedures for metallic materials – Part 1: General rules for fusion welding.*

EN 288-3, *Specification and approval of welding procedures for metallic material – Part 3: Welding procedure tests for the arc welding of steels.*

EN 473, *Qualification and certification of NDT personnel – General principles.*

EN 910, *Destructive tests on weld in metallic materials – Bend test*

EN 1418, *Welding personnel - Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials.*

EN 10002-1, *Metallic materials – Tensile testing – Part 1: Method of test (at ambient temperature).*

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- EN 10002-5, *Metallic materials – Tensile testing – Part 5: Method of test (at elevated temperatures)*.
- EN 10020, *Definitions and classification of grades of steel*.
- EN 10021, *General technical delivery requirements for steel and iron products*.
- EN 10027-1, *Designation systems for steel – Part 1: Steel names, principal symbols*.
- EN 10027-2, *Designation systems for steel – Part 2: Numerical system*.
- EN 10028-7, *Flat products made of steels for pressure purposes – Part 7: Stainless steels*.
- EN 10045-1, *Metallic materials – Charpy impact test – Part 1: Method of test*.
- EN 10052, *Vocabulary of heat treatment terms for ferrous products*.
- EN 10079, *Definitions of steel products*.
- EN 10088-1, *Stainless steels – Part 1: List of stainless steel*.
- EN 10088-2, *Stainless steels – Part 2: Technical delivery conditions for sheet/plate and strip for general purposes*.
- EN 10204, *Metallic products – Types of inspection documents*.
- EN 10216-5, *Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 5: Stainless steel tubes*.
- EN 10217-7, *Welded steel tubes for pressure purposes – Technical delivery conditions – Part 7: Stainless steel tubes*.
- EN 10234, *Metallic materials – Tube – Drift expanding test*.
- EN 10266, *Steel tubes and fittings and structural hollow sections – Definitions and symbols for use in product standards*.
- EN 10272, *Stainless steel bars for pressure purposes*.
- EN 13445-3, *Unfired pressure vessels – Part 3: Design*.
- EN 13480-3, *Metallic industrial piping – Part 3: Design and calculation*.
- EN ISO 377, *Steel and steel products – Location of samples and test pieces for mechanical testing (ISO377:1999)*.
- EN ISO 1127, *Stainless steel tubes – Dimensions, tolerances and conventional masses per unit length*.
- EN ISO 2566-1, *Steel - Conversion of elongation values – Part 1: Carbon and low alloy steels*.
- EN ISO 3651-2, *Determination of resistance to intergranular corrosion – Stainless steels – Part 2: Ferritic, austenitic and austenitic-ferritic stainless steels – Corrosion test in media containing sulfuric acid*.
- EN ISO 6708, *Pipework components – Definition and selection of DN (nominal size)*.
- ISO 3419, *Non-alloy and alloy steel butt-welding fittings*.
- ISO 5251, *Stainless steel butt-welding fittings*.
- ISO 14284, *Iron and steel products – Sampling and preparation of samples for the determination of the chemical composition*.
- CR 10260, *Designation system for steel – Additional symbols*.

### 3 Terms and definitions

For the purpose of this European Standard, the relevant definitions in EN 10020, EN 10021, EN 10052, EN 10079 and EN ISO 377 apply, except as defined below.

#### 3.1

##### **type**

for elbows and return bend, the type defines the bending radius of the piece

#### 3.2

##### **welded fitting**

##### 3.2.1

fittings made from welded tubes

##### 3.2.2

fittings made from sheet/plate or strip where welding is a part of the fabrication

#### 3.3

##### **purchaser**

person or organisation that orders products in accordance with this standard. The purchaser is not necessarily, but may be, a manufacturer of pressure equipment in accordance with the EU Directive listed in Annex ZA. 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

##### **employer**

organisation for which a person works on a regular basis. The employer may be either the fitting manufacturer or supplier or a third party organisation providing a service, e.g. NDT

### 4 Symbols

For the purpose of this European Standard, the symbols of EN 10266 and the following apply:

DN, DN 1	Conventional dimension used in piping ; non measurable value (See EN ISO 6708) ;
D	Specified outside diameter for elbows, return ends, equal tees, caps and the major outside diameter for reducers and reducing tees, expressed in millimetres;
D1	Specified minor outside diameter for reducers and reducing tees, expressed in millimetres;
T	Specified wall thickness at the welding ends for elbows, return bends and equal tees or on the D end for reducers and reducing tees, expressed in millimetres;
T1	Specified wall thickness on the D <sub>1</sub> welding end of reducers and reducing tees, expressed in millimetres

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ID	Internal diameter at the welding ends of elbows, return bends, equal tees and at the major welding end of reducers and reducing tees ( $ID = D - 2T$ );
ID1	Internal diameter at the minor welding end of reducers and reducing tees ( $ID_1 = D_1 - 2T_1$ );
C	Centre to centre distance for return bends ( $C=2R$ ), expressed in millimetres;
B	Back to face distance for return bends, 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 of reducing tees, expressed in millimetres;
H	Height of the straight part of dished ends, expressed in millimetres
H	Face to centre distance for 45° elbows, expressed in millimetres
K <sub>2</sub>	Total height for caps, expressed in millimetres;
L	Face to face distance for reducers, expressed in millimetres;
X	Tolerance on the form of fittings;
R	Bending radius of elbows and return bends, expressed in millimetres;
R <sub>m</sub>	Tensile strength at room temperature, expressed in megapascals;
R <sub>p0,2</sub>	Minimum 0,2 % proof strength at room temperature, expressed in megapascals;
R <sub>p1,0</sub>	Minimum 1,0 % proof strength at room temperature, expressed in megapascals;
A	Percentage of elongation at rupture, with reference to gauge length of $5,65 \sqrt{S_0}$ ;
HB	Brinell hardness;
W0	Welded from hot or cold rolled plate, sheet or strip 1 D, 2 D, 2 E, 2 B (Symbols of flat products according to EN 10088-2);
W 1	Welded from hot rolled plate, sheet or strip 1 D, descaled;
W2	Welded from cold rolled plate, sheet or strip 2 D, 2 E and 2 B, descaled.

## **5 Classification of grades and designation**

### **5.1 Classification of grades**

Steels covered in this European Standard are classified according to their structure into:

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

For more details see EN 10088 – 1.



