BRITISH STANDARD

BS EN
10028-7:2000
Incorporating
Corrigendum No. 1

Flat products made of steels for pressure purposes —

Part 7: Stainless steels

The European Standard EN 10028-7:2000 has the status of a British Standard

ICS 77.140.20; 77.140.30

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 10028-7:2000, including Corrigendum July 2004. It supersedes BS 1501-3:1990 which is withdrawn.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 international/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

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

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This British Standard having been prepared under the direction of the Engineering Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 July 2000

Summary of pages

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Amendments issued since publication

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15330 Corrigendum No. 1	17 August 2004	Changes to Table 1 and Table 3.

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EUROPEAN STANDARD

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EN 10028-7

January 2000

ICS 77.140.20; 77.140.30

Incorporating corrigendum July 2004

English version

Flat products made of steels for pressure purposes - Part 7: Stainless steels

Produits plats en aciers pour appareils à pression - Partie 7: Aciers inoxydables

Flacherzeugnisse aus Druckbehälterstählen - Teil 7: Nichtrostende Stähle

This European Standard was approved by CEN on 3 September 1999.

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

Ref. No. EN 10028-7:2000 E

Contents

NOTE: The clauses marked by two points (••) contain information relating to agreements that may be made at the time of enquiry and order.

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 22, Steels for pressure purposes - Qualities, the Secretariat of which is held by 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 July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

The steel grades covered by this European Standard have been selected from EN 10088-1, additionally considering austenitic creep resisting steels.

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

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.

The other parts of this European Standard are:

Part 1 General requirements;

Part 2 Non-alloy and alloy steels with specified elevated temperature properties;

Part 3 Weldable fine grain steels, normalized;

Part 4 Nickel alloy steels with specified low temperature properties;

Part 5 Weldable fine grain steels, thermomechanically rolled;

Part 6 Weldable fine grain steels, quenched and tempered.

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

This EN 10028-7 specifies requirements for flat products for pressure purposes made of stainless steels, including austenitic creep resisting steels, in thicknesses as indicated in Tables 6 to 9.

The requirements of EN 10028-1 also 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 10028-1	Flat products made of steels for pressure purposes - Part 1: General requirements.
EN 10029	Hot rolled plates 3 mm thick or above - Tolerances on dimensions, shape and mass.
EN 10088-1	Stainless steels - Part 1: List of stainless steels.
EN 10204	Metallic products - Types of inspection documents.
EN ISO 3651-2	Determination of the resistance to intergranular corrosion of stainless steels - Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test in media containing sulfuric acid.
EURONORM 103	Microscopic determination of the ferritic or austenitic grain size of steels.

3 Definitions

See EN 10028-1.

4 Dimensions and tolerances on dimensions

See EN 10028-1.

5 Calculation of mass

For density of corrosion-resisting steels, see annex A of EN 10088-1.

For density of austenitic creep-resisting steels, see annex A of this EN 10028-7.

6 Classification and designation

See EN 10028-1.

7 Information to be supplied by the purchaser

7.1 Mandatory information

See EN 10028-1.

7.2 Options

A number of options are specified in this EN 10028-7 and listed below. Additionally the relevant options of EN 10028-1 apply. If the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the supplier shall supply in accordance with the basic specification (see EN 10028-1).

a) mechanical properties for increased product thicknesses (see Table 7, footnote 5);

b) higher $R_{p0,2}$ and $R_{p1,0}$ values for continuously hot rolled products (see Table 9, footnote 4 and Table 10, footnote 2);

7.3 Example for ordering

10 plates made of a steel grade with the name X5CrNi18-10 and the number 1.4301 as specified in EN 10028-7 with nominal dimensions, thickness = 8 mm, width = 2 000 mm, length = 5 000 mm; tolerances on dimensions, shape and mass as specified in EN 10029 with thickness tolerance class A and ‘normal’ flatness tolerance in process route 1D (see Table 6), inspection document 3.1.B as specified in EN 10204:

10 plates EN 10029 - 8A × 2 000 × 5 000
Steel EN 10028-7 - X5CrNi18-10+1D
Inspection document 3.1.B

or

10 plates EN 10029 - 8A × 2 000 × 5 000
Steel EN 10028-7 - 1.4301+1D
Inspection document 3.1.B

8 Requirements

8.1 Steelmaking process

See EN 10028-1.

8.2 Delivery condition

The products shall be supplied in the delivery condition specified in the order by reference to the process route given in Table 6 and, where alternatives exist, to the treatment conditions given in Tables 7 to 10. Guidelines for further treatment including heat treatment are given in annex B.

8.3 Chemical composition and chemical corrosion properties

8.3.1 The chemical composition requirements given in Tables 1 to 4 apply in respect of the chemical composition according to the cast analysis.

8.3.2 The product analysis may deviate from the limiting values for the cast analysis given in Tables 1 to 4 by the values listed in Table 5.

8.3.3 Referring to resistance to intergranular corrosion as defined in EN ISO 3651-2, for ferritic, austenitic and austenitic-ferritic steels the specifications in Tables 7, 9 and 10 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.

8.4 Mechanical properties

8.4.1 The tensile properties at room temperature and the impact energy at room and at low temperatures as specified in Tables 7 to 10 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.

8.4.2 The values in Tables 11 to 14 apply for the 0,2 % and 1,0 % proof strength at elevated temperatures. Additionally, the values in Table 15 apply for the tensile strength at elevated temperatures.

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

8.4.3 Annex E gives mean values as preliminary data for the purchaser about creep strength and creep rupture. These data apply for the solution annealed condition only.

8.4.4 In annex F preliminary data on mechanical properties at low temperatures of austenitic steels are listed.

8.5 Surface condition

See EN 10028-1 and Table 6.

8.6 Internal soundness

See EN 10028-1.

8.7 Physical properties

Reference data on some physical properties of austenitic creep resisting steels are given in annex A. For other stainless steels, see annex A of EN 10088-1.

8.8 Post weld heat treatment

Guidelines for the purchaser on post weld heat treatment are given in annex C.

9 Inspection

9.1 Types of inspection and inspection documents

See EN 10028-1.

9.2 Tests to be carried out

See Table 16 and EN 10028-1.

9.3 Re-tests

See EN 10028-1.

10 Sampling

10.1 Frequency of testing

See Table 16 and EN 10028-1.

10.2 Selection and preparation of samples and test pieces

See EN 10028-1.

11 Test methods

See EN 10028-1.

12 Marking

See EN 10028-1.

Table 1: Chemical composition (cast analysis)[1)] of ferritic steels

Steel designation		% by mass										
name	number	C max.	Si max.	Mn max.	P max.	S max.	N max.	Cr	Mo	Nb	Ni	Ti
Standard grades												
X2CrNi12	1.4003	0,030	1,00	1,50	0,040	0,015	0,030	10,50 to 12,50			0,30 to 1,00	
X6CrNiTi12	1.4516	0,08	0,70	1,50	0,040	0,015		10,50 to 12,50			0,50 to 1,50	0,05 to 0,35
X3CrTi17	1.4510	0,05	1,00	1,00	0,040	0,015		16,00 to 18,00				[4 × (C+N) + 0,15] to 0,80[2)]
X2CrMoTi18-2	1.4521	0,025	1,00	1,00	0,040	0,015	0,030	17,00 to 20,00	1,80 to 2,50			[4 × (C+N) + 0,15] to 0,80[2)]
Special grades												
X2CrTi17	1.4520	0,025	0,50	0,50	0,040	0,015	0,015	16,00 to 18,00				0,30 to 0,60
X2CrTiNb18	1.4509	0,030	1,00	1,00	0,040	0,015		17,50 to 18,50		[3 × C + 0,30] to 1,00]		0,10 to 0,60

1) Elements not listed in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing of 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.

2) The stabilization may be made by use of titanium or niobium or zirconium. According to the atomic number of these elements and the content of carbon and nitrogen, the equivalence shall, if additional stabilizing with niobium or zirconium is used, be the following:

$$\mathrm{Ti} \cong \frac{7}{4}\mathrm{Nb} \cong \frac{7}{4}\mathrm{Zr}$$

Table 2: Chemical composition (cast analysis)[1] of martensitic steels

Steel designation		% by mass								
name	number	C max.	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N min.
Standard grades										
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	0,015	15,00 to 17,00	0,80 to 1,50	4,00 to 6,00	0,020

[1] Elements not quoted in this table may 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.

