

Stainless steel bars for pressure purposes

The European Standard EN 10272:2000 has the status of a
British Standard

ICS 77.140.30

National foreword

This British Standard is the official English language version of EN 10272:2000. This standard, along with BS EN 10273:2000, supersedes BS 1502:1982 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/30, Stainless steels, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Cross-references

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 39 and a back cover.

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Stainless steel bars for pressure purposes

Barres en acier inoxydable pour appareils à pression

Nichtrostende Stäbe für Druckbehälter

This European Standard was approved by CEN on 15 September 2000.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 22. Steels for pressure purposes – Qualities, and ECISS/TC 23/SC 1, Stainless steels, the Secretariat of which is held by Normenausschuß Eisen und Stahl (FES) im DIN.

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 April 2001, and conflicting national standards shall be withdrawn at the latest by April 2001.

This European Standard 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 standard.

Annex D contains national A-deviations specifying the restrictions for the application of this European Standard in Sweden.

NOTE The clauses marked with a point (•) contain information relating to agreements which are to be made at the time of ordering. The clauses marked with two points (••) contain information relating to agreements which may be made at the time of enquiry and order.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

1.1 This European Standard specifies the technical delivery conditions for hot and cold formed stainless steel bars for pressure purposes supplied in accordance with one of the process routes and surface finishes listed in Table 5.

1.2 The general technical delivery conditions specified in EN 10021 apply in addition to the specifications of this European Standard, unless otherwise specified in this European Standard.

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 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 (including amendments).

EN 10002-1, *Metallic materials - Tensile testing - Part 1: Method of test (at ambient temperature) "including Addendum AC1:1990"*

EN 10002-5, *Metallic materials - Tensile testing - Part 5: Method of test at elevated temperature*

EN ISO 6506-1, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:1999)*

EN 10021, *General technical delivery requirements for steel and iron products*

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

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

EN 10045-1, *Metallic materials - Charpy impact test - Part 1: Test method*

EN 10052, *Vocabulary of heat treatment terms for ferrous products*

EN 10079, *Definition of steel products*

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

EN 10204, *Metallic products - Types of inspection documents (includes amendment A1:1995)*

EN 10221, *Surface quality classes for hot-rolled bars and rods - Technical delivery conditions*

EN ISO 377, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)*

prEN 10168:2000, *Iron and steel products - Inspection documents - List of information and description*

EN ISO 3651-2, *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)*

ISO 14284, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition*

See also annex C.

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 10052, EN 10079, EN 10088-1 and the following shall apply.

3.1

purchaser

person or organization 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

4 • Dimensions and tolerances on dimensions

The dimensions and the tolerances on dimensions are to be agreed at the time of enquiry and order, as far as possible with reference to the dimensional standards listed in annex C.

5 Calculation of mass

When calculating the nominal mass from the nominal dimensions, the values given in EN 10088-1 shall be used as a basis for the density of the steel concerned.

6 Designation

The steel names are allocated in accordance with EN 10027-1; the steel numbers are allocated in accordance with EN 10027-2.

7 Information to be supplied by the purchaser

7.1 Mandatory information

The complete order of a product as specified in this European Standard shall include the following information:

- a) the quantity to be delivered (mass, length, number of pieces);
- b) the shape of bar;
- c) the number of the European Standard specifying the tolerances on dimensions, shape and mass (see clause 4) and, if the relevant European Standard permits the purchaser certain options, e.g. regarding tolerance classes, specific information on these aspects;
- d) the dimensions and tolerances on dimensions and shape;
- e) the number of this European Standard;
- f) the steel name or the steel number;
- g) the delivery condition (see 9.2);
- h) the process route and surface finish (see Table 5);
- i) the type of inspection document in accordance with EN 10204 (see 10.2.1).

EXAMPLE 10 t rounds of a steel grade with the name X5CrNi18-10 and the number 1.4301 as specified in EN 10272 of 50 mm diameter, dimensional tolerances as specified in prEN 10060:2000, in process route 1D (see Table 5), inspection document 3.1.B as specified in EN 10204:

10 t rounds prEN 10060:2000 60-50
EN 10272-X5CrNi18-10+1D
Inspection document 3.1.B

or

10 t rounds prEN 10060:2000 60-50
EN 10272-1.4301+1D
Inspection document 3.1.B

7.2 Options

A number of options are specified in this European Standard and these are listed below. If the purchaser does not indicate his wish to implement any of these options marked with 2 points (••) at the corresponding subclauses, the supplier shall supply in accordance with the basic specification of this standard (see 7.1):

- a) specification of the steelmaking process (see 9.1);

- b) verification of product analysis (see 9.3.2 and Table 13);
- c) verification of tensile properties at elevated temperature (see 9.5.2, 10.6.3 and Table 13);
- d) verification of impact properties of austenitic steels at room temperature (see 9.5.1, 10.6.4 and Table 13);
- e) verification of impact properties at low temperature (see 9.5.1, 10.6.4 and Table 13);
- f) verification of resistance to intergranular corrosion (see 9.4, 10.6.5 and Table 13);
- g) special requirements on surface quality (see 9.6);
- h) verification of internal soundness (see 9.7);
- i) specific tests for verification of general delivery requirements (see 10.1);
- j) special marking requirements (see 11.2).

8 Classification of grades

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

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

NOTE For more details see EN 10088-1.

9 Requirements

9.1 • Steelmaking process

Unless a special steelmaking process is agreed at the time of enquiry and order, the steelmaking process for steels in accordance with this European Standard shall be at the discretion of the manufacturer.

9.2 • Delivery condition

The products shall be supplied in the delivery condition agreed in the order by reference to the process route given in Table 5 and, where different alternatives exist, to the treatment conditions given in Tables 6 to 8 (see also annex A).

9.3 Chemical composition

9.3.1 The chemical composition requirements given in Tables 1 to 3 apply in respect of the chemical composition according to the cast analysis.

9.3.2 •• The product analysis shall not deviate from the limiting values for the cast analysis as specified in Tables 1 to 3 by more than the values given in Table 4.

9.4 Corrosion resistance

•• Referring to resistance to intergranular corrosion as defined in EN ISO 3651-2, for austenitic and austenitic-ferritic steels the specifications in Tables 7 and 8 apply.

NOTE 1 EN ISO 3651-2 is not applicable for testing martensitic steels.

NOTE 2 The corrosion resistance of stainless steels is very dependent on the type of environment and can therefore not always be clearly ascertained through laboratory tests. It is therefore advisable to draw on the available experience of the use of the steels.

9.5 Mechanical properties

9.5.1 The tensile properties at room temperature and the impact energy at room and at low temperatures as specified in Tables 6 to 8 apply for the relevant specified heat treatment condition.

NOTE Austenitic steels are insensitive to brittle fracture in the solution annealed condition. Because they do not have a pronounced transition temperature, which is characteristic of other steels they are also useful for application at cryogenic temperatures.

9.5.2 The values in Tables 9 to 11 apply for the 0,2 % and, Table 10 only, for the 1 % proof strength at elevated temperatures. For austenitic steels, the values given in Table 12 apply for the tensile strength at elevated temperatures.

Tensile strength values at elevated temperatures for austenitic-ferritic steels are given for guidance in annex B.

9.6 •• Surface quality

Slight surface imperfections, inherent in the production process, are permitted.

If more exact requirements for the surface quality are necessary, these shall be agreed at the time of enquiry and order, where appropriate, on the basis of EN 10221.