## 5.2 Designation

For the fittings covered by this European Standard the designation shall consist of:

— the number of this European Standard (EN 10253-4)

plus either :

— the steel name in accordance with EN 10027-1 and CR 10260;

or :

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

## 6 Information to be supplied by the purchaser

### 6.1 Mandatory information

#### 6.1.1 Designation of fittings

Fittings may be designated by their outside diameter  $D$  (and  $D_1$ ) or by their inside diameter  $ID$  (and  $ID_1$ ).

##### 6.1.1.1 Elbows and return bends

Elbows and return bends are designated by the type, the angle and the diameter ( $D$  or  $ID$ ).

Types of elbows designated by their outside diameter  $D$  are:

$R \sim 1 D$ ,  $R \sim 1,5 D$  and  $R \sim 2,5 D$ .

Types of elbows designated by their inside diameter  $ID$  are :

$R \sim ID + 100$ ,  $R \sim 1,5 ID$  and  $R \sim 3 ID$ .

##### 6.1.1.2 Reducers

The reducers are designated by the type (concentric or eccentric), the major diameter ( $D$  or  $ID$ ) and the minor diameter ( $D_1$  or  $ID_1$ ).

##### 6.1.1.3 Tees

The equal tees are designated by the diameter ( $D$  or  $ID$ ).

The reducing tees are designated by the major diameter ( $D$  or  $ID$ ), the minor diameter ( $D_1$  or  $ID_1$ ).

##### 6.1.1.4 Caps

The caps are designated by the diameter ( $D$  or  $ID$ ).

#### 6.1.2 Information

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

- a) the quantity required (number of pieces);
- b) designation of fittings (see 5.1.1) and the wall thickness  $T(T_1)$ ;

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- c) the designation of the steel grade according to this European Standard;
- d) reference to this European Standard;
- e) type of fitting, A or B.

## **6.2 Options**

A number of options are specified in this European Standard 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 5.1).

- 1) steelmaking process (see 7.1);
- 2) method of manufacture of the fitting (see 7.2. );
- 3) starting product form and /or delivery condition (see 7.2.1);
- 4) heat treatment of the fittings (see 7.2.3.1);
- 5) product analysis (see 8.2.2);
- 6) verification of impact properties at room temperature (see 8.3.1);
- 7) agreed mechanical properties at room temperature for austenitic stainless steel fittings with wall thicknesses greater than 60 mm (see table 6);
- 8) verification of tensile properties at elevated temperature (see 8.3.2);
- 9) verification of impact properties at low temperature (see 8.3.3);
- 10) pickling (see 9.9);
- 11) shot blasting or bright annealing (see 9.9);
- 12) pickling and passivation (see 9.9);
- 13) specific dimensions of fittings according to Annex A (see 10.1.2);
- 14) fittings are ordered with tolerance class D 3 or D 4 (see table 8);
- 15) type of inspection document other than the standard document (see 11.2.1);
- 16) special test size units (see table 10);
- 17) verification of impact properties transverse to the weld (see 12.2.2.6);
- 18) liquid penetrant of weld and weld ends (see 13.9.2);
- 19) liquid penetrant of surfaces (see 13.9.2);
- 20) ultrasonic testing of strip or plates (see 13.9.2);
- 21) additional marking (see 14.1);
- 22) special packaging (see 15).

## 6.3 Examples of an order

### 6.3.1 Example 1

1000 elbows in accordance with this European Standard of type 3D with angle 90° and dimensions 60,3 X 2,9 not having an increased wall thickness of the body of the fitting and with a bending radius according to Annex A made of steel grade 1.4436.

1000 elbows – EN 10253-4 – A – type 3D – 90° – 60,3 X 2,9 – 1.4436 – option 13.

### 6.3.2 Example 2

2000 concentric reducers in accordance with this European Standard of form 2 with dimensions 219,1 X 6,3 – 139,7 X 4,0 with an increased wall thickness of the body of the fitting and with a length according to Annex A made of steel grade X2CrNi19-11.

2000 concentric reducers – EN 10253-4 – B – 219,1 X 6,3 – 139,7 X 4,0 – X2CrNi19-11 – option 13.

### 6.3.3 Example 3

3000 equal tees in accordance with this European Standard with dimension ID 40.0 x 2.0 made of steel grade 1.4301 with their surface pickled.

3000 equal tees – EN 10253-4 – A – ID 40.0 x 2.0 – 1.4301 – option 10

## 7 Resistance to internal pressure

### 7.1 General

The Pressure Equipment Directive (Dir. 97/23/EC – Annex I – subclause 2.2.2) imposes that the design for adequate strength be based on a calculation method.

The resistance to internal pressure of a fitting conforming to this European Standard shall be determined according to the relevant design rules laid down in e.g. EN 13480-3 or EN 13445-3.

The selection of the appropriate fitting (material, thickness) is the ultimate responsibility of the manufacturer of the pressure equipment.

### 7.2 Fittings of type A

Fittings of type A have the same wall thickness at the welding ends and on the body of the fitting. 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.

For elbows the wall thickness at the extrados may be 25 % less than the nominal wall thickness.

For reducers the wall thickness at the conical section shall be the specified wall thickness at the mayor 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 with the same specified diameter, wall thickness and of the same steel grade.

Wall thickness requirements of 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 C.

## 8 Manufacturing process

### 8.1 Steelmaking process

The steelmaking process is left at the discretion of the manufacturer.

**Option 1:** *The purchaser shall be informed about the steelmaking process used. The process shall be reported in the inspection document.*

### 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. The method of manufacturing is left at the discretion of the manufacturer.

The product making process shall be so applied that it will not produce injurious imperfections in the fittings.

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

- the choice of the tubes (seamless or welded) is left at the discretion of the manufacturer;
- when manufacturing fittings from tubes, tubes according to EN 10216-5 (seamless) and EN 10217-7 (welded) shall be used. Tubes marked "C1" and/or "C2" are not allowed.

Where plate/strip are used as starting material, the following conditions shall apply.

- when manufacturing fittings from plate / strip, plate / strip according to EN 10028-7 shall be used.

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

- when manufacturing fittings from bars, bars according to EN 10272 shall be used.