Table 3: Chemical composition (cast analysis)[1)] of austenitic steels

Steel designation		% by mass												
name	number	C	Si	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
Standard grades														
X2CrNiN18-7	1.4318	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,10 to 0,20	16,50 to 18,50				6,00 to 8,00		
X2CrNi18-9	1.4307	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	17,50 to 19,50				8,00 to 10,00		
X2CrNi19-11	1.4306	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	18,00 to 20,00				10,00 to 12,00		
X2CrNiN18-10	1.4311	≤ 0,030	≤ 1,00	2,00	0,045	0,015	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	0,015	≤ 0,11	17,00 to 19,50				8,00 to 10,50		
X5CrNiN19-9	1.4315	≤ 0,06	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	18,00 to 20,00				8,00 to 11,00		
X6CrNi18-10	1.4948	0,04 to 0,08	≤ 1,00	2,00	0,035	0,015	≤ 0,11	17,00 to 19,00				8,00 to 11,00		
X6CrNi23-13	1.4950	0,04 to 0,08	≤ 0,70	2,00	0,035	0,015	≤ 0,11	22,00 to 24,00				12,00 to 15,00		
X6CrNi25-20	1.4951	0,04 to 0,08	≤ 0,70	2,00	0,035	0,015	≤ 0,11	24,00 to 26,00				19,00 to 22,00		
X6CrNiTi18-10	1.4541	≤ 0,08	≤ 1,00	2,00	0,045	0,015		17,00 to 19,00				9,00 to 12,00	5 × C to 0,70	
X6CrNiTiB18-10	1.4941	0,04 to 0,08	≤ 1,00	2,00	0,035	0,015		17,00 to 19,00				9,00 to 12,00	5 × C to 0,70	0,0015 to 0,0050 B
X2CrNiMo17-12-2	1.4404	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	16,50 to 18,50		2,00 to 2,50		10,00 to 13,00		
X2CrNiMoN17-11-2	1.4406	≤ 0,030	≤ 1,00	2,00	0,045	0,015	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	0,015	≤ 0,11	16,50 to 18,50		2,00 to 2,50		10,00 to 13,00		
X6CrNiMoTi 17-12-2	1.4571	≤ 0,08	≤ 1,00	2,00	0,045	0,015		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	0,015	≤ 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	0,015	≤ 0,11	17,00 to 19,00		2,50 to 3,00		12,50 to 15,00		
X2CrNiMoN17-13-5	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		
X1NiCrMoCu 25-20-5	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		
X5NiCrAlTi31-20 (+RA)	1.4958 (+RA)	0,03 to 0,08	≤ 0,70	1,50	0,015	0,010	≤ 0,030	19,00 to 22,00	≤ 0,50		≤ 0,10	30,00 to 32,50	0,20 to 0,50	0,20 to 0,50 Al Al+Ti: ≤ 0,70 ≤ 0,50 Co Ni+Co: 30,00 to 32,50
X8NiCrAlTi32-21	1.4959	0,05 to 0,10	≤ 0,70	1,50	0,015	0,010	≤ 0,030	19,00 to 22,00	≤ 0,50			30,00 to 34,00	0,25 to 0,65	0,25 to 0,65 Al ≤ 0,50 Co Ni+Co: 30,00 to 34,00
X3CrNiMoBN 17-13-3	1.4910	≤ 0,04	≤ 0,75	2,00	0,035	0,015	0,10 to 0,18	16,00 to 18,00		2,00 to 3,00		12,00 to 14,00		0,0015 to 0,0050 B

(continued)

Table 3 (continued)

Steel designation		% by mass												
name	number	C	Si	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
Special grades														
X1CrNi25-21	1.4335	≤ 0,020	≤ 0,25	2,00	0,025	0,010	≤ 0,11	24,00 to 26,00		≤ 0,20		20,00 to 22,00		
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		
X8CrNiNb16-13	1.4961	0,04 to 0,10	0,30 to 0,60	1,50	0,035	0,015		15,00 to 17,00			≥ 10 × C to 1,20	12,00 to 14,00		
X1CrNiMoN25-22-2	1.4466	≤ 0,020	≤ 0,70	2,00	0,025	0,010	0,10 to 0,16	24,00 to 26,00		2,00 to 2,50		21,00 to 23,00		
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		
X2CrNiMoN17-13-3	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	0,015	≤ 0,11	16,50 to 18,50		2,50 to 3,00		10,50 to 13,00		
X2CrNiMoN18-12-4	1.4434	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,10 to 0,20	16,50 to 19,50		3,00 to 4,00		10,50 to 14,00		
X2CrNiMo18-15-4	1.4438	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	17,50 to 19,50		3,00 to 4,00		13,00 to 16,00		
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		
X1CrNiMoCuN25-25-5	1.4537	≤ 0,020	≤ 0,70	2,00	0,030	0,010	0,17 to 0,25	24,00 to 26,00	1,00 to 2,00	4,70 to 5,70		24,00 to 27,00		
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		

1) Elements not listed in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing of 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.

Table 4: Chemical composition (cast analysis)[1] of austenitic-ferritic steels

Steel designation		% by mass										
name	number	C max.	Si max.	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Ni	W
12												
X2CrNiN23-4*)	1.4362*)	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	0,10 to 0,60	3,50 to 5,50	
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	
Special grades												
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	1,00 to 2,50	2,70 to 4,00	5,50 to 7,50	
X2CrNiMoN25-7-4*)	1.4410*)	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

1) Elements not quoted in this table may 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.

*) Patented steel grade.

Table 5: Permissible product analysis tolerances on the limiting values given in Tables 1 to 4 for the cast analysis

Element	Specified limits, cast analysis % by mass		Permissible tolerance[1)] % by mass
Carbon		≤ 0,030	+0,005
	> 0,030	≤ 0,10	±0,01
Silicon		≤ 1,00	+0,05
Manganese		≤ 1,00	+0,03
	> 1,00	≤ 2,00	+0,04
Phosphorus		≤ 0,045	+0,005
Sulfur		≤ 0,010	+0,003
	> 0,010	≤ 0,030	+0,005
Nitrogen		≤ 0,35	±0,01
Aluminium		≤ 0,65	±0,10
Boron	≥ 0,0015	≤ 0,0050	±0,0003
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	≤ 34,00	±0,20
Cobalt		≤ 0,50	+0,05
Titanium		≤ 0,80	±0,05
Tungsten		≤ 1,00	±0,05

[1)] 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.

Table 6: Type of process route of sheet, plate and strip[1)]

	Abbreviation[2)]	Type of treatment	Surface finish	Notes
Hot-rolled	1C	Hot-rolled, heat treated, not descaled	Covered with the rolling scale	Suitable for parts which will be descaled or machined in subsequent production or for certain heat-resisting applications.
	1E	Hot-rolled, heat treated, mechanically descaled	Free of scale	The type of mechanical descaling, e.g. coarse grinding or shot blasting, depends on the steel grade and the product, and is left to the manufacturer's discretion, unless otherwise agreed.
	1D	Hot-rolled, heat treated, pickled	Free of scale	Usually standard for most steel types to ensure good corrosion resistance; also common finish for further processing. It is permissible for grinding marks to be present. Not as smooth as 2D or 2B.
Cold rolled	2C	Cold-rolled, heat treated, not descaled	Smooth with scale from heat treatment	Suitable for parts which will be descaled or machined in subsequent production or for certain heat-resisting applications.
	2E	Cold-rolled, heat treated, mechanically descaled	Rough and dull	Usually applied to steels with a scale which is very resistant to pickling solutions. May be followed by pickling.
	2D	Cold-rolled, heat treated, pickled	Smooth	Finish for good ductility, but not as smooth as 2B or 2R.
	2B	Cold-rolled, heat treated, pickled, skin passed	Smoother than 2D	Most common finish for most steel types to ensure good corrosion resistance, smoothness and flatness. Also common finish for further processing. Skin passing may be by tension levelling.
	2R	Cold-rolled, bright annealed[3)]	Smooth, bright, reflective	Smoother and brighter than 2B. Also common finish for further processing.
Special finishes	1G or 2G	Ground[4)]	See footnote 5.	Grade of grit or surface roughness can be specified. Unidirectional texture, not very reflective.
	1J or 2J	Brushed[4)] or dull polished[4)]	Smoother than ground See footnote 5.	Grade of brush or surface roughness can be specified. Unidirectional texture, not very reflective.
	1K or 2K	Satin polish[4)]	See footnote 5.	Additional specific requirements to a 'J' type finish, in order to achieve adequate corrosion resistance for marine and external architectural applications. Transverse *Ra* < 0,5µm with clean cut surface finish.
	1P or 2P	Bright polished[4)]	See footnote 5.	Mechanical polishing. Process or surface roughness can be specified. Non-directional finish, reflective with high degree of image clarity.
	2F	Cold-rolled, heat treated, skin passed on roughened rolls	Uniform non-reflective matt surface	Heat treatment by bright annealing or by annealing and pickling.

1) Not all process routes and surface finishes are available for all steels.

2) First digit, 1 = hot-rolled, 2 = cold-rolled.

3) May be skin passed.

4) One surface only, unless specifically agreed at the time of enquiry and order.

5) Within each finish description the surface characteristics can vary, and more specific requirements may need to be agreed between manufacturer and purchaser (e.g. grade of grit or surface roughness).