9.7 •• 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.

10 Testing

10.1 • General

The manufacturer shall carry out appropriate process control, inspection and testing to assure himself that the delivery complies with the requirements of the order.

This includes the following:

- a suitable frequency of verification of the dimensions of the products;
- an adequate intensity of visual examination of the surface quality of the products;
- an appropriate frequency and type of test to ensure that the correct grade of steel is used.

The nature and frequency of these verifications, examinations and tests are determined by the manufacturer, in the light of the degree of consistency that has been determined. In view of this, verifications by specific tests for these requirements are not necessary unless otherwise agreed.

10.2 Type and content of inspection documents

10.2.1 • The compliance with the requirements of the order shall be checked for products in accordance with this European Standard by specific inspection. The purchaser shall specify the type of inspection document according to EN 10204 at the time of enquiry and order.

10.2.2 The inspection document shall contain, in accordance with prEN 10168:2000, the following information:

- a) the information blocks A, B and Z; the tempering temperature shall also be given in the case of quenched and tempered products;
- b) the results of the cast analysis in accordance with boxes C 71 to C 92;
- c) the results of the tensile test at room temperature in accordance with boxes C 00 to C 03 and C 10 to C 13;
- d) except for austenitic steels, the results of the impact test at room temperature in accordance with boxes C 00 to C 03 and C 40 to C 43;
- e) the result of the visual examination of the products (see information Block D);
- f) if one or several of the following options have been agreed at the time of enquiry and order, the relevant information on:
 - 1) the steelmaking process (section C 70);
 - 2) the product analysis in accordance with boxes C 71 to C 92;

- 3) verification of the tensile properties at elevated temperature in accordance with boxes C 00 to C 03, C 10 and C 11;
- 4) verification of impact properties of austenitic steels at room temperature in accordance with boxes C 00 to C 03 and C 40 to C 43;
- 5) verification of impact properties at low temperature in accordance with boxes C 00 to C 03 and C 40 to C 43;
- 6) verification of resistance to intergranular corrosion (see information Block D);
- 7) the surface quality (see information Block D);
- 8) verification of internal soundness (see information Block D);
- 9) special marking requirements (see information Block D).

10.3 Tests to be carried out

The following tests shall be carried out (see Table 13):

- a) tensile test at room temperature;
- b) impact test (except for austenitic steels) at room temperature;
- c) tests specially agreed at the time of enquiry and order (see 7.2).

10.4 Extent of testing

The tests to be carried out, either mandatorily (m) or by agreement (o) and the composition and size of the test units, and the number of sample products, samples and test pieces to be taken are given in Table 13.

10.5 Sampling and preparation of samples and test pieces

10.5.1 Sampling and sample preparation shall be in accordance with the requirements of ISO 14284 and EN ISO 377. In addition, the requirements in 10.5.2 shall apply to the mechanical tests.

10.5.2 The samples shall be taken in accordance with Figures 1 and 2 for the tensile test at room temperature, the impact test and the tensile test at elevated temperatures.

10.5.3 • If, following agreement (see 9.2), the products are not to be delivered in the heat treated condition, the samples shall be heat treated prior to the test.

10.6 Test methods

10.6.1 Unless otherwise agreed at the time of enquiry and order, the choice of a suitable physical or chemical analytical method for the product analysis shall be at the discretion of the manufacturer. In cases of dispute, the analysis shall be carried out by a laboratory approved by both parties. In this case,

the analysis method to be used shall be agreed upon, if possible, with reference to the corresponding European Standards or EURONORMs.

10.6.2 The tensile test at room temperature shall be carried out as described in EN 10002-1, generally using a proportional test piece of gauge length $L_0 = 5,65 \sqrt{S_0}$ (S_0 = cross-sectional area of the test piece).

The tensile strength and elongation after fracture shall be determined and additionally for ferritic, martensitic and austenitic-ferritic steels the 0,2 %-proof strength and for austenitic steels the 0,2 %- and 1 %-proof strength.

10.6.3 •• The tensile test at elevated temperatures shall be determined as described in EN 10002-5 at a temperature to be agreed at the time of enquiry and order.

If the tensile properties shall be verified, the 0,2 % proof strength shall be verified for ferritic and martensitic steels. For austenitic-ferritic steels, the 0,2 %-proof strength and the tensile strength shall be determined. In case of austenitic steels, the 0,2 %-proof strength, the 1 %-proof strength and the tensile strength shall be determined.

Unless otherwise agreed, testing shall be carried out at the highest temperature for which the value is specified in the relevant table.

10.6.4 •• The impact test on V-Notch test pieces shall be carried out as described in EN 10045-1.

The minimum impact values apply for the mean of three test pieces. One individual value may be lower than the specified value provided that it is not less than 70 % of this value.

If the above conditions are not met, an additional set of three test pieces shall be taken from the same specimen and shall be tested. In order to regard the test unit as acceptable after testing the second set, the following requirements shall also be met:

- a) the mean value of six tests shall be greater than or equal to the specified minimum value;
- b) not more than two of the six individual values shall be less than the specified minimum value;
- c) not more than one of the six individual values shall be less than 70 % of the specified minimum value.

If these requirements are not met, the sample product shall be rejected and re-tests shall be carried out on the remainder of the test unit.

10.6.5 •• The resistance to intergranular corrosion shall be tested in accordance with EN ISO 3651-2.

10.6.6 The Brinell hardness test shall be carried out in accordance with EN ISO 6506-1

10.6.7 Dimensions and dimensional tolerances of the products shall be tested in accordance with the requirements of the relevant dimensional standards, where available.

10.7 Re-tests

See EN 10021.

11 Marking

11.1 The products or the bundle or boxes shall be marked in a suitable way such that it is possible to determine the cast, the steel grade and the origin of the delivery (see Table 14).

11.2 •• Special marking may be agreed at the time of enquiry and order.