**Table 1 — Product making process – Starting product forms <sup>a</sup>**

Process	Hot deformation			Cold deformation		
	Bending <sup>b</sup>	Pressed in die <sup>c</sup>	Rolled, forged followed by machining	Bending <sup>b</sup>	Pressed in die <sup>c</sup>	Machining from round bars (DN < 50)
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

<sup>a</sup> Starting material

- 1 Seamless pipe
- 2 Welded pipe (v= 1,0)
- 3 Plate and strip
- 4 Forging
- 5 Bar

<sup>b</sup> When producing elbows from welded pipe, the position of the weld is at the discretion of the manufacturer.

<sup>c</sup> For these processes welding with or without filler metal may be used. When filler metal is used it shall be compatible with the parent metal.

**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.*

### 8.2.2 Welding

When producing fittings from plate or strip, welding is considered being a part of the manufacturing of fittings, the following criteria's is valid:

- welding process/procedures shall be qualified in accordance with EN 288-3;
- welders and/or welding operators shall be qualified in accordance with EN 287-1 and/or EN 1418.

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

If heat treatment is required, the repair welding shall be carried out in advance.

#### 8.2.2.1 Finished joint requirement

As welded surfaces are permitted provided the surface imperfections permit proper interpretation of radiographic or other non-destructive examination.

A reduction in thickness due to the welding process is acceptable provided that the material of the joining surfaces shall not be reduced below minimum required thickness at any point.

Concavity due to the welding process on the root side of a single welded joint is permitted when the resulting thickness of the weld is at least equal to the minimum thickness of the thinner part of the parts being joined and the contour of the concavity is smooth.

The height of the reinforcement on each face of the weld shall not exceed the values specified in Table 2.

**Table 2 — Height of reinforcement**

Dimensions in millimetres

Base metal thickness ( T )	Reinforcement
$T < 2,5$	1,0
$2,5 \leq T \leq 5,0$	1,5
$5,0 < T \leq 10,0$	2,0
$10,0 < T \leq 25,0$	2,5
$25,0 < T \leq 50,0$	3,5

### 8.2.3 Heat treatment

#### 8.2.3.1 Cold forming

Fittings, produced from solution – annealed and quenched or stabilised 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  $A_5 \geq 30\%$ , 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  $A_5$  of 15 %.

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

**Option 4:** *Heat treatment of the fittings shall be carried out.*

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### **8.2.3.2 Hot forming**

Fittings manufactured by hot forming shall be solution annealed.

## **9 Technical requirements**

### **9.1 General**

Fittings supplied and inspected in accordance with clauses 7, 11 and 12, shall comply with the requirements of this Part of EN 10253.

In addition to the requirements of this Part of EN 10253, the general technical delivery requirements specified in EN 10021 shall apply.

### **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 for austenitic steels and of Table 4 for austenitic-ferritic steels.

#### **9.2.2 Product analysis**

**Option 5:** *A product analysis shall be supplied.*

Table 5 specifies the permissible deviations of the product analysis from the specified cast analysis given in Tables 3 and 4.

Table 3 — Chemical composition (cast analysis)<sup>a</sup> of austenitic stainless steels, in % by mass

Steel grade		C max	Si max	Mn max	P max	S max	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
Steel name	Steel number													
X2CrNi18-9	1.4307	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	17,50-19,50	—	—	—	8,00-10,00	—	—
X2CrNi19-11	1.4306	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	18,00-20,00	—	—	—	10,00-12,00	—	—
X2CrNi18-10	1.4311	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	0,12-0,22	17,00-19,50	—	—	—	8,50-11,50	—	—
X5CrNi18-10	1.4301	0,07	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	17,00-19,50	—	—	—	8,00-10,50	—	—
X6CrNiTi18-10	1.4541	0,08	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	—	17,00-19,00	—	—	—	9,00-12,00	5xC-0,70	—
X6CrNiNb18-10	1.4550	0,08	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	—	17,00-19,00	—	—	10xC-1,00	9,00-12,00	—	—
X1CrNi25-21	1.4335	0,020	0,25	2,00	0,025	0,010	≤ 0,11	24,00-26,00	—	≤ 0,20	—	20,00-22,00	—	—
X2CrNiMo17-12-2	1.4404	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	16,50-18,50	—	2,00-2,50	—	10,00-13,00	—	—
X5CrNiMo17-12-2	1.4401	0,07	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	16,50-18,50	—	2,00-2,50	—	10,00-13,00	—	—
X6CrNiMoTi17-12-2	1.4571	0,08	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	—	16,50-18,50	—	2,00-2,50	—	10,50-13,50	5xC-0,70	—
X2CrNiMo17-12-3	1.4432	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	16,50-18,50	—	2,50-3,00	—	10,50-13,00	—	—
X2CrNiMoN17-13-3	1.4429	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	0,12-0,22	16,50-18,50	—	2,50-3,00	—	11,00-14,00	—	—
X3CrNiMo17-13-3	1.4436	0,05	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	16,50-18,50	—	2,50-3,00	—	10,50-13,00	—	—
X2CrNiMo18-14-3	1.4435	0,030	1,00	2,00	0,045 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	17,00-19,00	—	2,50-3,00	—	12,50-15,00	—	—

"to be continued"

Table 3 (end)

Steel grade		C max	Si max	Mn max	P max	S max	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
Steel name	Steel number													
X2CrNiMoN17-13-5	1.4439	0,030	1,00	2,00	0,040 <sup>b</sup>	0,015 <sup>b</sup>	0,12-0,22	16,50-18,50	—	4,00-5,00	—	12,50-14,50	—	—
X2CrNiMo18-15-4	1.4438	0,030	1,00	2,00	0,040 <sup>b</sup>	0,015 <sup>b</sup>	≤ 0,11	17,50-19,50	—	3,00-4,00	—	13,00-16,00	—	—
X1NiCrMoCu31-27-4	1.4563	0,020	0,70	2,00	0,030	0,010	≤ 0,11	26,00-28,00	0,70-1,50	3,00-4,00	—	30,00-32,00	—	—
X1NiCrMoCu25-20-5	1.4539	0,020	0,70	2,00	0,030	0,010	≤ 0,15	19,00-21,00	1,20-2,00	4,00-5,00	—	24,00-26,00	—	—
X1CrNiMoCuN20-18-7	1.4547	0,020	0,70	1,00	0,030	0,010	0,18-0,25	19,50-20,50	0,50-1,00	6,00-7,00	—	17,50-18,50	—	—
X1NiCrMoCuN25-20-7	1.4529	0,020	0,50	1,00	0,030	0,010	0,15-0,25	19,00-21,00	0,50-1,50	6,00-7,00	—	24,00-26,00	—	—

<sup>a</sup> 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.