Table 7: Mechanical properties at room temperature for ferritic steels in the annealed condition (see Table B.1) and resistance to intergranular corrosion

Steel designation		Product form[1]	Thick-ness	0,2 %-proof strength		Tensile strength	Elongation after fracture		Resistance to intergranular corrosion[4]		Impact energy (ISO-V)
				$R_{p0,2}$		R_m	$A_{80\ mm}$[2] < 3 mm thick	A[3] ≥ 3 mm thick	in the delivery condition	in the welded condition	
name	number		mm max.	N/mm² min. (long.)	N/mm² min. (tr.)	N/mm²	% min. (long. + tr.)	% min. (long. + tr.)			kV min. (tr.)
Standard grades											
X2CrNi12	1.4003	C	6	280	320	450 to 650	20		no	no	50
		H	12								
		P	25[5]	250	280		18				
X6CrNiTi12	1.4516	C	6	280	320	450 to 650	23		no	no	50
		H	12								
		P	25[5]	250	280		20				
X3CrTi17	1.4510	C	3	230	240	420 to 600	23		yes	yes	-
X2CrMoTi 18-2	1.4521	C	2,5	300	320	420 to 640	20	-	yes	yes	-
Special grades											
X2CrTi17	1.4520	C	2,5	180	200	380 to 530	24	-	yes	yes	-
X2CrTiNb18	1.4509	C	2,5	230	250	430 to 630	18	-	yes	yes	-

1) C = cold-rolled strip; H = hot-rolled strip; P = hot-rolled plate.
2) The values are related to test pieces with a gauge length of 80 mm and a width of 20 mm. Test pieces with a gauge length of 50 mm and a width of 12,5 mm may also be used.
3) The values are related to test pieces with a gauge length of $5{,}65\sqrt{S_o}$.
4) When tested according to EN ISO 3651-2.
5) ●●For thicknesses above 25 mm up to 75 mm the mechanical properties may be agreed.

Table 8: Mechanical properties at room temperature and impact energy at –20 °C for martensitic steels in the quenched and tempered condition (see Table B.2)

Steel designation		Product form[1)]	Thickness	0,2%-proof strength	Tensile strength	Elongation after fracture A[2)]	Impact energy (ISO-V) kV J min.	
name	number		mm max.	$R_{p0,2}$ N/mm^2 min.	R_m N/mm^2	≥ 3 mm thick % min. (long. + tr.)	at 20 °C (long. + tr.)	at –20 °C (long. + tr.)
Standard grades								
X3CrNiMo13-4	1.413	P	75	650	780 to 980	14	70	40
X4CrNiMo16-5-1	1.4418	P	75	680	840 to 980	14	55	40

1) P= hot-rolled plate.

2) The values apply for test pieces with a gauge length of $5{,}65\sqrt{S_o}$.

Table 9: Mechanical properties at room temperature and impact energy at −196 °C of austenitic steels in the solution annealed condition[1] (see Table B.3) and resistance to intergranular corrosion

Steel designation		Product form[2]	Thick-ness	0,2 %-proof strength	1,0 %-proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) kV >10 mm thick J min.			Resistance to intergranular corrosion[7]	
									at 20 °C		at −196 °C		
name	number		mm max.	$R_{p0,2}$ N/mm² min. (tr.)[3][4]	$R_{p1,0}$ N/mm² min. (tr.)[3][4]	R_m N/mm²	A_{80mm}[5] < 3 mm thick % min. (tr.)[3]	A[6] ≥ 3 mm thick % min. (tr.)[3]	(long.)	(tr.)	(tr.)	in the delivery condition	in the sensitized condition
Standard grades													
X2CrNiN 18-7	1.4318	C	6	350	380	650 to 850	35	40	90	60	-	yes	yes
		H	12	330	370								
		P	75	330	370								
X2CrNi 18-9	1.4307	C	6	220	250	520 to 670	45	45	100	60	60	yes	yes
		H	12	200	240								
		P	75	200	240	500 to 650							
X2CrNi 19-11	1.4306	C	6	220	250	520 to 670	45	45	100	60	60	yes	yes
		H	12	200	240								
		P	75	200	240	500 to 650							
X2CrNiN 18-10	1.4311	C	6	290	320	550 to 750	40	40	100	60	60	yes	yes
		H	12	270	310								
		P	75	270	310								
X5CrNi 18-10	1.4301	C	6	230	260	540 to 750	45[8]	45[8]	100	60	60	(yes)[9]	no[10]
		H	12	210	250	520 to 720							
		P	75	210	250		45	45					
X5CrNiN 19-9	1.4315	C	6	290	320	550 to 750	40	40	100	60	60	(yes)[9]	no[10]
		H	12	270	310								
		P	75	270	310								
X6CrNi 18-10	1.4948	C	6	230	260	530 to 740	45[8]	45[8]	100	60	-	no	no
		H	12	210	250	510 to 710							
		P	75	190	230		45	45					
X6CrNi 23-13	1.4950	C	6	220	250	530 to 730	35	35	100	60	-	no	no
		H	12	200	240	510 to 710							
		P	75	200	240								
X6CrNi 25-20	1.4951	C	6	220	250	530 to 730	35	35	100	60	-	no	no
		H	12	200	240	510 to 710							
		P	75	200	240								

(continued)

Table 9 (continued)

Steel designation		Product form[2]	Thick-ness mm max.	0,2 %-proof strength $R_{p0,2}$	1,0 %-proof strength $R_{p1,0}$	Tensile strength Rm N/mm²	Elongation after fracture		Impact energy (ISO-V) kV >10 mm thick J min.			Resistance to intergranular corrosion[7]	
				N/mm² min. (tr.)[3][4]			A_{80mm}[5] < 3 mm thick % min. (tr.)[3]	A[6] ≥ 3 mm thick % min. (tr.)[3]	at 20 °C (long.)	at 20 °C (tr.)	at −196 °C (tr.)	in the delivery condition	in the sensitized condition
name	number												
X6CrNiTi 18-10	1.4541	C	6	220	250	520 to 720	40	40	100	60	60	yes	yes
		H	12	200	240								
		P	75	200	240	500 to 700							
X6CrNiTiB 18-10	1.4941	C	6	220	250	510 to 710	40	40	100	60	-	yes	yes
		H	12	200	240								
		P	75	200	240	490 to 690							
X2CrNiMo 17-12-2	1.4404	C	6	240	270	530 to 680	40	40	100	60	60	yes	yes
		H	12	220	260								
		P	75	220	260	520 to 670	45	45					
X2CrNiMo N 17-11-2	1.4406	C	6	300	330	580 to 780	40	40	100	60	60	yes	yes
		H	12	280	320								
		P	75	280	320								
X5CrNiMo 17-12-2	1.4401	C	6	240	270	530 to 680	40	40	100	60	60	(yes)[9]	no[10]
		H	12	220	260								
		P	75	220	260	520 to 670	45	45					
X6CrNiMo Ti 17-12-2	1.4571	C	6	240	270	540 to 690	40	40	100	60	60	yes	yes
		H	12	220	260								
		P	75	220	260	520 to 670							
X2CrNiMo 17-12-3	1.4432	C	6	240	270	550 to 700	40	40	100	60	60	yes	yes
		H	12	220	260								
		P	75	220	260	520 to 670	45	45					
X2CrNiMo 18-14-3	1.4435	C	6	240	270	550 to 700	40	40	100	60	60	yes	yes
		H	12	220	260								
		P	75	220	260	520 to 670	45	45					
X2CrNiMo N 17-13-5	1.4439	C	6	290	320	580 to 780	35	35	100	60	60	yes	yes
		H	12	270	310								
		P	75	270	310		40	40					
X1NiCrMo Cu25-20-5	1.4539	C	6	240	270	530 to 730	35	35	100	60	60	yes	yes
		H	12	220	260								
		P	75	220	260	520 to 720							
X5NiCrAl Ti31-20	1.4958	P	75	170	200	500 TO 750	30	30	120	80	-	yes	no

(continued)

Table 9 (continued)

Steel designation		Product form[2]	Thick-ness	0,2 %-proof strength	1,0 %-proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) kV >10 mm thick J min.			Resistance to intergranular corrosion[7]	
				$R_{p0,2}$	$R_{p1,0}$	R_m	A_{80mm}[5]	A[6]	at 20 °C		at –196 °C		
name	number		mm max.	N/mm² min. (tr.)[3][4]		N/mm²	< 3 mm thick % min. (tr.)[3]	≥ 3 mm thick % min. (tr.)[3]	(long.)	(tr.)	(tr.)	in the delivery condition	in the sensitized condition
Standard grades													
X5NiCrAlTi 31-20 +RA[11]	1.4958	P	75	210	240	500 to 750	30	30	120	80	-	yes	no
X8NiCrAlTi 32-21	1.4959	P	75	170	200	500 to 750	30	30	120	80	-	yes	no
X3CrNiMoBN 17-13-3	1.4910	C	6	300	330	580 to 780	35	40	100	60	-	yes	yes
		H	12	260	300	550 to 750							
		P	75	260	300								
Special grades													
X1CrNi25-21	1.4335	P	75	200	240	470 to 670	40	40	100	60	60	yes	yes
X6CrNiNb 18-10	1.4550	P	75	200	240	500 to 700	40	40	100	60	40	yes	yes
X8CrNiNb 16-13	1.4961	P	75	200	240	510 to 690	35	35	100	60	-	yes	yes
X1CrNiMoN 25-22-2	1.4466	P	75	250	290	540 to 740	40	40	100	60	60	yes	yes
X6CrNiMoNb 17-12-2	1.4580	P	75	220	260	520 to 720	40	40	100	60	-	yes	yes
X2CrNiMoN 17-13-3	1.4429	C	6	300	330	580 to 780	35	35	100	60	60	yes	yes
		H	12	280	320								
		P	75	280	320		40	40					
X3CrNiMo 17-13-3	1.4436	C	6	240	270	550 to 700	40	40	100	60	60	(yes)[9]	no[10]
		H	12	220	260								
		P	75	220	260	530 to 730	40	40					
X2CrNiMoN 18-12-4	1.4434	C	6	290	320	570 to 770	35	35	100	60	60	yes	yes
		H	12	270	310								
		P	75	270	310	540 to 740	40	40					