Dimensions in millimetres

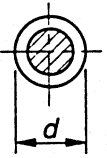
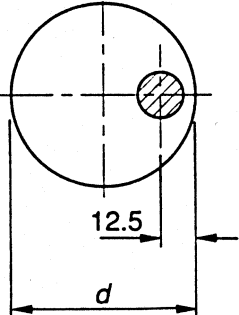
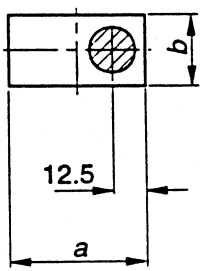
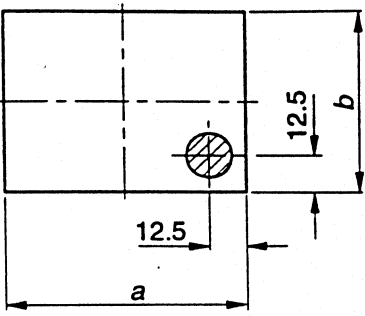
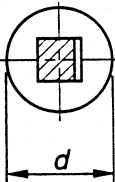
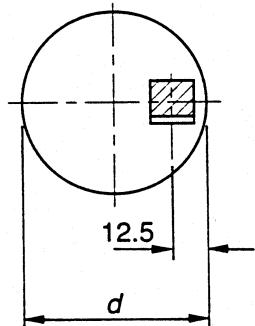
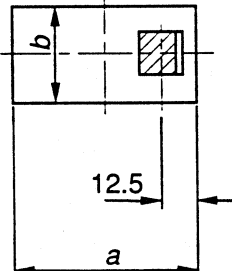
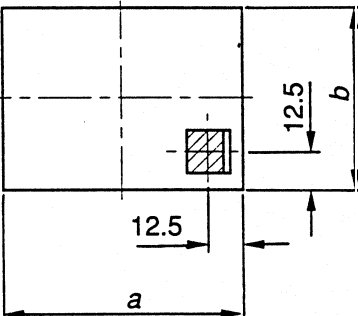
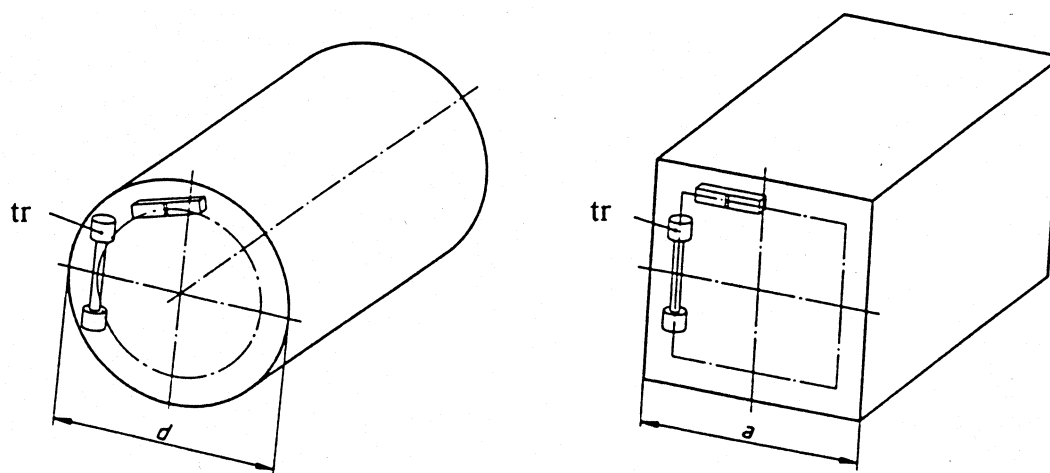
Type of test	Round cross-section products	Rectangular cross-section products
Tensile	$d \leq 25$  $25 < d \leq 160$ 	$b \leq 25$ $a \geq b$  $25 < b \leq 160$ $a \geq b$ 
Impact ^a	$15 \leq d \leq 25$  $25 < d \leq 160$ 	$b \leq 25$ $a \geq b$  $25 < b \leq 160$ $a \geq b$ 
^a For products of a round cross-section, the axis of the notch is approximately a diameter; for products with a rectangular cross-section, the axis of the notch is perpendicular to the greatest rolled surface.		

Figure 1 - Position of test pieces for steel bars ≤ 160 mm diameter or thickness (longitudinal test pieces)



tr transverse

**Figure 2 - Position of test pieces for steel bars > 160 mm diameter or thickness
(transverse test pieces)**

Table 1 - Chemical composition (cast analysis)^a of ferritic and martensitic stainless steels

Steel designation		% by mass									
name	number	C	Si max	Mn max	P max	S max	Cr	Mo	Ni	N	
ferritic stainless steel											
X2CrNi12	1.4003	≤ 0,030	1,00	1,50	0,040	0,015	10,50 to 12,50		0,30 to 1,00	≤ 0,030	
martensitic stainless steels ^b											
X12Cr13	1.4006	0,08 to 0,15	1,00	1,50	0,040	0,030 ^c	11,50 to 13,50		≤ 0,75		
X17CrNi16-2	1.4057	0,12 to 0,22	1,00	1,50	0,040	0,030 ^c	15,00 to 17,00		1,50 to 2,50		
X3CrNiMo13-4	1.4313	≤ 0,05	0,70	1,50	0,040	0,015	12,00 to 14,00	0,30 to 0,70	3,50 to 4,50	≥ 0,020	
X4CrNiMo16-5-1	1.4418	≤ 0,06	0,70	1,50	0,040	0,030 ^c	15,00 to 17,00	0,80 to 1,50	4,00 to 6,00	≥ 0,020	
^a Elements not quoted 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.											
^b Tighter carbon ranges may be agreed at the time of enquiry and order.											
^c For products to be machined a controlled sulfur content of 0,015 % to 0,030 % is recommended.											

Table 2 - Chemical composition (cast analysis)^a of austenitic stainless steels

Steel designation		% by mass												
name	number	C	Si	Mn	P	S	N	Cr	Cu	Mo	Nb	Ni	Ti	
		max	max	max	max	max								
X2CrNi18-9	1.4307	0,030	1,00	2,00	0,045	0,030 ^b	≤ 0,11	17,50 to 19,50				8,00 to 10,00		
X2CrNi19-11	1.4306	0,030	1,00	2,00	0,045	0,030 ^b	≤ 0,11	18,00 to 20,00				10,00 to 12,00		
X2CrNi18-10	1.4311	0,030	1,00	2,00	0,045	0,030 ^b	0,12 to 0,22	17,00 to 19,50				8,50 to 11,50		
X5CrNi18-10	1.4301	0,07	1,00	2,00	0,045	0,030 ^b	≤ 0,11	17,00 to 19,50				8,00 to 10,50		
X6CrNiTi18-10	1.4541	0,08	1,00	2,00	0,045	0,030 ^b		17,00 to 19,50				9,00 to 12,00		
X2CrNiMo17-12-2	1.4404	0,030	1,00	2,00	0,045	0,030 ^b	≤ 0,11	16,50 to 18,50		2,00 to 2,50		10,00 to 13,00	5 × C to 0,70	
X2CrNiMoNi17-11-2	1.4406	0,030	1,00	2,00	0,045	0,030 ^b	0,12 to 0,22	16,50 to 18,50		2,00 to 2,50		10,00 to 12,00		
X5CrNiMo17-12-2	1.4401	0,07	1,00	2,00	0,045	0,030 ^b	≤ 0,11	16,50 to 18,50		2,00 to 2,50		10,00 to 13,00		
X6CrNiMoTi17-12-2	1.4571	0,08	1,00	2,00	0,045	0,030 ^b		16,50 to 18,50		2,00 to 2,50		10,50 to 13,50	5 × C to 0,70	
X2CrNiMo17-12-3	1.4432	0,030	1,00	2,00	0,045	0,030 ^b	≤ 0,11	16,50 to 18,50		2,50 to 3,00		10,50 to 13,00		
X2CrNiMo18-14-3	1.4435	0,030	1,00	2,00	0,045	0,030 ^b	≤ 0,11	17,00 to 19,00		2,50 to 3,00		12,50 to 15,00		
X2CrNiMoNi17-13-5	1.4439	0,030	1,00	2,00	0,045	0,015	0,12 to 0,22	16,50 to 18,50		4,00 to 5,00		12,50 to 14,50		
X1NiCrMoCu25-20-5	1.4539	0,020	0,70	2,00	0,030	0,010	≤ 0,15	19,00 to 21,00	1,20 to 2,00	4,00 to 5,00		24,00 to 26,00		
X6CrNiNb18-10	1.4550	0,08	1,00	2,00	0,045	0,015		17,00 to 19,00			10 × C to 1,00	9,00 to 12,00		
X6CrNiMoNb17-12-2	1.4580	0,08	1,00	2,00	0,045	0,015		16,50 to 18,50		2,00 to 2,50	10 × C to 1,00	10,50 to 13,50		
X2CrNiMoNi17-13-3	1.4429	0,030	1,00	2,00	0,045	0,015	0,12 to 0,22	16,50 to 18,50		2,50 to 3,00		11,00 to 14,00		
X3CrNiMo17-13-3	1.4436	0,05	1,00	2,00	0,045	0,030 ^b	≤ 0,11	16,50 to 18,50		2,50 to 3,00		10,50 to 13,00		
X1NiCrMoCu31-27-4	1.4563	0,020	0,70	2,00	0,030	0,010	≤ 0,11	26,00 to 28,00	0,70 to 1,50	3,00 to 4,00		30,00 to 32,00		
X1CrNiMoCuN20-18-7	1.4547	0,020	0,70	1,00	0,030	0,010	0,18 to 0,25	19,50 to 20,50	0,50 to 1,00	6,00 to 7,00		17,50 to 18,50		
X1NiCrMoCuN25-20-7	1.4529	0,020	0,50	1,00	0,030	0,010	0,15 to 0,25	19,00 to 21,00	0,50 to 1,50	6,00 to 7,00		24,00 to 26,00		

^a Elements not quoted 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.