<sup>b</sup> For fittings welded without filler material the sum of sulphur and phosphorus shall be maximum 0,040 %.

Table 4 — Chemical composition (cast analysis)<sup>a</sup> of austenitic-ferritic stainless steels, in % by mass

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

<sup>a</sup> 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.

<sup>b</sup> Patented steel grade



**Table 5 — Permissible deviations of the product analysis from specified limits on cast analysis given in Tables 3 and 4**

Element	Limiting value for the cast analysis in accordance with Tables 3 and 4	Permissible deviation of the product analysis <sup>a</sup>
	% by mass	% by mass
Carbon	≤ 0,030	+ 0,005
	> 0,030 ≤ 0,08	± 0,01
Silicon	≤ 1,00	± 0,05
Manganese	≤ 1,00	+ 0,03
	> 1,00 ≤ 2,00	+0,04
Phosphorus	≤ 0,030	+ 0,003
	> 0,030 to ≤ 0,045	+ 0,005
Sulphur	≤ 0,015	+ 0,003
Nitrogen	≤ 0,35	± 0,01
Chromium	≥ 10,50 ≤ 15,00	± 0,15
	> 15,00 ≤ 20,00	± 0,20
	> 20,00 ≤ 28,00	± 0,25
Copper	≤ 1,00	± 0,07
	> 1,00 ≤ 2,50	± 0,10
Molybdenum	≤ 0,60	± 0,03
	> 0,60 ≤ 1,75	± 0,05
	> 1,75 ≤ 7,00	± 0,10
Niobium	≤ 1,00	± 0,05
Nickel	≤ 1,00	± 0,03
	>1,00 ≤ 5,00	± 0,07
	> 5,00 ≤ 10,00	± 0,10
	> 10,00 ≤ 20,00	± 0,15
	> 20,00 ≤ 32,00	± 0,20
Titanium	≤ 0,70	± 0,05
Tungsten	≤ 1,00	± 0,05

<sup>a</sup> 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 European Standard shall conform to the requirements given in Tables 6 and 7 (see also 7.2.3.1).

**Option 6:** *Impact test shall be carried out at room temperature (see Tables 6 and 7). 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 7:** *(see Table 6).*

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**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 8:** *Proof strength  $R_{p0,2}$  or  $R_{p1,0}$  shall be verified for austenitic steels in Table 6. Proof strength  $R_{p0,2}$  shall be verified for austenitic-ferritic steels in Table 7. 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 Tables 6 and 7.

**Option 9:** *Impact test at low temperature shall be carried out. 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 6 — Mechanical properties for wall thicknesses up to 60 mm at room temperature and impact properties at – 196 °C of austenitic stainless steels in the solution annealed condition (+AT), heat treatment and information about resistance to intergranular corrosion**

Steel grade		Hardness HB max	Tensile properties at room temperature <sup>b</sup>					Impact properties <sup>a</sup>			Reference heat treatment conditions		Resistance to intergranular corrosion		Limit temp. °C <sup>i</sup>
			Proof strength $R_{p0,2}$ MPa min		Tensile strength <sup>h</sup> $R_m$ MPa	Elongation <sup>c</sup> A % min		Minimum average absorbed energy KV J min			Solution temperature d	Cooling in e	f	Method of EN ISO 3651-2	
Steel name	Steel number				$l$	$t$	at RT		at-196 °C						
							$l$	$t$	$t$						
X2CrNi18-9	1.4307	200	180	215	470-670	40	35	100	60	60	1000-1100	w, a	yes	A	350
X2CrNi19-11	1.4306	200	180	215	460-680	40	35	100	60	60	1000-1100	w, a	yes	A	350
X2CrNiN18-10	1.4311	210	270	305	550-760	35	30	100	60	60	1000-1100	w, a	yes	A	400
X5CrNi18-10	1.4301	200	195	230	500-700	40	35	100	60	60	1000-1100	w, a	yes <sup>g</sup>	A	300
X6CrNiTi18-10	1.4541	210	200	235	500-730	35	30	100	60	60	1020-1120	w, a	yes	A	400
X6CrNiNb18-10	1.4550	210	205	240	510-740	35	30	100	60	60	1020-1120	w, a	yes	A	400
X1CrNi25-21	1.4335	220	180	210	470-670	45	40	100	60	60	1030-1110	w, a	yes	A	400
X2CrNiMo17-12-2	1.4404	200	190	225	490-690	40	30	100	60	60	1020-1120	w, a	yes	A	400
X5CrNiMo17-12-2	1.4401	200	205	240	510-710	40	30	100	60	60	1020-1120	w, a	yes <sup>g</sup>	A	300
X6CrNiMoTi17-12-2	1.4571	210	210	245	500-730	35	30	100	60	60	1020-1120	w, a	yes	A	400
X2CrNiMo 17-12-3	1.4432	200	190	225	490-690	40	30	100	60	60	1020-1120	w, a	yes	A	400
X2CrNiMoN17-13-3	1.4429	220	295	330	580-800	35	30	100	60	60	1020-1120	w, a	yes	A	400
X3CrNiMo17-13-3	1.4436	200	205	240	510-710	40	30	100	60	60	1020-1120	w, a	yes <sup>g</sup>	A	300
X2CrNiMo18-14-3	1.4435	200	190	225	490-690	40	30	100	60	60	1020-1120	w, a	yes	A	400
X2CrNiMoN17-13-5	1.4439	200	285	315	580-800	35	30	100	60	60	1100-1140	w, a	yes	C	400
X2CrNiMo18-15-4	1.4438	200	220	250	490-690	35	30	100	60	60	1100-1160	w, a	yes	C	400
X1CrMoCu31-27-4	1.4563	220	215	245	500-750	40	35	120	90	60	1100-1160	w, a	yes	C	400

"to be continued"

Table 6 (end)