(continued)

Table 9 (concluded)

Steel designation		Product form[2]	Thick-ness	0,2 %-proof strength	1,0 %-proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) kV >10 mm thick J min.			Resistance to intergranular corrosion[7]	
				$R_{p0,2}$	$R_{p1,0}$	R_m	A_{80mm}[5]	A[6]	at 20 °C		at −196 °C		
name	number		mm max.	N/mm² min. (tr.)[3][4]		N/mm²	< 3 mm thick % min. (tr.)[3]	≥ 3 mm thick % min. (tr.)[3]	(long.)	(tr.)	(tr.)	in the delivery condition	in the sensitized condition
X2CrNiMo 18-15-4	1.4438	C	6	240	270	550 to 700	35	35	100	60	60	yes	yes
		H	12	220	260								
		P	75	220	260	520 to 720	40	40					
X1NiCrMoCu 31-27-4	1.4563	P	75	220	260	500 to 700	40	40	100	60	60	yes	yes
X1CrNiMoCu N25-25-5	1.4537	P	75	290	330	600 to 800	40	40	100	60	60	yes	yes
X1CrNiMoCu N20-18-7	1.4547	C	6	320	350	650 to 850	35	35	100	60	60	yes	yes
		H	12	300	340								
		P	75	300	340		40	40					
X1NiCrMoCu N25-20-7	1.4529	P	75	300	340	650 to 850	40	40	100	60	60	yes	yes

1) 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.

2) C = cold-rolled strip; H = hot-rolled strip; P = hot-rolled plate.

3) If, in the case of strip in rolling widths < 300 mm, longitudinal test pieces are taken, the minimum values are reduced as follows:

proof strength: minus 15 N/mm²
elongation for constant gauge length: minus 5 %
elongation for proportional gauge length: minus 2 %

4) •• For continuously hot-rolled products, 20 N/mm² higher minimum values of $R_{p0,2}$ and 10 N/mm² higher minimum values of $R_{p1,0}$ may be agreed at the time of enquiry and order.

5) The values are related to test pieces with a gauge length of 80 mm and a width of 20 mm; test pieces with a gauge length of 50 mm and a width of 12,5 mm can also be used.

6) The values are related to test pieces with a gauge length of 5,65 $\sqrt{S_o}$.

7) When tested according to EN ISO 3651-2.

8) For stretcher levelled material, the minimum value is 5 % lower.

9) Normally for thicknesses up to 6 mm.

10) Resistance to intergranular corrosion is given for thicknesses up to 6 mm in the welded condition.

11) +RA = recrystallizing annealed condition.

Table 10: Mechanical properties at room temperature and impact energy at –40 °C of austenitic-ferritic steels in the solution annealed condition (see Table B.4) and resistance to intergranular corrosion

Steel designation		Product form[1]	Thickness	0,2 %-proof strength $R_{p0,2}$ N/mm² min. (tr.)[2] strip width		Tensile strength R_m	Elongation after fracture A_{80mm} < 3 mm thick[3] % min.	Elongation after fracture A ≥ 3 mm thick[4] % min.	Impact energy (ISO-V) kV J min.			Resistance to intergranular corrosion[5]	
									at 20 °C		at –40 °C		
name	number		mm max.	< 300 mm	≥ 300 mm	N/mm²	(long. + tr.)	(long. + tr.)	(long.)	(tr.)	(tr.)	in the delivery condition	in the sensitized condition
Standard grades													
X2CrNiN23-4	1.4362	C	6	405	420	600 to 850	20	20	100	60	40	yes	yes
		H	12	385	400								
		P	75	385	400	630 to 800	25	25					
X2CrNiMoN22-5-3	1.4462	C	6	465	480	660 to 950	20	20	100	60	40	yes	yes
		H	12	445	460		25	25					
		P	75	445	460	640 to 840	25	25					
Special grades													
X2CrNiMoCuN25-6-3	1.4507	C	6	495	510	690 to 940	20	20	100	60	40	yes	yes
		H	12	475	490								
		P	75	475	490	690 to 890	25	25					
X2CrNiMoN25-7-4	1.4410	C	6	535	550	750 to 1000	20	20	100	60	40	yes	yes
		H	12	515	530								
		P	75	515	530	730 to 930	20	20					
X2CrNiMoCuWN 25-7-4	1.4501	P	75	515	530	730 to 930	25	25	100	60	40	yes	yes

[1] C = cold-rolled strip; H = hot-rolled strip; P = hot-rolled plate.

[2] •• For continuously hot-rolled products, 20 N/mm² higher minimum values of $R_{p0,2}$ may be agreed at the time of enquiry and order.

[3] The values are related to test pieces with a gauge length of 80 mm and a width of 20 mm; test pieces with a gauge length of 50 mm and a width of 12,5 mm may also be used.

[4] The values are related to test pieces with a gauge length of 5,65 $\sqrt{S_0}$.

[5] When tested according to EN ISO 3651-2.

Table 11: Minimum values for the 0,2 % proof strength of ferritic steels at elevated temperatures in the annealed condition (see Table B.1)

Steel designation		Minimum 0,2 % proof strength (N/mm²) at a temperature (in °C) of					
name	number	100	150	200	250	300	350
Standard grades							
X2CrNi12	1.4003	240	235	230	220	215	-
X6CrNiTi12	1.4516	300	270	250	245	225	215
X3CrTi17	1.4510	195	190	185	175	165	155
X2CrMoTi18-2	1.4521	250	240	230	220	210	205
Special grades							
X2CrTi17	1.4520	195	180	170	160	155	-
X2CrTiNb18	1.4509	230	220	210	205	200	180

Table 12: Minimum values for the 0,2 % proof strengthof martensitic steels at elevated temperatures in the quenched and tempered condition (see Table B.2)

Steel designation		Minimum 0,2 % proof strength (N/mm²) at a temperature (in °C) of					
name	number	100	150	200	250	300	350
Standard grades							
X3CrNiMo13-4	1.4313	590	575	560	545	530	515
X4CrNiMo16-5-1	1.4418	660	640	620	600	580	-

Table 13: Minimum values for the 0,2 % and 1,0 % proof strength of austenitic steels at elevated temperatures in the solution annealed condition (see Table B.3)

Steel designation		Minimum 0,2 % proof strength (N/mm²)											Minimum 1,0 % proof strength (N/mm²)										
name	number	at a temperature (in °C) of																					
		100	150	200	250	300	350	400	450	500	550	600	100	150	200	250	300	350	400	450	500	550	600
Standard grades																							
X2CrNiN18-7	1.4318	265	200	185	180	170	165	-	-	-	-	-	300	235	215	210	200	195	-	-	-	-	-
X2CrNi18-9	1.4307	147	132	118	108	100	94	89	85	81	80	-	181	162	147	137	127	121	116	112	109	108	-
X2CrNi19-11	1.4306	147	132	118	108	100	94	89	85	81	80	-	181	162	147	137	127	121	116	112	109	108	-
X2CrNiN18-10	1.4311	205	175	157	145	136	130	125	121	119	118	-	240	210	187	175	167	161	156	152	149	147	-
X5CrNi18-10	1.4301	157	142	127	118	110	104	98	95	92	90	-	191	172	157	145	135	129	125	122	120	120	-
X5CrNiN19-9	1.4315	205	175	157	145	136	130	125	121	119	118	-	240	210	187	175	167	161	156	152	149	147	-
X6CrNi18-10	1.4948	157	142	127	117	108	103	98	93	88	83	78	191	172	157	147	137	132	127	122	118	113	108
X6CrNi23-13	1.4950	140	128	116	108	100	94	91	86	85	84	82	185	167	154	146	139	132	126	123	121	118	114
X6CrNi25-20	1.4951	140	128	116	108	100	94	91	86	85	84	82	185	167	154	146	139	132	126	123	121	118	114
X6CrNiTi18-10	1.4541	176	167	157	147	136	130	125	121	119	118	-	208	196	186	177	167	161	156	152	149	147	-
X6CrNiTiB18-10	1.4941	162	152	142	137	132	127	123	118	113	108	103	201	191	181	176	172	167	162	157	152	147	142
X2CrNiMo17-12-2	1.4404	166	152	137	127	118	113	108	103	100	98	-	199	181	167	157	145	139	135	130	128	127	-
X2CrNiMoN17-11-2	1.4406	211	185	167	155	145	140	135	131	128	127	-	246	218	198	183	175	169	164	160	158	157	-
X5CrNiMo17-12-2	1.4401	177	162	147	137	127	120	115	112	110	108	-	211	191	177	167	156	150	144	141	139	137	-
X6CrNiMoTi17-12-2	1.4571	185	177	167	157	145	140	135	131	129	127	-	218	206	196	186	175	169	164	160	158	157	-
X2CrNiMo17-12-3	1.4432	166	152	137	127	118	113	108	103	100	98	-	199	181	167	157	145	139	135	130	128	127	-
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	-
X2CrNiMoN17-13-5	1.4439	225	200	185	175	165	155	150	-	-	-	-	255	230	210	200	190	180	175	-	-	-	-
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	-

(continued)

Table 13 (continued)