^b For products to be machined a controlled sulfur content of 0,015 % to 0,030 % is recommended.

Table 3 - Chemical composition (cast analysis) ^a of austenitic-ferritic stainless steels

Steel designation		% by mass										
name	number	C max	Si max	Mn max	P max	S max	N	Cr	Cu	Mo	Ni	W
X2CrNiMoN22-5-3	1.4462	0,030	1,00	2,00	0,035	0,015	0,10 to 0,22	21,00 to 23,00		2,50 to 3,50	4,50 to 6,50	
X2CrNiN23-4 ^{a)}	1.4362 ^{a)}	0,030	1,00	2,00	0,035	0,015	0,05 to 0,20	22,00 to 24,00		0,10 to 0,60	3,50 to 5,50	
X2CrNiMoCuN25-6-3	1.4507	0,030	0,70	2,00	0,035	0,015	0,15 to 0,30	24,00 to 26,00		2,70 to 4,00	5,50 to 7,50	
X2CrNiMoN25-7-4 ^{a)}	1.4410 ^{a)}	0,030	1,00	2,00	0,035	0,015	0,20 to 0,35	24,00 to 26,00		3,00 to 4,50	6,00 to 8,00	
X2CrNiMoCuWN25-7-4	1.4501	0,030	1,00	1,00	0,035	0,015	0,20 to 0,30	24,00 to 26,00	0,50 to 1,00	3,00 to 4,00	6,00 to 8,00	0,50 to 1,00
^{a)} Elements not quoted 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 product analysis tolerances on the limiting values given in Tables 1 to 3 for the cast analysis

Element	Specified limits, cast analysis % by mass	Permissible tolerance ^a % by mass
Carbon	$\leq 0,030$ $> 0,030 \leq 0,22$	$+0,005$ $\pm 0,01$
Silicon	$\leq 1,00$	$+0,05$
Manganese	$\leq 1,00$ $> 1,00 \leq 2,00$	$+0,03$ $+0,04$
Phosphorus	$\leq 0,045$	$+0,005$
Sulfur	$\leq 0,015$ $> 0,015 \leq 0,030$	$+0,003$ $+0,005$
Nitrogen	$\geq 0,05 \leq 0,35$	$\pm 0,01$
Chromium	$\geq 10,50 < 15,00$ $\geq 15,00 \leq 20,00$ $> 20,00 \leq 28,00$	$\pm 0,15$ $\pm 0,20$ $\pm 0,25$
Copper	$\leq 1,00$ $> 1,00 \leq 2,50$	$\pm 0,07$ $\pm 0,10$
Molybdenum	$\leq 0,60$ $> 0,60 < 1,75$ $\geq 1,75 \leq 7,00$	$\pm 0,03$ $\pm 0,05$ $\pm 0,10$
Niobium	$\leq 1,00$	$\pm 0,05$
Nickel	$\leq 1,00$ $> 1,00 \leq 5,00$ $> 5,00 \leq 10,00$ $> 10,00 \leq 20,00$ $> 20,00 \leq 32,00$	$\pm 0,03$ $\pm 0,07$ $\pm 0,10$ $\pm 0,15$ $\pm 0,20$
Titanium	$\leq 0,80$	$\pm 0,05$
Tungsten	$\leq 1,00$	$\pm 0,05$
^a If several product analyses are carried out on one cast, and the content of an individual element determined lies 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.		

Table 5 - • Type of process route and surface finish ^a

	Abbreviation ^b	Type of process route	Surface finish	Notes ^c
Hot formed	1U	Hot formed, not heat treated, not descaled	Covered with scale (spot ground if necessary)	Suitable for products to be further hot formed. For semi-finished products, ground on all sides can be specified
	1C	Hot formed, heat treated ^c , not descaled	Covered with scale (spot ground if necessary)	Suitable for products to be further processed. For semi-finished products, ground on all sides can be specified
	1E	Hot formed, heat treated ^c , mechanically descaled	Largely free of scale (but some black spots may remain)	The type of mechanical descaling, e.g. grinding, peeling or shot blasting, is left to the manufacturer's discretion unless otherwise agreed. Suitable for products to be further processed
	1D	Hot formed, heat treated ^c , pickled	Free of scale	Tolerance $\geq$ IT 14 ^{f,g}
	1X	Hot formed, heat treated ^c , rough machined (peeled or rough turned)	Metallically clean	Tolerance $\geq$ IT 12 ^{f,g}
Cold processed	2H	Heat treated ^c , mechanically or chemically descaled, cold processed ^d	Smooth and bright. Substantially smoother than finishes 1E, 1D or 1X	On products formed by cold drawing without subsequent heat treatment, the tensile strength is substantially increased, particularly on austenitic structure, depending on the degree of forming. Tolerance IT 9 to IT 11 ^{f,g}
	2D	Cold processed ^d , heat treated ^c , pickled (skin-passed)	Smoother than finishes 1E or 1D	Finish for good ductility
	2B	Heat treated ^c , machined (peeled), mechanically smoothed	Smoother and brighter than finishes 1E, 1D or 1X	Pre-finish for close ISO-tolerances. Tolerance IT 9 or IT 11 ^{f,g}
Special finishing processes	1G or 2G	Centreless ground	Uniform finish. Type and degree of grinding to be agreed	Surface roughness can be specified. Finish for close ISO-tolerances. Normally obtained from material in finishes 1E, 1D, 2H or 2B. Tolerance $\leq$ IT 8 ^{f,g}
	1P or 2P	Polished	Smoother and brighter than finish 1G or 2G. Type and degree of polishing to be agreed	Surface roughness can be specified. Finish for close ISO-tolerances. Normally obtained from material in finishes 1E, 1D, 2B, 1G, 2G or 2H. Tolerance $\leq$ IT 11 ^{f,g}

^a Not all process routes and surface finishes are available for all steels.

^b First digit, 1 hot formed, 2 cold processed.

^c On ferritic, austenitic and austenitic-ferritic grades, the heat treatment may be omitted if the conditions for hot forming and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion are obtained.

^d The type of cold processing, e. g. cold drawing, turning, or centreless grinding, is left to the manufacturer's discretion, provided that the requirements concerning tolerances on dimensions and surface roughness are respected.

^e The notes contain information concerning tolerances for bright bars; special agreements are necessary if such information should become obligatory. The given standard tolerance grades IT are taken from ISO 286-1 (see annex C).

^f For information.

^g Specific tolerance within the ranges shall be agreed upon at the time of enquiry and order.