Steel grade		Hardness HB max	Tensile properties at room temperature <sup>b</sup>				Impact properties <sup>a</sup>			Reference heat treatment conditions		Resistance to intergranular corrosion		Limit temp. °C <sup>i</sup>	
			Proof strength		Tensile strength <sup>h</sup>	Elongation <sup>c</sup>	Minimum average absorbed energy			Solution temperature <sup>d</sup>	Cooling in <sup>e</sup>	f	Method of EN ISO 3651-2		
Steel name	Steel number	$R_{p0,2}$ MPa	$R_{p1,0}$ MPa	$R_m$ MPa	A %	KV J min		at RT						at-196 °C	
		min	min		min	$l$	$t$	$l$	$t$	$t$					
X1NiCrMoCu25-20-5	1.4539	220	220	250	520-720	35	30	120	90	60	1100-1150	w, a	yes	C	400
X1CrNiMoCuN20-18-7	1.4547	220	300	340	650-850	35	30	100	60	60	1180-1230	w, a	yes	C	400
X1NiCrMoCuN25-20-7	1.4529	220	300	340	600-800	40	40	120	90	60	1120-1180	w, a	yes	C	400

<sup>a</sup> For wall thicknesses greater than 60 mm the mechanical properties are subject to agreement at the time of enquiry and order. **Option 7:** Agreed mechanical properties for wall thicknesses greater than 60 mm apply.

<sup>b</sup>  $l$  = longitudinal ;  $t$  = transverse.

<sup>c</sup> See also 7.2.3.1.

<sup>d</sup> The maximum temperatures are for guidance only.

<sup>e</sup> w = water ; a = air ; cooling sufficiently rapid.

<sup>f</sup> When tested in accordance with EN ISO 3651-2 (Appropriate method, A or B or C, shall be as indicated) up to the limit temperatures indicated in the last column of table 8.

<sup>g</sup> In delivery condition. (Normally not fulfilled in the sensitized condition).

<sup>h</sup> For the delivery conditions W 0, W 1 and W 2 which do not include solution annealing, the upper  $R_m$  limit may be exceeded by 70 MPa .

<sup>i</sup> 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.

**Table 7 — Mechanical properties for wall thicknesses up to 30 mm at room temperature and impact properties at - 40°C of austenitic-ferritic stainless steel in the solution annealed condition (+AT), heat treatment and information about resistance to intergranular corrosion**

Steel grade	Steel name	Steel number	Hardness HB max	Tensile properties at room temperature <sup>a</sup>			Impact properties <sup>a</sup>			Reference heat treatment conditions		Resistance to intergranular corrosion		Limit temp. f °C	
				Proof strength h R <sub>p0,2</sub> MPa min	Tensile strength R <sub>m</sub> MPa	Elongation <sup>b</sup> A % min	Minimum average absorbed energy KV J min		Solution temperature c	Cooling in <sup>d</sup>	e	Method in EN ISO 3651-2			
				at RT		at -40 °C									
				l	t	l	t	t							
X2CrNiMoN22-5-3		1.4462	290	450	700-920	25	20	120	90	40	1020-1100	w, a	yes	B	250
X2CrNiN23-4		1.4362	290	400	600-820	25	25	120	90	40	950-1050	w, a	yes	A	250
X2CrNiMoCuN25-6-3		1.4507	310	500	700-900	20	20	100	100	40	1080-1160	w	yes	B	250
X2CrNiMoN25-7-4		1.4410	310	550	800-1000	20	20	100	100	40	1040-1120	w	yes	B or C	250
X2CrNiMoCuWN 25-7-4		1.4501	310	550	800-1000	20	20	100	100	40	1080-1160	w	yes	B or C	250

<sup>a</sup> l = longitudinal ; t = transverse.

<sup>b</sup> See also 7.2.3.1.

<sup>c</sup> The maximum temperatures are for guidance only.

<sup>d</sup> w = water ; a = air ; cooling sufficiently rapid.

<sup>e</sup> When tested in accordance with EN ISO 3651-2 (Appropriate method, A or B or C, shall be as indicated) up to 250 °C.

<sup>f</sup> 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.

## 10 Appearance and internal soundness

### 10.1 Appearance

**10.1.1** The fittings shall be free from internal and external surface defects that can be detected by visual inspection in accordance with this European Standard.

**10.1.2** The internal and external surface finish of the fittings shall be typical of the manufacturing process and, where applicable, the heat-treated condition employed. Normally the finish and surface condition shall be such, that any surface imperfections or marks requiring dressing shall be identified.

**10.1.3** It shall be permissible to dress, by grinding or machining, surface marks and imperfections provided that, the wall thickness of the fitting in the dressed area is not less than the specified minimum wall thickness.

**10.1.4** All dressed areas shall blend smoothly into the contour of the fitting.

**10.1.5** Any surface imperfection, which demonstrates to be deeper than 5 % of the nominal thickness or 3 mm whichever is the lesser, but not less than 0,3 mm, shall be dressed. This also applies to repairs of surface defects according to 9.1.6.

**10.1.6** Fittings with surface imperfections which encroach on the minimum wall thickness shall be considered defects and shall not comply with this European Standard. For mechanical marks the acceptance limit is 1,5 mm.

**10.1.7** If surface imperfections acceptable under 9.1.5 is not scattered and appears over a large area which is not acceptable as "workmanlike finish", the fittings shall be rejected or alternatively subject to dressing as agreed between purchaser and manufacturer.

**10.1.8** Repairs of the fitting parent metal shall only be carried out by grinding or machining.

**10.1.9** The surface of the fittings shall be metallically clean by a method suitable to stainless steels (by pickling, or bright annealing or shot blasting).

**Option 10:** *Pickling shall be specified at the time of enquiry and order.*

**Option 11:** *Shot blasting or bright annealing shall be specified at the time of enquiry and order.*

**Option 12:** *Pickling and passivation shall be specified at the time of enquiry and order.*

### 10.2 Internal soundness

For the internal soundness, where appropriate, requirements together with the conditions for their verification shall be agreed at the time of enquiry and order.

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 Diameter and wall thickness

Preferred outside diameters and wall thicknesses covered by this European Standard are given in EN ISO 1127.

Preferred inside diameters (and wall thicknesses) covered by this European Standard are listed in Annex D.