Steel designation		Minimum 0,2 % proof strength (N/mm²)											Minimum 1,0 % proof strength (N/mm²)										
name	number	at a temperature (in °C) of																					
		100	150	200	250	300	350	400	450	500	550	600	100	150	200	250	300	350	400	450	500	550	600
Standard grades																							
X5NiCrAlTi31-20	1.4958	140	127	115	105	95	90	85	82	80	75	75	160	147	135	125	115	110	105	102	100	95	95
X5NiCrAlTi31-20+RA	1.4958+RA	180	170	160	152	145	137	130	125	120	115	110	205	193	180	172	165	160	155	150	145	140	135
X8NiCrAlTi32-21	1.4959	140	127	115	105	95	90	85	82	80	75	75	160	147	135	125	115	110	105	102	100	95	95
X3CrNiMoBN17-13-3	1.4910	205	187	170	159	148	141	134	130	127	124	121	240	220	200	189	178	171	164	160	157	154	151
Special grades																							
X1CrNi25-21	1.4335	150	140	130	120	115	110	105	-	-	-	-	180	170	160	150	140	135	130	-	-	-	-
X6CrNiNb18-10	1.4550	177	167	157	147	136	130	125	121	119	118	-	211	196	186	177	167	161	156	152	149	147	-
X8CrNiNb16-13	1.4961	175	166	157	147	137	132	128	123	118	118	113	205	195	186	176	167	162	157	152	147	147	142
X1CrNiMoN25-22-2	1.4466	195	170	160	150	140	135	-	-	-	-	-	225	205	190	180	170	165	-	-	-	-	-
X6CrNiMoNb17-12-2	1.4580	185	177	167	157	145	140	135	131	129	127	-	218	206	196	186	175	169	164	160	158	157	-
X2CrNiMoN17-13-3	1.4429	211	185	167	155	145	140	135	131	129	127	-	246	218	198	183	175	169	164	160	158	157	-
X3CrNiMo17-13-3	1.4436	177	162	147	137	127	120	115	112	110	108	-	211	191	177	167	156	150	144	141	139	137	-
X2CrNiMoN18-12-4	1.4434	211	185	167	155	145	140	135	131	129	127	-	246	218	198	183	175	169	164	160	158	157	-
X2CrNiMo18-15-4	1.4438	172	157	147	137	127	120	115	112	110	108	-	206	188	177	167	156	148	144	140	138	136	-
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	-
X1CrNiMoCuN25-25-5	1.4537	240	220	200	190	180	175	170	-	-	-	-	270	250	230	220	210	205	200	-	-	-	-
X1CrNiMoCuN20-18-7	1.4547	230	205	190	180	170	165	160	153	148	-	-	270	245	225	212	200	195	190	184	180	-	-
X1CrNiMoCuN25-20-7	1.4529	230	210	190	180	170	165	160	130	120	105	-	270	245	225	215	205	195	190	160	150	135	-

Table 14: Minimum values for the 0,2 % proof strength of austenitic-ferritic steels at elevated temperatures in the solution annealed condition (see Table B.4)

Steel designation		Minimum 0,2 % proof strength (N/mm²)			
name	number	at a temperature (in °C) of			
		100	150	200	250
Standard grades					
X2CrNiN23-4	1.4362	330	300	280	265
X2CrNiMoN22-5-3	1.4462	360	335	315	300
Special grades					
X2CrNiMoCuN25-6-3	1.4507	450	420	400	380
X2CrNiMoN25-7-4	1.4410	450	420	400	380
X2CrNiMoCuWN25-7-4	1.4501	450	420	400	380

Table 15: Minimum values for the tensile strength of austenitic steels at elevated temperatures in the solution annealed condition (see Table B.3)

Steel designation		Minimum tensile strength (N/mm²) at a temperature (in °C) of										
name	number	100	150	200	250	300	350	400	450	500	550	600
Standard grades												
X2CrNiN18-7	1.4318	530	490	460	450	440	430	-	-	-	-	-
X2CrNi18-9	1.4307	410	380	360	350	340	340	-	-	-	-	-
X2CrNi19-11	1.4306	410	380	360	350	340	340	-	-	-	-	-
X2CrNiN18-10	1.4311	490	460	430	420	410	410	-	-	-	-	-
X5CrNi18-10	1.4301	450	420	400	390	380	380	380	370	360	330	-
X5CrNiN19-9	1.4315	490	460	430	420	410	410	-	-	-	-	-
X6CrNi18-10	1.4948	440	410	390	385	375	375	375	370	360	330	300
X6CrNi23-13	1.4950	470	450	430	420	410	405	400	385	370	350	320
X6CrNi25-20	1.4951	470	450	430	420	410	405	400	385	370	350	320
X6CrNiTi18-10	1.4541	440	410	390	385	375	375	375	370	360	330	-
X6CrNiTiB18-10	1.4941	410	390	370	360	350	345	340	335	330	320	300
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		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	-	-	-	-	-
X5NiCrAlTi31-20[1)]	1.4958	465	445	435	425	420	418	415	415	415	-	-
X8NiCrAlTi32-21	1.4959	465	445	435	425	420	418	415	415	415	-	-
X3CrNiMoBN17-13-3	1.4910	495	472	450	440	430	425	420	410	400	385	365
Special grades												
X1CrNi25-21	1.4335	440	425	410	390	385	380	-	-	-	-	-
X6CrNiNb18-10	1.4550	435	400	370	350	340	335	330	320	310	300	-
X8CrNiNb16-13	1.4961	465	440	420	400	385	375	370	360	350	340	320
X1CrNiMoN25-22-2	1.4466	490	475	460	450	440	435	-	-	-	-	-
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	-	-
X2CrNiMoN18-12-4	1.4434	500	470	440	430	420	415	415	415	410	390	-
X2CrNiMo18-15-4	1.4438	430	410	390	385	380	380	-	-	-	-	-
X1NiCrMoCu31-27-4	1.4563	460	445	430	410	400	395	-	-	-	-	-
X1CrNiMoCuN25-25-5	1.4537	550	535	520	500	480	475	-	-	-	-	-
X1CrNiMoCuN20-18-7	1.4547	615	587	560	542	525	517	510	502	495	-	-
X1CrNiMoCuN25-20-7	1.4529	550	535	520	500	480	475	-	-	-	-	-

[1)] The tensile strength values also apply for the recrystallizing annealed condition (+RA).

Table 16: Tests to be carried out, test units and extent of testing

Test	Test status[1)]	Test unit	Product form		Number of test pieces per test sample
			Strip and sheet cut from strip in rolling width (C, H)	Rolled plate (P)	
Chemical analysis	m	Cast	Cast analysis[2)]		
Tensile test at room temperature	m	Cast, thickness ±10 %, heat treatment batch	1 test sample from each coil	a) Plates ≤ 20 mm [≤ 15 mm[3)]] thickness: Plates processed under identical conditions may be collected into a batch comprising not more than 20 plates. One test sample per batch shall be taken from heat treated plates up to 15 m in length. One test sample shall be taken from each end of the longest plate in the batch where heat treated plates are longer than 15 m. b) Plates > 20 mm [> 15 mm[3)]] thickness: Each single plate; one test sample shall be taken from heat treated plates up to 15 m long and one sample shall be taken from each end of heat treated plates longer than 15 m.	1
Tensile test at elevated temperature[4)]	o		To be agreed at the time of enquiry and order.		1
Impact test at room temperature	m[5)]		To be agreed at the time of enquiry and order.		3
Impact test at low temperature	o		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
Other tests	o	See EN 10028-1			

1) Tests marked with an 'm' (mandatory) shall be carried out as acceptance tests. In all cases, those marked with an 'o' (optional) shall be carried out as acceptance tests only if agreed at the time of enquiry and order.

2) A product analysis may be agreed at the time of enquiry and order; the extent of testing shall be specified at the same time.

3) Limit value for martensitic, ferritic and austenitic-ferritic steels.

4) See EN 10028-1.

5) For ferritic, martensitic and austenitic-ferritic grades > 6 mm thickness and for austenitic grades for cryogenic service > 20 mm thickness; optional for austenitic grades for other applications.

Annex A
(informative)

Reference data on some physical properties of austenitic creep-resisting steels

Table A.1: Density and modulus of elasticity

Steel designation		Density	Modulus of elasticity at										
			20 °C	100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C	800 °C	900 °C	1 000 °C
name	number	kg/dm³	kN/mm²										
X6CrNi18-10	1.4948	7,9	200	190	185	175	170	160	155	145	140	135	125
X6CrNi23-13	1.4950	7,9											
X6CrNi25-20	1.4951	7,9											
X6CrNiTiB18-10	1.4941	7,9											
X5NiCrAlTi31-20	1.4958	8,0											
X8NiCrAlTi32-21	1.4959	8,0											
X3CrNiMoBN17-13-3	1.4910	8,0											
X8CrNiNb16-13	1.4961	7,95											

Table A.2: Thermal expansion, conductivity and capacity and electrical resistivity

Steel designation		Mean coefficient of thermal expansion between 20 °C and										Thermal conductivity at 20 °C	Specific thermal capacity at 20 °C	Specific electrical resistivity at 20 °C
		100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C	800 °C	900 °C	1 000 °C			
name	number	$10^{-6}K^{-1}$										W/(m K)	J/(kg K)	$(\Omega\ mm^2)/m$
X6CrNi18-10	1.4948	16,3	16,9	17,3	17,8	18,2	18,5	18,7				17	450	0,71
X6CrNi23-13	1.4950		16,0	16,8	17,5	17,8	18,0	18,3	18,5	19,0	19,5	15	500	0,78
X6CrNi25-20	1.4951		15,5	16,3	17,0	17,3	17,5	18,0	18,5	18,8	19,0	15	500	0,85
X6CrNiTiB18-10	1.4941	16,3	16,9	17,3	17,8	18,2	18,5	18,7				17	450	0,71
X5NiCrAlTi31-20	1.4958	15,4	16,0	16,5	16,8	17,2	17,5	17,9	18,3	18,6	19,0	12	460	0,99
X8NiCrAlTi32-21	1.4959	15,4	16,0	16,5	16,8	17,2	17,5	17,9	18,3	18,6	19,0	12	460	0,99
X3CrNiMoBN17-13-3	1.4910	16,3	16,9	17,3	17,8	18,2	18,5	18,7				16	450	0,77
X8CrNiNb16-13	1.4961	16,3	16,9	17,3	17,8	18,2	18,5	18,7				16	450	0,78

Annex B
(informative)

Guidelines for further treatment (including heat treatment) in fabrication

B.1 The guidelines given in Tables B.1 to B.4 are intended for hot forming and heat treatment.