Table 6 - Mechanical properties at room temperature and minimum impact energy for ferritic and martensitic steels in the heat-treated condition (see Table A.1)

Steel designation		Thickness <i>d</i> mm	Heat- treatment condition ^a	Hardness HB ^b max	0,2 %-proof strength <i>R</i> _{p0,2} N/mm ² min	Tensile strength <i>R</i> _m N/mm ²	Elongation after fracture <i>A</i> % min		Impact energy after fracture (ISO-V) <i>KV</i> J min		
name	number						(long.)	(tr.)	(long.)	(tr.)	at 20 °C (long.)
ferritic stainless steel											
X2CrNi12	1.4003	≤ 100	+A	200 °c	260	450 to 600 °c	20 ^d	-	60		
martensitic stainless steels											
X12Cr13 ^e	1.4006		+A	220 ^e	-	max 730 °c	-	-	-	-	
		≤ 160	+QT650		450	650 to 850	15	-	25	-	
X17CrNi16-2 ^e	1.4057		+A	295 ^e	-	max 950 °c	-	-	-	-	-
		≤ 60					14		25		
		60 < <i>d</i> ≤ 160	+QT800	-	600	800 to 950	12	-	20	-	
		≤ 60	+QT900	-	700	900 to 1 050	12		20		
		60 < <i>d</i> ≤ 160					10	-	15	-	
X3CrNiMo13-4 ^e	1.4313		+A	320	-	max 1 100	-	-	-	-	
		≤ 160					15	-	70	-	40
		160 < <i>d</i> ≤ 250	+QT650	-	520	650 to 830	-	12	-	50	
		≤ 160					15	-	70	-	
		160 < <i>d</i> ≤ 250	+QT780	-	620	780 to 980	-	12	-	50	
		≤ 160					12	-	50	-	
		160 < <i>d</i> ≤ 250	+QT900	-	800	900 to 1 100	-	10	-	40	
(to be continued)											

Table 6 (continued)

Steel designation		Thickness <i>d</i> mm	Heat- treatment condition ^a	Hardness HB ^b max	0,2 %-proof strength <i>R</i> _{p0,2} N/mm ² min	Tensile strength <i>R</i> _m N/mm ²	Elongation after fracture <i>A</i> % min		Impact energy (ISO-V) <i>KV</i> J min			
name	number						(long.)	(tr.)	at 20 °C		at -20 °C	
							(long.)	(tr.)	(long.)	(tr.)	(long.)	(tr.)
X4CrNiMo16-5-1	1.4418		+A ^e	320	-	max 1 100	-	-	-	-	-	-
		≤ 160					16	-	90	-	40	-
		160 < <i>d</i> ≤ 250	+QT760	-	550	760 to 960	-	14	-	70	-	-
		≤ 160					16	-	80	-	-	-
		160 < <i>d</i> ≤ 250	+QT900	-	700	900 to 1 100	-	14	-	60	-	-

^a +A annealed; +QT quenched and tempered
^b Only for guidance.
^c HB_{max}-values may be raised by 60 units or *R*_{m,max}-values may be raised by 150 N/mm² for bars of ≤ 35 mm thickness having a final cold deformation.
^d The minimum elongation value may be lowered to 10 % for bars of ≤ 35 mm thickness having a final cold deformation.
^e **Warning: Products made of these material grades and to this heat treatment conditions respectively are unlikely to support the essential requirements of Directive 97/23/EC unless other criteria are taken into account, see annex 1, section 7.5 of this Directive.**

Table 7 - Mechanical properties at room temperature and minimum impact energy of austenitic steels in the solution annealed condition ^{*)} (see Table A.2) and resistance to intergranular corrosion

Steel designation		Thickness <i>d</i> mm	Hardness a, b HB max	0,2 %- proof strength <i>R</i> _{p0,2} <i>R</i> _{p1,0} N/mm ² min		Tensile strength <i>R</i> _m ^b N/mm ²	Elongation after fracture <i>A</i> ^b % min		Impact energy (ISO-V) <i>KV</i> J min. at 20 °C at –196 °C (long.) (tr.) (tr.)			Resistance to intergranular corrosion ^c in the delivery condition		in the sensitized condition ^d
name	number			(long.)	(tr.)		(tr.)	(tr.)	(tr.)	(tr.)	(tr.)	(tr.)		
X2CrNi18-9	1.4307	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	175	210	450 to 680	45 -	- 35	100 -	- 60	60	yes	yes	
X2CrNi19-11	1.4306	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	180	215	460 to 680	45 -	- 35	100 -	- 60	60	yes	yes	
X2CrNi18-10	1.4311	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	230	270	305	550 to 760	40 -	- 30	100 -	- 60	60	yes	yes	
X5CrNi18-10	1.4301	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	190	225	500 to 700	45 -	- 35	100 -	- 60	60	yes ^e	yes ^e	no ^f
X6CrNiTi18-10	1.4541	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	190	225	500 to 700	40 -	- 30	100 -	- 60	60	yes	yes	
X2CrNiMo17-12-2	1.4404	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	200	235	500 to 700	40 -	- 30	100 -	- 60	60	yes	yes	
X2CrNiMoN17-11-2	1.4406	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	250	280	315	580 to 800	40 -	- 30	100 -	- 60	60	yes	yes	
X5CrNiMo17-12-2	1.4401	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	200	235	500 to 700	40 -	- 30	100 -	- 60	60	yes ^e	yes ^e	no ^f
X6CrNiMoTi17-12-2	1.4571	<i>d</i> ≤ 160 160 < <i>d</i> ≤ 250	215	200	235	500 to 700	40 -	- 30	100 -	- 60	60	yes	yes	

(to be continued)

(to be continued)

Table 7 (continued)

Steel designation		Thickness <i>d</i> mm	Hardness _{a, b} HB max	0,2 %- proof strength $R_{p0,2}$ $R_{p1,0}$ N/mm ² min		Tensile strength R_m^b N/mm ²	Elongation after fracture A^b % min		Impact energy (ISO-V) KV J min			Resistance to intergranular corrosion _c	
name	number						(long.)	(tr.)	at 20 °C	(long.)	(tr.)	in the delivery condition	in the sensitized condition ^d
X2CrNiMo17-12-3	1.4432	$d \leq 160$	215	200	235	500 to 700	40	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	60		
X2CrNiMo18-14-3	1.4435	$d \leq 160$	215	200	235	500 to 700	40	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	60		
X2CrNiMoN17-13-5	1.4439	$d \leq 160$	250	280	315	580 to 800	35	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	60		
X1NiCrMoCu25-20-5	1.4539	$d \leq 160$	230	230	260	530 to 730	35	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	60		
X6CrNiNb18-10	1.4550	$d \leq 160$	230	205	240	510 to 740	40	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	40		
X6CrNiMoNb17-12-2	1.4580	$d \leq 160$	230	215	250	510 to 740	35	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	-		
X2CrNiMoN17-13-3	1.4429	$d \leq 160$	250	280	315	580 to 800	40	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	60		
X3CrNiMo17-13-3	1.4436	$d \leq 160$	215	200	235	500 to 700	40	-	100	-	-	yes	no ^f
		$160 < d \leq 250$					-	30	-	60	60		
X1NiCrMoCu31-27-4	1.4563	$d \leq 160$	230	220	250	500 to 750	35	-	100	-	-	yes	yes
		$160 < d \leq 250$					-	30	-	60	60		

(to be continued)