### 11.1.2 Specific dimensions of fittings

For reducers and tees it is not mandatory that the produced pieces correspond to the exact representation in the figures.

The specific dimensions:

- F for elbows 90°;
- C and B for elbows 180°;
- F and H for elbows 45°;
- L for reducers;
- F and G for tees;
- $K_2$ , R, v for caps;

shall be agreed at the time of enquiry and order.

**Option13:** *The specific dimensions of fittings specified by their outside diameter shall be according to Annex A.*

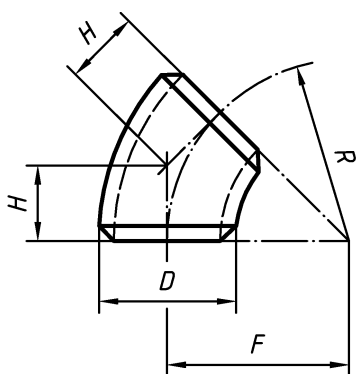


Figure 1 — 45° elbow

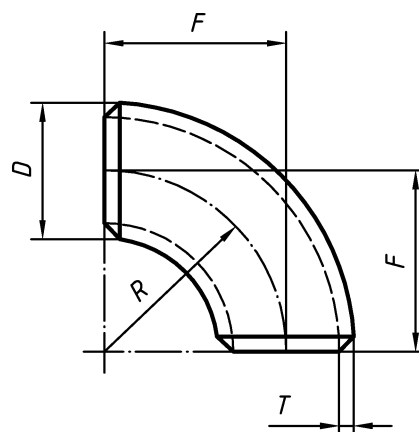


Figure 2 — 90° elbow

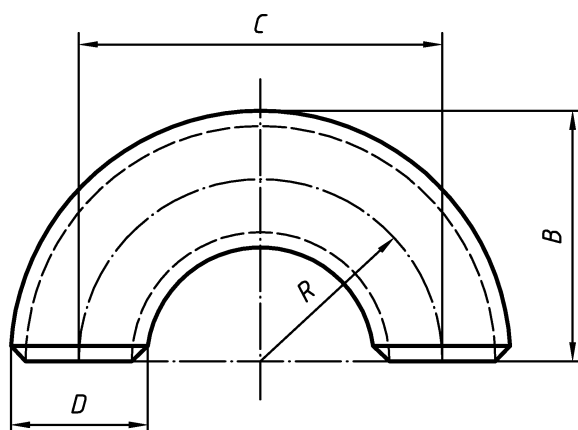


Figure 3 — Return bend

Elbows and return bends are produced according to Figures 1, 2 and 3 (45° - 90° - 180°). Specific dimensions are listed in Annex A.

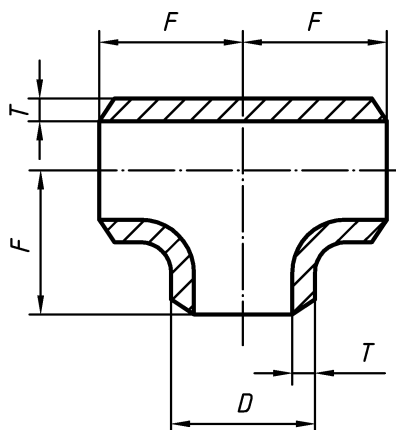


Figure 4 — Equal tee

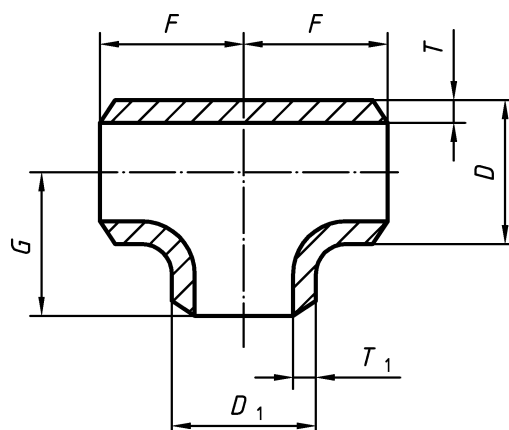


Figure 5 — Reducing tee

Equal tees are produced in accordance with Figure 4. Specific dimensions are listed in Annex A.

Reducing tees are produced in accordance with Figure 5. Specific dimensions are listed in Annex A.

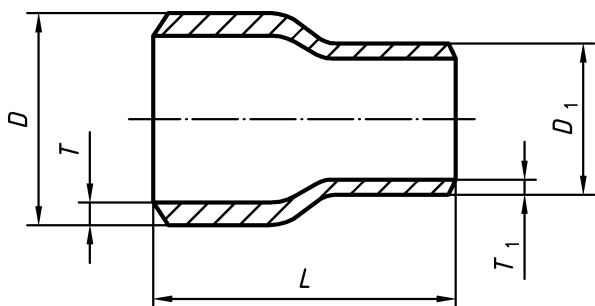


Figure 6 — Concentric reducer

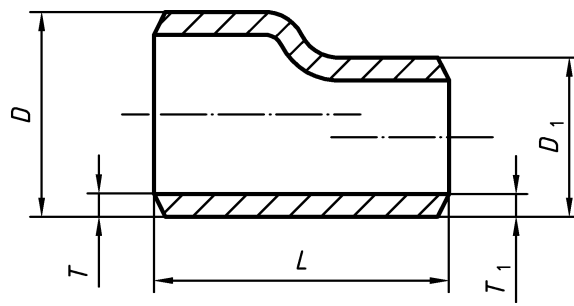
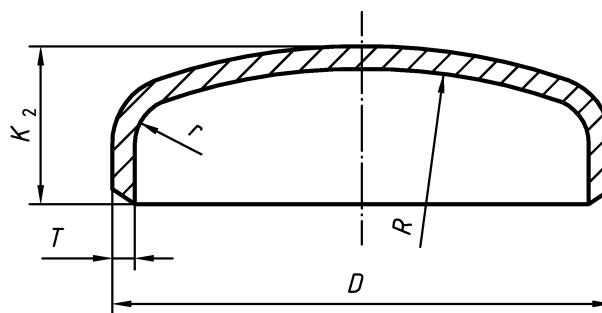


Figure 7 — Eccentric reducer

Concentric and eccentric reducers are produced in accordance respectively with Figures 6 and 7. Specific dimensions are listed in Annex A.