B.2 Flame cutting may adversely affect edge areas; they should be machined.

B.3 Scale and annealing colours produced during hot forming, heat treatment or welding may adversely affect the corrosion resistance. They should be removed as far as possible before use, e.g. by pickling.

B.4 For further information see EN 1011-3.

Table B.1: Guidelines on the temperatures for hot forming and heat treatment[1] of ferritic stainless steels

Steel designation		Hot forming		Heat treatment symbol[2]	Annealing	
name	number	Temperature °C	Type of cooling		Temperature[3] °C	Type of cooling
Standard grades						
X2CrNi12	1.4003	1 100 to 800	air	+A	700 to 750	air, water
X6CrNiTi12	1.4516				790 to 850	
X3CrTi17	1.4510				770 to 830	
X2CrMoTi18-2	1.4521				820 to 880	
Special grades						
X2CrTi17	1.4520	1 100 to 800	air	+A	820 to 880	air, water
X2CrTiNb18	1.4509				870 to 930	

[1] The temperatures of annealing should be agreed for simulated heat treated test pieces.
[2] +A = annealed.
[3] If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.

Table B.2: Guidelines on the temperatures for hot forming and heat treatment[1] of martensitic stainless steels

Steel designation		Hot forming		Heat treatment symbol[2]	Quenching		Tempering
name	number	Temperature °C	Type of cooling		Temperature[3] °C	Type of cooling	Temperature °C
Standard grades							
X3CrNiMo13-4	1.4313	1 150 to 900	air	+QT	950 to 1 050	oil, air, water	560 to 640
X4CrNiMo16-5-1	1.4418			+QT	900 to 1 000		570 to 650

[1] The temperatures of quenching and tempering should be agreed for simulated heat treated test pieces.
[2] +QT = Quenched and tempered.
[3] If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.

Table B.3: Guidelines on the temperatures for hot forming and heat treatment[1)] of austenitic stainless steels

Steel designation		Hot forming		Heat treatment symbol[2)]	Solution annealing[3)] (but see footnote 7)	
name	number	Temperature °C	Type of cooling		Temperature[4) 5)] °C	Type of cooling
Standard grades						
X2CrNiN18-7	1.4318	1 150 to 850	air	+AT	1 020 to 1 100	water, air[6)]
X2CrNi18-9	1.4307				1 000 to 1 100	
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	
X5CrNiN19-9	1.4315				1 000 to 1 100	
X6CrNi18-10	1.4948				1 050 to 1 110	
X6CrNi23-13	1.4950				1 050 to 1 150	
X6CrNi25-20	1.4951				1 050 to 1 150	
X6CrNiTi18-10	1.4541				1 000 to 1 100	
X6CrNiTiB18-10	1.4941				1 050 to 1 110	
X2CrNiMo17-12-2	1.4404				1 030 to 1 110	
X2CrNiMoN17-11-2	1.4406				1 030 to 1 110	
X5CrNiMo17-12-2	1.4401				1 030 to 1 110	
X6CrNiMoTi17-12-2	1.4571				1 030 to 1 110	
X2CrNiMo17-12-3	1.4432				1 030 to 1 110	
X2CrNiMo18-14-3	1.4435				1 030 to 1 110	
X2CrNiMoN17-13-5	1.4439				1 060 to 1 140	
X1NiCrMoCu25-20-5	1.4539				1 060 to 1 140	
X5NiCrAlTi31-20	1.4958				1 100 to 1 200	
X5NiCrAlTi31-20+RA	1.4958+RA			+ RA	920 to 1 000[7)]	
X8NiCrAlTi32-21	1.4959			+ AT	1 100 to 1 200[8)]	
X3CrNiMoBN17-13-3	1.4910				1 020 to 1 100	

(continued)

Table B.3 (continued)

Steel designation		Hot forming		Heat treatment symbol[2]	Solution annealing[3] (but see footnote 7)	
name	number	Temperature °C	Type of cooling		Termperature[4)5)] °C	Type of cooling
X1CrNi25-21	1.4335	1 150 to 850	air	+AT	1 030 to 1 110	water, air[6]
X6CrNiNb18-10	1.4550				1 020 to 1 120	
X8CrNiNb16-13	1.4961				1 050 to 1 110	
X1CrNiMoN25-22-2	1.4466				1 070 to 1 150	
X6CrNiMoNb17-12-2	1.4580				1 030 to 1 110	
X2CrNiMoN17-13-3	1.4429				1 030 to 1 110	
X3CrNiMo17-13-3	1.4436				1 030 to 1 110	
X2CrNiMoN18-12-4	1.4434				1 070 to 1 150	
X2CrNiMo18-15-4	1.4438				1 070 to 1 150	
X1NiCrMoCu31-27-4	1.4563				1 070 to 1 150	
X1CrNiMoCuN25-25-5	1.4537				1 120 to 1 180	
X1CrNiMoCuN20-18-7	1.4547				1 140 to 1 200	
X1NiCrMoCuN25-20-7	1.4529				1 120 to 1 180	

1) The temperatures of annealing should be agreed for simulated heat treated test pieces.

2) +AT = solution annealed, +RA = recrystallizing annealed.

3) 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.

4) If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.

5) 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 a 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 %.

6) Cooling sufficiently rapid.

7) Recrystallizing annealing.

8) After solution annealing the grain size according to EURONORM 103 must be 1 to 5.

Table B.4: Guidelines on the temperatures for hot forming and heat treatment[1)] of austenitic-ferritic stainless steels

Steel designation		Hot forming		Heat treatment	Solution annealing[3)]	
		Temperature	Type of cooling	symbol[2)]	Temperature[4)]	Type of cooling
name	number	°C			°C	
Standard grades						
X2CrNiN23-4	1.4362	1 150 to 950	air	+AT	1 000 ± 50	water, air
X2CrNiMoN22-5-3	1.4462				1 060 ± 40	
Special grades						
X2CrNiMoCuN25-6-3	1.4507	1 150 to 1 000	air	+AT	1 080 ± 40	water, air
X2CrNiMoN25-7-4	1.4410					
X2CrNiMoCuWN25-7-4	1.4501					

1) The temperatures of annealing, should be agreed for simulated heat treated test pieces.
2) +AT = Solution annealed.
3) Solution annealing in the range specified followed by sufficiently rapid cooling to avoid precipitation of deleterious phases is essential after hot forming these steels.
4) If heat treatment is carried out in a continuous furnace, the upper part of the range specified is usually preferred, or even exceeded.

Annex C
(informative)

Post weld heat treatment

C.1 In general, welded assemblies of stainless steels covered by this European Standard are not subjected to any heat treatment with the following exception:

- martensitic grades are retempered; and

- ferritic grades are reannealed if there is any risk of residual martensite in the heat affected zone; for appropriate temperatures see Tables B.1 and B.2.

C.2 During heating of high chromium and molybdenum austenitic-ferritic or austenitic steel weldments containing some ferrite, intermetallic phases may be formed which must be re-dissolved during post weld heat treatment. As most filler metals are overalloyed in comparison with the equivalent basic grades, minimum solution temperatures higher than those given in Table B.3 and B.4 may be necessary.

In the case of fully austenitic weld structures it should be verified that mechanical properties of heat treated weldments conform to this European Standard.

Oxidation of surfaces which necessitates pickling, and possible distortion of the welded construction may raise further difficulties.

Consequently post weld heat treatment of duplex and austenitic steels should be avoided, and therefore welding be planned carefully.

C.3 In special cases, e.g. for parts with greater wall thickness, requirements concerning stress-relief and resistance to intergranular corrosion, in order to avoid failure by stress corrosion cracking or corrosion fatigue, may prove the necessity for post weld heat treatment. This should be carried out according to Table C.1 by holding at an intermediate stage below the usual solution temperature (see Table B.3) and is defined as stabilizing annealing for the niobium or titanium bearing grades and as stress-relieving for the unstabilized low carbon grades.

In some cases post weld heat treatment may be also performed as solution annealing according to Table B.3 or at a temperature below the precipitation range of carbides and intermetallic phases; however, the latter reduces only peak stresses.