Table 7 (continued)

name	Steel designation	number	Thickness <i>d</i> mm	Hardness <i>a, b</i> HB max	0,2 %- proof strength <i>R_{p0,2}</i> <i>R_{p1,0}</i> N/mm ² min	1 %- proof strength <i>R_{p1,0}</i> N/mm ² min	Tensile strength <i>R_m^b</i> N/mm ²	Elongation after fracture <i>A^b</i> % min			Impact energy (ISO-V) <i>KV</i> J min			Resistance to intergranular corrosion <i>c</i>		
								(long.)	(tr.)	(tr.)	(long.)	(tr.)	(tr.)	at 20 °C at -196 °C	in the delivery condition	in the sensitized condition ^d
X1CrNiMoCuN20-18-7		1.4547	<i>d</i> ≤ 160	260	300	340	650 to 850	35	-	100	-	60	yes	yes		
			160 < <i>d</i> ≤ 250					-	30	-						
X1NiCrMoCuN25-20-7		1.4529	<i>d</i> ≤ 160	250	300	340	650 to 850	40	-	100	-	40	yes	yes		
			160 < <i>d</i> ≤ 250					-	35	-	60					
^a	Only for guidance.															
^b	The maximum HB-values may be raised by 100 HB or the tensile strength value may be raised by 200 N/mm ² and the minimum elongation value be lowered to 20 % for bars of ≤ 35 mm thickness having a final cold deformation.															
^c	When tested according to EN ISO 3651-2.															
^d	See NOTE 2 to 9.4.															
^e	Resistance to intergranular corrosion is given for cross-sections up to 40 mm diameter.															
^f	Resistance to intergranular corrosion in the sensitized condition is given for cross-sections up to 40 mm diameter, when the sensitization treatment is carried out according to method T2 of EN ISO 3651-2 (sensitization treatment of 10 min at 650 °C ± 10 °C, followed by cooling in water).															
^{*)}	The solution treatment may be omitted if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EN ISO 3651-2 are obtained.															

Table 8 - Mechanical properties at room temperature and minimum impact energy of austenitic-ferritic steels in the solution annealed condition (see Table A.3) and resistance to intergranular corrosion

Steel designation		Thickness <i>d</i> mm	Hardness ^a HB max	0,2 %- proof strength <i>R</i> _{p0,2} N/mm ² min	Tensile strength <i>R</i> _m N/mm ²	Elonga- tion after fracture <i>A</i> % min (long.)	Impact energy (ISO-V) <i>KV</i>		Resistance to intergranular corrosion ^b		
name	number						J min at 20 °C (long.)	at -40 °C (long.)	in the delivery condition	in the welded condition ^c	
X2CrNiMoN22-5-3	1.4462	<i>d</i> ≤ 160	270	450	650 to 880	25	100	40	yes	yes	
X2CrNiN23-4	1.4362	<i>d</i> ≤ 160	260	400	600 to 830	25	100	40	yes	yes	
X2CrNiMoCuN25-6-3	1.4507	<i>d</i> ≤ 160	270	500	700 to 900	25	100	40	yes	yes	
X2CrNiMoN25-7-4	1.4410	<i>d</i> ≤ 160	290	530	730 to 930	25	100	40	yes	yes	
X2CrNiMoCuWN25-7-4	1.4501	<i>d</i> ≤ 160	290	530	730 to 930	25	100	40	yes	yes	
^a Only for guidance. ^b When tested according to EN ISO 3651-2. ^c See NOTE 2 to 9.4.											

Table 9 - Minimum values for the 0,2 % proof strength of ferritic and martensitic steels at elevated temperatures

Steel designation		Heat treatment condition ^a	Minimum 0,2 % proof strength (N/mm²) at a temperature (in °C) of <i>R</i> _{p0,2} , min						
name	number		100	150	200	250	300	350	400
ferritic stainless steel									
X2CrNi12	1.4003	+A	240	230	220	215	210	-	-
martensitic stainless steels									
X12Cr13	1.4006	+QT650	420	410	400	385	365	335	305
X17CrNi16-2	1.4057	+QT800	515	495	475	460	440	405	355
		+QT900	565	525	505	490	470	430	375
X3CrNiMo13-4	1.4313	+QT650	500	490	480	470	460	450	-
		+QT780	590	575	560	545	530	515	-
		+QT900	720	690	665	640	620	-	-
X4CrNiMo16-5-1	1.4418	+QT760	520	510	500	490	480	-	-
		+QT900	660	640	620	600	580	-	-
^a +A annealed; +QT quenched and tempered									

Table 10 - Minimum values for the 0,2 % and 1 % proof strength of austenitic steels at elevated temperatures in the solution annealed condition (see Table A.2)

Steel designation		Minimum 0,2 % proof strength (N/mm ²) <i>R_{p0,2}</i> , min												Minimum 1 % proof strength (N/mm ²) <i>R_{p1,0}</i> , min												Limit temperature in °C									
name	number	at a temperature (in °C) of																																	
		100	150	200	250	300	350	400	450	500	550	100	150	200	250	300	350	400	450	500	550														
X2CrNi18-9		1.4307	145	130	118	108	100	94	89	85	81	80	180	160	145	135	127	121	116	112	109	108													350
X2CrNi19-11		1.4306	145	130	118	108	100	94	89	85	81	80	180	160	145	135	127	121	116	112	109	108													350
X2CrNiN18-10		1.4311	205	175	157	145	136	130	125	121	119	118	240	210	187	175	167	160	156	152	149	147													400
X5CrNi18-10		1.4301	155	140	127	118	110	104	98	95	92	90	190	170	155	145	135	129	125	122	120	120													300
X6CrNiTi18-10		1.4541	175	165	155	145	136	130	125	121	119	118	205	195	185	175	167	161	156	152	149	147													400
X2CrNiMo17-12-2		1.4404	165	150	137	127	119	113	108	103	100	98	200	180	165	153	145	139	135	130	128	127													400
X2CrNiMoN17-11-2		1.4406	215	195	175	165	155	150	145	140	138	136	245	225	205	195	185	180	175	170	168	166													400
X5CrNiMo17-12-2		1.4401	175	158	145	135	127	120	115	112	110	108	210	190	175	165	155	150	145	141	139	137													300
X6CrNiMoTi17-12-2		1.4571	185	175	165	155	145	140	135	131	129	127	215	205	192	183	175	169	164	160	158	157													400
X2CrNiMo17-12-3		1.4432	165	150	137	127	119	113	108	103	100	98	200	180	165	153	145	139	135	130	128	127													400
X2CrNiMo18-14-3		1.4435	165	150	137	127	119	113	108	103	100	98	200	180	165	153	145	139	135	130	128	127													400
X2CrNiMoN17-13-5		1.4439	225	200	185	175	165	155	150	-	-	-	255	230	210	200	190	180	175	-	-	-													400
X1NiCrMoCu25-20-5		1.4539	205	190	175	160	145	135	125	115	110	105	235	220	205	190	175	165	155	145	140	135													400
X6CrNiNb18-10		1.4550	175	165	155	145	136	130	125	121	119	118	210	195	185	175	167	161	156	152	149	147													400
X6CrNiMoNb17-12-2		1.4580	186	177	167	157	145	140	135	131	129	127	221	206	196	186	175	169	164	160	158	157													400
X2CrNiMoN17-13-3		1.4429	215	195	175	165	155	150	145	140	138	136	245	225	205	195	185	180	175	170	168	166													400
X3CrNiMo17-13-3		1.4436	175	158	145	135	127	120	115	112	110	108	210	190	175	165	155	150	145	141	139	137													300
X1NiCrMoCu31-27-4		1.4563	190	175	160	155	150	145	135	125	120	115	220	205	190	185	180	175	165	155	150	145													400
X1CrNiMoCuN20-18-7		1.4547	230	205	190	180	170	165	160	153	148	-	270	245	225	212	200	195	190	184	180	-													400
X1NiCrMoCuN25-20-7		1.4529	230	210	190	180	170	165	160	-	-	-	270	245	225	215	205	195	190	-	-	-													400

^a When used up to temperatures listed in the table, and for service times up to 100 000 hours, no intercrystalline corrosion will occur when tested as described in EN ISO 3651-2.