**Key**

- R approximately equal to 0,8 D
- r approximately equal to 0,15 D

**Figure 8 — Cap**

**11.2 Dimensional tolerances**

**11.2.1 Tolerances on diameter**

Tolerances on outside diameter shall be measured at the welding ends.

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

Internal diameter is calculated as follows :

Internal diameter = OD – 2 x nominal wall thickness

The outside diameter (OD) of fittings covered by this European Standard shall be within the tolerance limits given in Table 8.

**Table 8 — Tolerances on outside diameter D**

Tolerance on D	
EN Tolerance class	Permissible deviation
D2	± 1,0 % or ± 0,5 mm whichever is the greater
D3 <sup>a</sup>	± 0,75 % or ± 0,3 mm whichever is the greater
D4 <sup>a</sup>	± 0,5 % or ± 0,1 mm whichever is the greater

<sup>a</sup> **Option 14:** The fittings may be ordered with tolerance classes D3 or D4.

**11.2.2 Out of roundness**

The out-of-roundness (0) shall be calculated using the following equation:

$$0 = \frac{D_{\max} - D_{\min}}{D} 100 \tag{1}$$

where

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$O$  = out-of-roundness, in percentage;

$D_{max}$  = maximum outside diameter  $D$  measured in the same plane, in millimetres;

$D_{min}$  = minimum outside diameter measured in the same plane, in millimetres;

$D$  = specified outside diameter, in millimetres.

For fittings of outside diameter  $D \leq 406,4$  mm, out-of-roundness, shall be included in the limits of the diameter tolerances. Measurement shall be performed at the welding ends.

For fittings of outside diameter  $D > 406,4$  mm and with  $D/T$  less than or equal to 100, out-of-roundness shall not exceed 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.

For elbows, the out-of-roundness on the body of the fitting shall not exceed 4 %.

**11.2.3 Wall thickness tolerances**

The wall thickness at the welding ends of fittings covered by this European Standard shall be within the tolerance limits given in Table 9. The minus tolerances apply also to the wall thickness at the body of the fitting.

**Table 9 — Tolerances on wall thickness  $T$**

Outside diameter ( OD )	Wall thickness ( $T$ )	Permissible deviation	
		Minus	Plus
OD $\leq$ 610	all	- 12,5 %	+ 15 %
OD $>$ 610	$\leq$ 10 mm	- 0,35 mm	+ 15 %
	$>$ 10 mm	- 0,50 mm	+ 15 %

**11.2.4 Tolerances on specific dimensions**

For the dimensions specific to fittings, the tolerances are given in Table 10.

**Table 10 — Tolerances on specific dimensions**

Dimensions in millimetres

D	F- G - H - L	B	C	K <sub>2</sub>
$\leq 114,3$	$\pm 2$	$\pm 7$	$\pm 7$	$\pm 4$
$114,3 < D \leq 219,1$	$\pm 2$	$\pm 7$	$\pm 7$	$\pm 7$
$219,1 < D \leq 406,4$	$\pm 3$	$\pm 7$	$\pm 10$	$\pm 7$
$406,4 < D \leq 762$	$\pm 3$	$\pm 10$	$\pm 10$	$\pm 7$
$762 < D \leq 1219$	$\pm 5$	$\pm 10$	$\pm 10$	$\pm 10$

**11.2.5 Tolerances on the form of fittings**

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

$X = 1$  % of the diameter at the point measured or 1 mm, whichever is the greater (see Figure 9).