C.4 Preheating of austenitic-ferritic steels is a very effective precaution against stress increase by shrinkage of thicker welded cross-sections, because temperatures of 200 to 250 °C bring down room temperature yield strength by about 50 %. Thus preheating is often more appropriate to avoid high stress levels in those weldments than any post weld heat treatment, and a preheating temperature between 120 and 200 °C according to the particular steel and thickness should be applied.

The same is advisable for complex welds of austenitic steels.

Table C.1: Guideline on post weld heat treatment of austenitic steels

Steel designation		Temperature[1)]	Type of cooling
name	number		
Stabilized steels			
X6CrNiTi18-10	1.4541	900 to 940	air
X6CrNiNb18-10	1.4550		
X6CrNiMoTi17-12-2	1.4571	not recommended	
X6CrNiMoNb17-12-2	1.4580		
Steels with ≤ 0,07 % C			
X5CrNi18-10	1.4301	not recommended	
X5CrNiN19-9	1.4315		
X5CrNiMo17-12-2	1.4401		
X3CrNiMo17-13-3	1.4436		
Steels with ≤ 0,03 % C			
X2CrNiN18-7	1.4318	900 to 940	air
X2CrNi18-9	1.4307		
X2CrNi19-11	1.4306		
X2CrNiN18-10	1.4311		
X2CrNiMo17-12-2	1.4404	960 to 1 040[3)]	forced air
X2CrNiMoN17-11-2	1.4406		
X2CrNiMo17-12-3	1.4432		
X2CrNiMo18-14-3	1.4435		
X2CrNiMoN17-13-5	1.4439		
X2CrNiMoN17-13-3	1.4429		
X2CrNiMoN18-12-4	1.4434		
X2CrNiMo18-15-4	1.4438		

(continued)

Table C.1 (continued)

Higher alloyed austenitic steels with ≤ 0,02 % C			
X1CrNi25-21	1.4335	not recommended	
X1CrNiMoN25-22-2	1.4466		
X1NiCrMoCu31-27-4	1.4563		
X1NiCrMoCu25-20-5	1.4539		
X1CrNiMoCuN25-25-5	1.4537		
X1CrNiMoCuN20-18-7	1.4547		
X1NiCrMoCuN25-20-7	1.4529		
Creep resisting steels			
X6CrNi18-10	1.4948	not recommended	
X6CrNi23-13	1.4950		
X6CrNi25-20	1.4951		
X6CrNiTiB18-10	1.4941	900 to 950[2)]	air
X5NiCrAlTi31-20 (+RA)	1.4958 (+RA)		
X8NiCrAlTi32-21	1.4959		
X3CrNiMoBN17-13-3	1.4910	900 to 950[2)]	air
X8CrNiNb16-13	1.4961		

[1)] Minimum holding time: 30 min.

[2)] Recommended for components with greater wall thickness.

[3)] Not recommended if welded with stabilized filler metal.

Annex D
(informative)

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

Table D.1: Minimum values for the tensile strength of austenitic-ferritic steels at elevated temperatures in the solution annealed condition (see Table B.4)

Steel designation		Minimum tensile strength N/mm^2 at a temperature (in °C) of			
name	number	100	150	200	250
Standard grades					
X2CrNiN23-4	1.4362	540	520	500	490
X2CrNiMoN22-5-3	1.4462	590	570	550	540
Special grades					
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 E
(informative)

Reference data of strength values for 1 % (plastic) creep strain and creep rupture

NOTE 1: The values given in Tables E.1 and E.2 are mean values of the scatter band considered until now. If referred to in regulations, however, they will be binding for calculation purposes.

NOTE 2: The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperatures listed in Tables E.1 and E.2 do not mean that the steels can be used in continuous duty up to these temperatures. The governing factor is the total stressing during operation. Where relevant, the oxidation conditions should also be taken into account.

Table E.1: Strength for 1 % (plastic) creep strain of austenitic creep resisting steels in the solution annealed condition (see Table B.3)

Steel designation		Temperature	Strength for 1 % (plastic) creep strain[1] in N/mm^2 for	
name	number	°C	10 000 h	100 000 h
X6CrNi18-10[2]	1.4948	500	147	114
		510	142	111
		520	137	108
		530	132	104
		540	127	100
		550	121	96
		560	116	92
		570	111	88
		580	106	84
		590	100	79
		600	94	74
		610	88	69
		620	82	63
		630	75	56
		640	68	49
		650	61	43
		660	55	37
		670	49	32
		680	44	28
		690	39	25
		700	35	22
		710	(31)	(15)
		720	(28)	(14)
		730	(26)	(13)
		740	(25)	(12)
		750	(24)	(11)
X6CrNi23-13[3]	1.4950	550	107	60
		600	80	35
		650	50	22
		700	25	12
		750		
		800	10	
X5NiCrAlTi31-20[2]	1.4958	600	115	(85)
		610	109	(79)
		620	102	(74)
		630	96	(69)
		640	90	(64)
		650	84	(59)
		660	78	(55)
		670	73	(51)
		680	68	(47)
		690	63	(43)
		700	58	(40)

(continued)

Table E.1 (continued)

Steel designation		Temperature	Strength for 1 % (plastic) creep strain[1] in N/mm^2 for	
name	number	°C	10 000 h	100 000 h
X5NiCrAlTi31-20 +RA[2]	1.4958 + RA	550	164	(132)
		560	154	(122)
		570	144	(111)
		580	133	(101)
		590	123	(92)
		600	113	(82)
		610	103	(74)
		620	93	(65)
		630	84	(58)
		640	75	(51)
		650	67	(46)
		660	60	(41)
		670	55	(37)
		680	50	(33)
		690	45	(30)
		700	41	(27)
X8NiCrAlTi32-21[2]	1.4959	700	59,0	42,0
		710	55,5	38,0
		720	52,0	34,4
		730	48,5	31,3
		740	45,0	28,4
		750	41,7	26,0
		760	38,4	23,5
		770	35,6	21,3
		780	32,9	19,3
		790	30,5	17,6
		800	28,2	16,0
		810	26,2	14,7
		820	24,2	13,4
		830	22,4	12,1
		840	20,8	11,1
		850	19,1	10,0
		860	17,6	9,1
		870	16,1	8,2
		880	14,7	7,3
		890	13,4	6,5
		900	12,1	5,7
		910	10,9	5,0
		920	9,8	4,4
		930	8,8	3,9
		940	7,8	3,4
		950	6,9	2,9
		960	6,1	2,5
		970	5,3	2,1
		980	4,6	1,8
		990	4,0	1,6
		1 000	3,5	1,4

(continued)

Table E.1 (concluded)

Steel designation		Temperature	Strength for 1 % (plastic) creep strain[1)] in N/mm^2 for	
name	number	°C	10 000 h	100 000 h
X8CrNiNb16-13[2)]	1.4961	580	127	91
		590	120	84
		600	113	78
		610	106	73
		620	99	67
		630	92	61
		640	85	55
		650	78	49
		660	72	44
		670	66	39
		680	59	34
		690	54	30
		700	49	26
		710	45	24
		720	42	21
		730	39	19
		740	36	17
		750	34	16

1) Values in parentheses involved extended time and/or stress extrapolation.

2) Values were taken from DIN 17460.

3) Those preliminary values were taken from NFA 36-209.

Table E.2: Creep rupture strength of austenitic creep-resisting steels in the solution annealed condition (see Table B.3)

Steel designation		Temperature	Stress for rupture[1)] in N/mm² for						
name	number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X6CrNi18-10[2)]	1.4948	500	250			192		176	
		510 520 530 540 550	239 227 215 203 191	 165	 155	182 172 162 151 140		166 156 146 136 125	
		560 570 580 590 600	177 165 154 143 132	154 144 135 126 117	145 136 126 118 110	128 117 107 98 89		114 104 95 86 78	
		610 620 630 640 650	122 113 104 95 87	109 101 94	102 94 87	81 73 65 58 52		70 62 55 49 43	
		660 670 680 690 700	80 73 67 61 55			47 42 37 32 28		38 34 30 26 22	
		710 720 730 740 750	(45) (41) (38) (36) (34)			(22) (20) (18) (16) (15)			
X6CrNi23-13[3)]	1.4950	550 600 650 700 750 800	160 120 70 36 18			90 65 35 16 7,5			
X6CrNi25-20[4)]	1.4951	600	137	113	104*	92*	89*	82*	79*
		610 620 630 640 650	120 105 92 81 72	98 85 75 66 58	90* 78* 68* 60* 53*	79* 69* 60* 53* 47*	74* 64* 56* 50* 44*	71* 61* 54* 47* 42*	68* 59* 52* 46* 41*
		660 670 680 690 700	64 57 51 47 42	52 46 42 38 34	47* 42* 38 35 32	42* 38* 34* 31* 28*	39* 35* 32* 29* 26*	38* 34* 31* 28* 25*	36* 33* 29* 27* 24*
		710 720 730 740 750	39 35 32 30 28	31 29 27 24,5 22,5	29 26 24,5* 22,5* 21*	26* 23,5* 22* 20* 18,5*	24* 22* 20* 18,5* 17*	23* 21* 19,5* 18* 16,5*	22* 20* 18,5* 17* 16*
		760 770 780 790 800	26 24 22 21 19,5	21 19,5 18 17 15,5	19* 18* 16,5* 15,5* 14*	17* 15,5* 14,5* 13,5* 12,5*	16* 14,5* 13,5* 12,5* 11,5*	15* 14* 13* 12* 11*	14,5* 13,5* 12,5* 11,5* 10,5*
		810 820 830 840 850	18 17 16 15 14	14,5 13,5 12,5 12 11	13* 12* 11,5* 10,5* 10*	11,5* 10,5* 10* 9*	10,5* 10* 9*	10* 9,5*	9,5* 9*
		860 870 880 890 900	13 12 11,5 10,5 10,0	10 9,5 9*	9*				
		910	9,5						