^a When used up to temperatures listed in the table, and for service times up to 100 000 hours, no intercrystalline corrosion will occur when tested as described in EN ISO 3651-2.

Table 11 - Minimum values for the 0,2 % proof strength of austenitic-ferritic steels at elevated temperatures in the solution annealed condition (see Table A.3)

Steel designation		Minimum 0,2 % proof strength (N/mm ²) $R_{p0,2}$, min at a temperature (in °C) of				Limit temperature ^a in °C
name	number	100	150	200	250	
X2CrNiMoN22-5-3	1.4462	360	335	315	300	250
X2CrNiN23-4	1.4362	330	300	280	265	250
X2CrNiMoCuN25-6-3	1.4507	450	420	400	380	250
X2CrNiMoN25-7-4	1.4410	450	420	400	380	250
X2CrNiMoCuWN25-7-4	1.4501	450	420	400	380	250
^a When used up to temperatures listed in the table, and for service times up to 100 000 hours, no intercrystalline corrosion will occur when tested as described in EN ISO 3651-2.						

Table 12 - Minimum values for the tensile strength of austenitic steels at elevated temperatures in the solution annealed condition (see Table A.2)

Steel designation		Minimum tensile strength (N/mm ²) <i>R_m</i> , min									
name	number	at a temperature (in °C) of									
		100	150	200	250	300	350	400	450	500	550
X2CrNi18-9	1.4307	410	380	360	350	340	340	-	-	-	-
X2CrNi19-11	1.4306	410	380	360	350	340	340	-	-	-	-
X2CrNi18-10	1.4311	490	460	430	420	410	410	-	-	-	-
X5CrNi18-10	1.4301	450	420	400	390	380	380	380	370	360	330
X6CrNiTi18-10	1.4541	440	410	390	385	375	375	375	370	360	330
X2CrNiMo17-12-2	1.4404	430	410	390	385	380	380	380	-	360	-
X2CrNiMoN17-11-2	1.4406	520	490	460	450	440	435	-	-	-	-
X5CrNiMo17-12-2	1.4401	430	410	390	385	380	380	-	-	-	-
X6CrNiMoTi17-12-2	1.4571	440	410	390	385	375	375	375	370	360	330
X2CrNiMo17-12-3	1.4432	430	410	390	385	380	380	380	375	360	-
X2CrNiMo18-14-3	1.4435	420	400	380	375	370	370	-	-	-	-
X2CrNiMoN17-13-5	1.4439	520	490	460	450	440	435	-	-	-	-
X1NiCrMoCu25-20-5	1.4539	500	480	460	450	440	435	-	-	-	-
X6CrNiNb18-10	1.4550	435	400	370	350	340	335	330	320	310	300
X6CrNiMoNb17-12-2	1.4580	440	410	390	385	375	375	375	370	360	330
X2CrNiMoN17-13-3	1.4429	520	490	460	450	440	435	435	-	430	-
X3CrNiMo17-13-3	1.4436	460	440	420	415	410	410	410	-	390	-
X1NiCrMoCu31-27-4	1.4563	460	445	430	410	400	395	-	-	-	-
X1CrNiMoCuN20-18-7	1.4547	615	587	560	542	525	517	510	502	495	-
X1NiCrMoCuN25-20-7	1.4529	610	585	560	540	525	515	510	-	-	-

Table 13 - Tests to be carried out, test units and extent of testing in specific testing

Test	^a	Test unit	Number of samples per test unit	Number of test pieces per sample
Chemical analysis	m	Cast	The cast analysis is provided by the manufacturer ^b	
Tensile test at room temperature	m	Batch ^c	1 sample per 2 000 kg; maximum of 2 per test unit; for individual bars of masses more than 2 000 kg, only one sample shall be taken	1
Impact test at room temperature	m ^d			3
Tensile test at elevated temperature	o ^e		To be agreed at the time of enquiry and order	1
Impact test at low temperature	o ^f		To be agreed at the time of enquiry and order	3
Resistance to intergranular corrosion	o		To be agreed at the time of enquiry and order	1
^a Tests marked with a “m” (mandatory) shall be carried out as specific tests. In all cases, those marked with an “o” (optional) shall be carried out as specific tests only if agreed at the time of ordering.				
^b A product analysis may be agreed at the time of ordering; unless otherwise agreed, one test piece per cast shall be taken for determining the elements indicated with numerical values for the particular steel grade in Tables 1 to 3.				
^c Each batch consists of products coming from the same cast. The products must have been subject to the same heat treatment cycle in the same furnace. In the case of a continuous furnace or in process annealing a batch is the lot heat treated without intermission with the same process parameters. The shape and size of cross-sections of products in a single batch may be different providing that the ratio of the largest to the smallest areas shall be equal or less than three.				
^d Optional for austenitic steels.				
^e Unless otherwise agreed, testing shall be carried out at the highest temperature for which the value is specified in the relevant table.				
^f For steels for use at low temperatures.				

Table 14 - Marking of the products

Marking of	Symbol ^a
Manufacturer's name, trade mark or logo	+
Steel name or number	+
Cast number	+
Identification number ^b	+
Inspector's mark	+
^a The symbol “+” means that the marking shall be applied. ^b The numbers or letters used for identification shall allow the product(s) to be related to the relevant inspection certificate or inspection report and to this European Standard.	

Annex A (informative)

Guidelines for further treatment (including heat treatment) in fabrication

A.1 The guidelines given in Tables A.1 to A.3 are intended for hot forming and heat treatment.

A.2 Flame cutting may adversely affect edge areas; where necessary, they should be machined.

A.3 As the corrosion resistance of stainless steels is only ensured with a metallurgically clean surface, layers of scale and annealing colours produced during hot forming, heat treatment or welding should be removed as far as possible before use. Finished parts made of ferritic and martensitic steels with a minimum of 10,5 % Cr also require the best surface condition (e.g. polished) in order to achieve maximum resistance to corrosion.