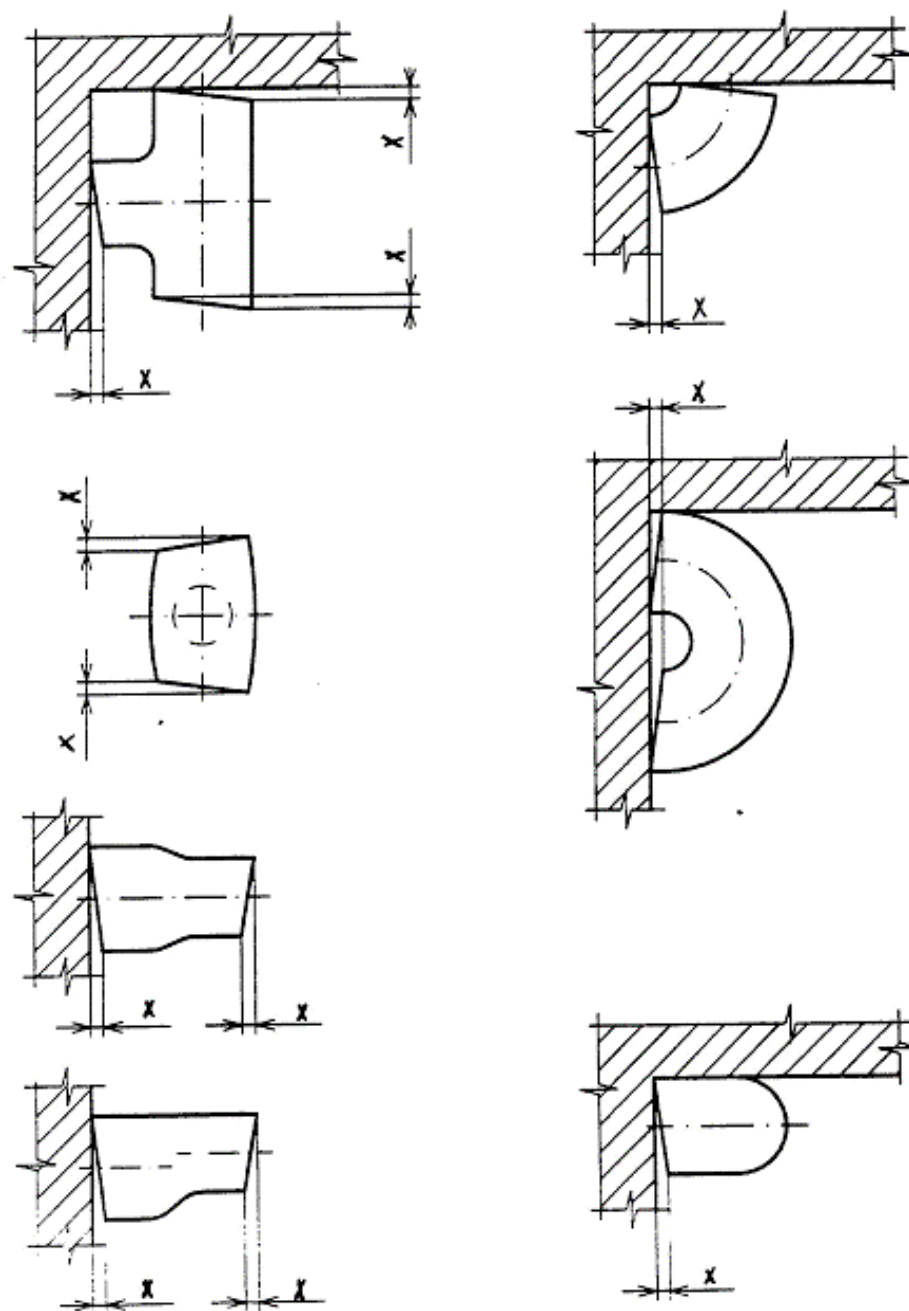


Figure 9 — Determination of the tolerance on the form of fittings

### 11.3 Performance of the end bevelling

**Wall thickness  $T \leq 3$  mm:** Fittings covered by this European Standard shall be delivered with square cut ends.

**Wall thickness  $3 \text{ mm} < T < 22$  mm:** Fittings covered by this European Standard shall be delivered with bevelled ends with an angle of  $30^\circ - 0^\circ / + 5^\circ$  and with a root face of  $1,6 \text{ mm} \pm 0,8 \text{ mm}$ .

**Wall thickness  $\geq 22$  mm:** Type of end bevelling shall be specified by the purchaser at the time of the enquiry and order.

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For wall thickness above 3 mm, where machining of the welding ends is necessary, the wall thickness may be reduced by taper, slope of the taper shall be:

- Internal: 15° - 18°;
- External: 27° - 30°.

The ends shall be free from excessive burrs.

## **12 Inspection**

### **12.1 Inspection documents**

#### **12.1.1 Types of inspection documents**

Unless option 15 is specified, an inspection certificate 3.1.B, in accordance with EN 10204, shall be issued.

**Option 15:** *One of the inspection documents 3.1.C or 3.2 in accordance with EN 10204 shall be issued.*

If an inspection document 3.1.C or 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organisation or person who is to carry out the inspection and produce inspection document. In case of inspection report 3.2 it shall be agreed which party shall issue the certificate.

#### **12.1.2 Content of inspection documents**

The content of the inspection document shall be in accordance with prEN 10168.

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

A – commercial transactions and parties involved;

B – description of products to which the inspection document applies;

C01-C03 – location of the samples and direction of the test pieces and testing temperature;

C10-C13 – tensile test;

C40-C43 – impact test if applicable;

C60-C69 – other tests (e.g. flattening);

C71-C92 – chemical composition on cast analysis (product analysis);

D01 – marking and identification, surface appearance, shape and dimensional properties;

D02-D99 – leak-tightness, NDT, material identification;

Z - validation.

### **12.2 Summary of inspection and testing**

The fittings shall be inspected and tested as specified at the time of enquiry and order.

Inspection and testing to be carried out are summarised in Table 12.

## 13 Sampling

### 13.1 Frequency of tests

#### 13.1.1 Test unit

A test unit shall consist of:

- same type;
- same specified dimensions;
- same manufacturing process;
- the same steel grade;
- same welding process (welded fittings);
- same cast;
- same heat treatment batch;
- same production lot.

If fittings fulfils above description but are heat treated in several batches depending on dimension or number of pieces, it may be regarded as one test unit provided that following conditions are obtained:

- temperature may be controlled within a range of 15 °C;
- cooling conditions are similar;
- furnace is equipped with recording devices so that complete records of heat treatment are available.

Test unit shall be as indicated in Table 11.

**Table 11 — Test unit**

Diameter (D) mm	Max. number of pieces in a test unit
$D < 60,3$	2500
$60,3 \geq D < 114,3$	1000
$114,3 \geq D \leq 219,1$	500
$219,1 < D \leq 323,9$	100
$323,9 < D \leq 610$	50
$610 < D \leq 1219,0$	25
$1219 < D$	10

**Option 16:** *The test unit size shall be as specified on the purchaser order.*

**Table 12 — Summary of inspection and testing**

Type of inspection and test		Frequency of testing	Reference to
Mandatory tests	Cast analysis of the starting material	One per cast	14.1
	Tensile test at room temperature	One per each sample of test unit	14.2.1
	Weld bend test ( welded fittings )	One per each sample of test unit	3.4.2 & 14.4
	Dimensional testing	See 14.7	
	Visual inspection	See 14.8	
	NDT of the weld seam ( 100 % )	See 14.9.2	
	Material identification	See 14.10	
Optional tests	Product analysis	One per cast	9.2.2
	Tensile test on the weld at room temperature	One per each sample of test unit	14.3
	Tensile test at elevated temperature	One per each sample of test unit	14.2.2
	Impact test at room temperature	One per each sample of test unit	14.5
	Impact test at low temperature	One per each sample of test unit	9.3.3
	Intergranular corrosion test	One per each sample of test unit	14.6
	Liquid penetrant of weld and weld ends	Agreement	14.9.2
	Liquid penetrant of surfaces	Agreement	14.9.2
	Ultrasonic testing for detection of laminar imperfections	Agreement	14.9.2

## 13.2 Preparation of samples and test pieces

### 13.2.1 Samples for product analysis

Samples for product analysis shall be taken from the test piece or samples for mechanical testing of from the whole thickness of the fitting at same location as for the mechanical test samples, in accordance with ISO 14284.

### 13.2.2 Samples and test pieces for mechanical tests

The samples for the mechanical testing shall be taken and the corresponding test pieces prepared in accordance with the general conditions of EN ISO 377, as far as applicable. The test pieces may be taken from the fitting itself or from excess material, or shall be one which is produced from the same semi-finished product and has undergone the same heat treatment as the fitting.

### 13.2.3 Test piece for the tensile test on the base material

The test piece for the tensile test on the base material at room temperature shall consist of longitudinal segment, over length of the fitting or representative sample. The test shall be according to EN 10002-1.