(continued)

Table E.2 (continued)

Steel designation		Temperature	Creep rupture strength[1] in N/mm² for						
name	number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X6CrNiTiB18-10[2]	1.4941	550	223			170		150	
		560 570 580 590 600	210 196 182 170 156			154 140 127 114 102		135 122 110 100 91	
		610 620 630 640 650	142 130 119 108 98			92 84 76 68 62		82 74 67 60 54	
		660 670 680 690 700	89 80 73 66 60			56 50 44 39 35		49 43 39 33 29	
X5NiCrAlTi31-20[2]	1.4958	500	290			215		(196)	
		510 520 530 540 550	279 267 254 240 225			205 195 184 172 160		(186) (176) (166) (155) (143)	
		560 570 580 590 600	208 190 172 155 140			147 133 119 106 95		(130) (117) (105) (93) (83)	
		610 620 630 640 650	128 118 109 103 97			85 78 72 67 63		(74) (68) (63) (59) (55)	
		660 670 680 690 700	91 85 80 74 69			59 55 52 48 44		(52) (48) (45) (41) (38)	
X5NiCrAlTi31-20 +RA[2]	1.4958 +RA	500	315			258		(242)	
		510 520 530 540 550	297 280 262 243 224			241 224 206 189 171		(225) (207) (190) (172) (155)	
		560 570 580 590 600	204 184 165 147 131			153 136 119 104 90		(138) (122) (106) (92) (80)	
		610 620 630 640 650	117 106 96 87 80			79 70 62 56 51		(70) (62) (55) (49) (44)	
		660 670 680 690 700	73 67 61 55 50			46 42 38 34 30		(40) (36) (33) (29) (26)	

(continued)

Table E.2 (continued)

Steel designation		Temperature	Creep rupture strength[1] in N/mm² for						
name	number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X8NiCrAlTi 32-21[5]	1.4959	700	73,0	58,2		44,8		38,2*	
		710 720 730 740 750	67,8 63,0 58,5 54,4 50,6	54,0 50,1 46,5 43,1 40,0		41,4 38,3 35,4 32,8 30,3		35,2* 32,5* 30,0* 27,7* 25,6*	
		760 770 780 790 800	47,0 43,7 40,7 37,8 35,2	37,1 34,4 31,9 29,6 27,4		28,0 25,9 24,0 22,1 20,4		23,6* 21,8* 20,1* 18,5* 17,0*	
		810 820 830 840 850	32,7 30,4 28,3 26,3 24,4	25,4 23,6 21,8 20,2 18,7		18,9 17,4 16,0 14,8 13,6		15,6* 14,4* 13,2* 12,1* 11,1*	
		860 870 880 890 900	22,7 21,0 19,5 18,1 16,8	17,3 16,0 14,8 13,6 12,6		12,5 11,5 10,5 9,60 8,76		10,1* 9,23* 8,41* 7,63* 6,91*	
		910 920 930 940 950	15,6 14,4 13,3 12,3 11,4	11,6 10,6 9,77 8,95 8,19		7,98 7,25 6,57 5,93 5,33		6,23* 5,60* 5,01* 4,45* 3,93*	
		960 970 980 990 1 000	10,5 9,63 8,85 8,11 7,42	7,47 6,80 6,17 5,57 5,01		4,77* 4,23* 3,73* 3,25* 2,79*		3,43* 2,95*	
X3CrNiMoBN 17-13-3[2]	1.4910	550	290			220		200*	
		560 570 580 590 600	272 254 237 220 205			202 186 170 155 141		184* 166* 151* 137* 122*	
		610 620 630 640 650	190 174 162 148 135			127 114 102 92 83		113* 100* 91* 81* 73*	
		660 670 680 690 700	122 112 102 93 84			75 68 61 56 52		65* 58* 52* 46* 42*	
		710 720 730 740 750	78 71 65 58 52			48 45 41 37 34		39* 36* 34* 31* 28*	
		760 770 780 790 800	48 44 41 37 33			31 28 25 22 20		26* 24* 21* 19* 17*	

(continued)

Table E.2 (concluded)

Steel designation		Temperature	Creep rupture strength[1)] in N/mm² for						
name	number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X8CrNiNb 16-13[2)]	1.4961	580 590 600	182 170 157			129 119 108		115 105 94	
		610 620 630 640 650	145 134 124 113 103			98 89 80 72 64		85 77 69 61 53	
		660 670 680 690 700	93 84 76 70 64			57 50 44 39 34		47 41 36 31 27	
		710 720 730 740 750	59 55 51 47 44			30 27 25 22 20		25 22 19 17 15	

1) Values in parantheses involved time and/or stress extrapolation; values with asterisk involved time extrapolation.
2) Values were taken from DIN 17460.
3) Those preliminary values were taken from NFA 36-209.
4) Values were taken from BS PD 6525 Part 1.
5) Values were prepared by ECCC, WG 3.3 [1].

Annex F
(informative)
Reference data on mechanical properties at low temperatures of austenitic steels

Table F.1: Tensile properties at low temperatures

Steel designation		20 °C				– 80 °C				– 150 °C				– 196 °C			
name	number	0,2 % proof strength $R_{p\,0,2}$ min N/mm²	1,0 % proof strength $R_{p\,1,0}$ min N/mm²	Tensile strength R_m min N/mm²	Elongation after fracture A min %	0,2 % proof strength $R_{p\,0,2}$, min N/mm²	1,0 % proof strength $R_{p\,1,0}$, min N/mm²	Tensile strength R_m min N/mm²	Elongation after Fracture A min %	0,2 % proof strength $R_{p\,0,2}$ min N/mm²	1,0 % proof strength $R_{p\,1,0}$ Min N/mm²	Tensile strength R_m min N/mm²	Elongation after fracture A min %	0,2 % proof strength $R_{p\,0,2}$ min N/mm²	1,0 % proof strength $R_{p\,1,0}$ min N/mm²	Tensile strength R_m min N/mm²	Elongation after fracture A min %
X2CrNi18-9	1.4307	200	240	500	45	220	290	830	35	225	325	1 070	30	300	400	1 200	30
X2CrNiN18-10	1.4311	270	310	550	40	350	420	850	40	450	550	1 050	35	550	650	1 250	35
X5CrNi18-10	1.4301	210	250	520	45	270	350	860	35	315	415	1 100	30	300	400	1 250	30
X5CrNiN19-9	1.4315	270	310	550	40	385	455	890	40	450	550	1 180	35	550	650	1 350	35
X6CrNiTi18-10	1.4541	200	240	500	40	200	240	855	35	200	240	1 100	35	200	240	1 200	30
X2CrNiMo17-12-2	1.4404	220	260	520	45	275	355	840	40	315	415	1 070	40	350	450	1 200	35
X2CrNiMoN17-11-2	1.4406	280	320	580	40	380	450	800	35	500	600	1 000	35	600	700	1 150	30
X2CrNiMoN17-13-3	1.4429	280	320	580	35	380	450	800	30	500	600	1 000	30	600	700	1 150	30
NOTE: For any temperature between 20 °C and –196 °C, mechanical properties may be estimated by linear interpolation.																	

Annex G
(informative)

Bibliography

EN 1011-3[1)]	Welding - Recommendation for welding of metallic materials - Arc welding - Part 3: Stainless steels.
DIN 17460:1992	Hochwarmfeste austenitische Stähle - Technische Lieferbedingungen für Blech, kalt- und warmgewalztes Band, Stäbe und Schmiedestücke. (High temperature austenitic steels - Technical delivery conditions for plate, cold and hot rolled strip, bars and forgings).
BS PD 6525 Part 1:1990	Elevated temperature properties for steels for pressure purposes - Part 1: Stress rupture properties.
NFA 36-209:1990	Produits sidérurgiques - Tôles en aciers inoxydables austénítiques et austéno-ferritiques pour chaudières et appareils à pression. (Iron and steel - Austenitic and austenitic-ferritic stainless steel plates for boilers and pressure vessels).

[1]Results of investigations of the European Creep Collaborative Committee (ECCC, WG 3.3), submitted to ECISS/TC 22 and ECISS/TC 28 by fax of 1996-11-20 (Document ECISS/TC 22 N 372).

1) In preparation.

Annex H
(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.

Clause	**Deviation**
	Sweden (Ordinance AFS 1994:39)
General	Only the following grades are regarded as adequately validated and documented according to Swedish regulations: Ferritic steels: **1.4521;** Martensitic steels: **none;** Austenitic steels: **1.4307, 1.4306, 1.4311, 1.4541, 1.4404, 1.4571, 1.4432, 1.4435, 1.4539, 1.4550, 1.4429, 1.4436, 1.4438;** Austenitic-ferritic steels: **none.**

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.

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

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