Table A.1 - Guidelines on the temperatures for hot forming and heat treatment ^a of ferritic and martensitic stainless steels

Steel designation		Hot forming		Heat treatment symbol	Annealing		Quenching		Tempering
name	number	Temperature °C	Type of cooling		Temperature °C	Type of cooling	Temperature °C	Type of cooling	Temperature °C
ferritic stainless steel									
X2CrNi12	1.4003	1 100 to 800	air	+A	680 to 740	air	-	-	-
martensitic stainless steels									
X12Cr13	1.4006	1 000 to 800	air	+A	745 to 825	air	-	-	-
				+QT650	-	-	950 to 1 000	oil, air	580 to 780
X17CrNi16-2	1.4057		slow cooling	+A ^b	680 to 800	furn., air	-	-	-
				+QT800 ^c	-	-	950 to 1 050	oil, air	750 to 800 + 650 to 700 ^e
				+QT900	-	-	950 to 1 050	oil, air	600 to 650
X3CrNiMo13-4	1.4313			air	+A ^d	600 to 650	furn., air	-	-
			+QT650		-	-	950 to 1 050	oil, air	650 to 700 + 600 to 620
			+QT780		-	-	950 to 1 050	oil, air	550 to 600
			+QT900		-	-	950 to 1 050	oil, air	520 to 580
X4CrNiMo16-5-1	1.4418		+A ^d		600 to 650	air, furn.	-	-	-
		+QT760	-		-	950 to 1 050	oil, air	590 to 620 ^e	
		+QT900	-		-	950 to 1 050	oil, air	550 to 620	
^a The temperatures of annealing, quenching and tempering shall be agreed for simulated heat-treated test pieces. ^b Double annealing might be advisable. ^c In the case that the nickel is at the lower side of the range specified in Table 1, a single tempering at 620 to 720 °C may be sufficient. ^d Tempering after martensitic transformation. ^e Either 2 × 4 h or 1 × 8 h as minimum time.									

Table A.2 - Guidelines on the temperatures for hot forming and heat treatment ^a of austenitic stainless steels

Steel designation		Hot forming		Heat treatment symbol	Solution annealing ^b	
name	number	Temperature °C	Type of cooling		Temperature ^c °C	Type of cooling
X2CrNi18-9	1.4307	1 200 to 900	air	+AT	1 000 to 1 100	water, air ^d
X2CrNi19-11	1.4306				1 000 to 1 100	
X2CrNiN18-10	1.4311				1 000 to 1 100	
X5CrNi18-10	1.4301				1 000 to 1 100	
X6CrNiTi18-10	1.4541				1 020 to 1 120	
X2CrNiMo17-12-2	1.4404				1 020 to 1 120	
X2CrNiMoN17-11-2	1.4406				1 020 to 1 120	
X5CrNiMo17-12-2	1.4401				1 020 to 1 120	
X6CrNiMoTi17-12-2	1.4571				1 020 to 1 120	
X2CrNiMo17-12-3	1.4432				1 020 to 1 120	
X2CrNiMo18-14-3	1.4435				1 020 to 1 120	
X2CrNiMoN17-13-5	1.4439				1 020 to 1 120	
X1NiCrMoCu25-20-5	1.4539				1 050 to 1 150	
X6CrNiNb18-10	1.4550	1 150 to 850			1 020 to 1 120	
X6CrNiMoNb17-12-2	1.4580	1 150 to 850			1 020 to 1 120	
X2CrNiMoN17-13-3	1.4429	1 200 to 900			1 020 to 1 120	
X3CrNiMo17-13-3	1.4436				1 020 to 1 120	
X1NiCrMoCu31-27-4	1.4563				1 050 to 1 150	
X1CrNiMoCuN20-18-7	1.4547	1 200 to 950			1 140 to 1 200	
X1NiCrMoCuN25-20-7	1.4529	1 200 to 950			1 120 to 1 180	
^a The temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.						
^b The solution annealing may be omitted, if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in ISO 3651-2 are obtained and maintained after an additional solution annealing.						
^c The lower end of the range specified for solution annealing should be aimed at for heat treatment as part of further processing, because otherwise the mechanical properties might be affected. If the temperature of hot forming does not drop below the lower temperature for solution annealing, a temperature of 980 °C is adequate as lower limit for Mo-free steels, a temperature of 1 000 °C for steels with Mo contents up to 3 % and a temperature of 1 020 °C for steels with Mo contents exceeding 3 %.						
^d Cooling sufficiently rapid.						

Table A.3 - Guidelines on the temperatures for hot forming and heat treatment ^a of austenitic-ferritic stainless steels

Steel designation		Hot forming		Heat treatment symbol	Solution annealing	
name	number	Temperature °C	Type of cooling		Temperature °C	Type of cooling
X2CrNiMoN22-5-3	1.4462	1 200 to 950	air	+AT	1 020 to 1 100	water, air ^b
X2CrNiN23-4	1.4362	1 200			950 to 1 050	water, air
X2CrNiMoCuN25-6-3	1.4507				1 040 to 1 120	water
X2CrNiMoN25-7-4	1.4410				to	1 040 to 1 120
X2CrNiMoCuWN25-7-4	1.4501	1 000			1 040 to 1 120	water
^a The temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.						
^b Cooling sufficiently rapid.						

Annex B
(informative)

Preliminary reference data for the tensile strength of austenitic-ferritic steels at elevated temperatures

Table B.1 - Minimum values for the tensile strength of austenitic-ferritic steels at elevated temperatures in the solution annealed condition (see A.3)

Steel designation		Minimum tensile strength R_m , min. N/mm ² at a temperature (in °C) of			
name	number	100	150	200	250
X2CrNiN23-4	1.4362	540	520	500	490
X2CrNiMoN22-5-3	1.4462	590	570	550	540
X2CrNiMoCuN25-6-3	1.4507	660	640	620	610
X2CrNiMoN25-7-4	1.4410	680	660	640	630
X2CrNiMoCuWN25-7-4	1.4501	680	660	640	630

Annex C
(informative)

Applicable dimensional standards

EN 10278, *Dimensions and tolerances of bright steel products*

prEN 10058:2000, *Hot rolled flat steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

prEN 10059:2000, *Hot rolled square steel bars for general purposes - Dimensions and tolerances on shape and dimensions*

prEN 10060:2000, *Hot rolled round steel bars - Dimensions and tolerances on shape and dimensions*

prEN 10061:2000, *Hot rolled hexagon steel bars - Dimensions and tolerances on shape and dimensions*

ISO 286-1, *ISO system of limits and fits - Part 1: Bases of tolerances, deviations and fits*

Annex D (informative)

National A-deviations

A-deviation: National deviations due to regulations, the alteration of which is for the time being outside the competence of the CEN/CENELEC member.

In the relevant CEN/CENELEC countries these A-deviations are valid instead of the provisions of the European Standard until they have been removed. This A-deviation becomes however invalid when the EU Directive 97/23/EC comes generally into force, at latest 2002-05-30.

Swedish national legislative deviations on stainless steel bars for pressure purposes in accordance with EN 10272.

This European Standard is, partly not considering the specific requirements laid down in Ordinance AFS 1994-39¹⁾, in conflict with the Swedish regulatory system which only accepts steels for which the specific properties are adequately validated and documented in Sweden. Only the following grades (given by the steel numbers) are therefore accepted for use in Sweden.

Austenitic steels: 1.4306, 1.4307, 1.4311, 1.4404, 1.4429, 1.4432, 1.4435, 1.4436, 1.4539, 1.4541, 1.4550 and 1.4571.

¹⁾ AFS is the abbreviation for the set of ordinances of the Swedish National Board of Occupational Safety and Health.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of EU Directives

This European Standard has been prepared under a mandate given to CEN by the European Commission and supports essential requirements of EU Directive 97/23/EC.

Warning: Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this European Standard.

The clauses of this European Standard are likely to support the essential requirements of section 4 of annex 1, “Essential safety requirements” of the Pressure Equipment Directive 97/23/EC (but see Table 6, footnote e).

Compliance with this European Standard provides one means of conforming with the specific essential requirements of the Directive concerned.

Bibliography

EN 10269, *Steels and nickel alloys for fasteners with specified elevated and/or low temperature properties*

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

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