DEUTSCHE NORM

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DIN EN 10028-7
Corrigendum 1:2006-05

Flat products made of steels for pressure purposes – Part 7: Stainless steels English version of DIN EN 10028-7:2008-02

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Teil 7: Nichtrostende Stähle
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National foreword

This standard has been prepared by Technical Committee ECISS/TC 22 “Steels for pressure purposes – Qualities” (Secretariat: DIN, Germany).

The responsible German body involved in its preparation was the *Normenausschuss Eisen und Stahl* (Iron and Steel Standards Committee), Technical Committee NA 04-02 *Stähle für den Druckbehälterbau.*

This document specifies requirements for flat products for pressure purposes made of stainless steels, including creep resisting steels.

Amendments

This standard differs from DIN EN 10028-7:2000-06 and DIN EN 10028-7 Corrigendum 1:2006-05 as follows:

a) Remarks regarding harmonization with Directive 97/23/EC have been made more precise.

b) Austenitic steels have been divided into corrosion resisting grades and creep resisting grades.

c) Chemical compositions have been brought in line with the relevant specifications in DIN EN 10088-1 and DIN EN 10088-2.

d) Minimum impact energy values for austenitic-ferritic steels have been increased.

e) Some of the maximum thickness values for cold-rolled and hot-rolled strip of austenitic-ferritic steel have been increased.

f) Values for the maximum thickness of hot-rolled plate of austenitic-ferritic steel have been modified.

g) Proof strength values for steels at 50 °C – which were determined by linear interpolation – are now specified.

h) Annex ZA has been revised.

i) The standard has been editorially revised.

Previous editions

DIN 17440: 1967-01, 1972-12, 1985-07, 1996-09
DIN 17441: 1985-07, 1997-02
DIN 17460: 1992-09
DIN EN 10028-7: 2000-06
DIN EN 10028-7 Corrigendum 1: 2006-05

National Annex NA
(informative)

Bibliography

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

DIN EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes*

EUROPEAN STANDARD

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EUROPÄISCHE NORM

EN 10028-7

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ICS 77.140.30; 77.140.50

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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 21 October 2007.

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 CEN Management Centre 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 CEN Management Centre has the same status as the official versions.

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

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Ref. No. EN 10028-7:2007: E

Contents

Foreword

This document (EN 10028-7:2007) 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 June 2008, and conflicting national standards shall be withdrawn at the latest by June 2008.

This document supersedes EN 10028-7:2000.

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 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

The steel grades covered by this European Standard have been selected from EN 10088-1.

EN 10028 consists of the following parts under the general title *Flat products made of steels for pressure purposes*:

— *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*

— *Part 7: Stainless steels*

NOTE The clauses marked by two points (••) contain information relating to agreements that 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, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies requirements for flat products for pressure purposes made of stainless steels, including austenitic creep resisting steels, in thicknesses as indicated in Tables 7 to 10.

The requirements of EN 10028-1 also apply.

NOTE 1 The steel grades covered by this European Standard have been selected from EN 10088-1.

NOTE 2 Once this European Standard is published in the Official Journal of the European Union (OJEU) under Directive 97/23/EC, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 97/23/EC is limited to technical data of materials in this European Standard (Part 1 and Part 7) and does not presume adequacy of the material to a specific item of equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of this specific item of equipment to verify that the ESRs of the Pressure Equipment Directive are satisfied, needs to be done.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10028-1:2007, *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 10088-1:2005, *Stainless steels — Part 1: List of stainless steels*

EN ISO 643, *Steels — Micrographic determination of the apparent grain size (ISO 643:2003)*

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 (ISO 3651-2:1998)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10028-1:2007 and the following apply.

3.1
cryogenic temperature
temperature lower than –75 °C used in the liquefaction of gases

4 Dimensions and tolerances on dimensions

Shall be according to EN 10028-1.

5 Calculation of mass

For density values, shall be according to EN 10088-1:2005, Annex A.

6 Classification and designation

Shall be according to EN 10028-1.

7 Information to be supplied by the purchaser

7.1 Mandatory information

Shall be according to EN 10028-1.

7.2 Options

A number of options are specified in this document 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 products shall be supplied in accordance with the basic specification (see EN 10028-1).

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

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

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 according to process route 1D (see Table 6), inspection document 3.1 as specified in EN 10204:

10 plates–EN 10029–8Ax2000x5000–steel EN 10028-7–X5CrNi18-10+1D–inspection document 3.1

or

10 plates– EN 10029–8Ax2000x5000–steel EN 10028-7–1.4301+1D–inspection document 3.1

8 Requirements

8.1 Steelmaking process

Shall be according to 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 A.

8.3 Chemical composition and chemical corrosion properties

8.3.1 The chemical composition requirements given in Tables 1 to 4 shall 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 The specifications in Tables 7, 9 and 10 shall apply in respect to resistance to intergranular corrosion as defined in EN ISO 3651-2, for ferritic, austenitic and austenitic-ferritic steels.

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 stainless steels are insensitive to brittle fracture in the solution annealed condition. As they have a good resistance to shock loads, due to their high impact energy, also at very low (cryogenic) temperatures, they are useful for applications at such temperatures (see also the NOTE to Tables 9 and 10).

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 C.

8.4.3 Annex D gives mean values as preliminary data for the purchaser about strength for 1 % (plastic) creep strain and creep rupture. These data apply for the solution annealed condition only (see Table A.3).

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

8.5 Surface condition

Shall be according to EN 10028-1 and Table 6.

8.6 Internal soundness

Shall be according to EN 10028-1.

8.7 Physical properties

For reference data on physical properties, see Annex A of EN 10088-1:2005.

8.8 Post weld heat treatment

Guidelines for the purchaser on post weld heat treatment are given in Annex B.

9 Inspection

9.1 Types of inspection and inspection documents

Shall be according to EN 10028-1.

9.2 Tests to be carried out

Shall be according to Table 16 and EN 10028-1.

9.3 Re-tests

Shall be according to EN 10028-1.

10 Sampling

10.1 Frequency of testing

Shall be according to Table 16 and EN 10028-1.

10.2 Selection and preparation of samples and test pieces

Shall be according to EN 10028-1.

11 Test methods

Shall be according to EN 10028-1.

12 Marking

Shall be according to EN 10028-1.

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

Steel grade		% by mass										
Steel name	Steel number	C max.	Si max.	Mn max.	P max.	S max.	N max.	Cr	Mo	Nb	Ni	Ti
X2CrNi12	1.4003	0,030	1,00	1,50	0,040	0,015	0,030	10,5 to 12,5	–	–	0,30 to 1,00	–
X6CrNiTi12	1.4516	0,08	0,70	1,50	0,040	0,015	–	10,5 to 12,5	–	–	0,50 to 1,50	0,05 to 0,35
X2CrTi17	1.4520	0,025	0,50	0,50	0,040	0,015	0,015	16,0 to 18,0	–	–	–	0,30 to 0,60
X3CrTi17	1.4510	0,05	1,00	1,00	0,040	0,015	–	16,0 to 18,0	–	–	–	[4 x(C+N) + 0,15] to 0,80 [b]
X2CrMoTi17-1	1.4513	0,025	1,00	1,00	0,040	0,015	0,020	16,0 to 18,0	0,80 to 1,40	–	–	0,30 to 0,60
X2CrMoTi18-2	1.4521	0,025	1,00	1,00	0,040	0,015	0,030	17,0 to 20,0	1,80 to 2,50	–	–	[4 x(C+N) + 0,15] to 0,80 [b]
X6CrMoNb17-1	1.4526	0,08	1,00	1,00	0,040	0,015	0,040	16,0 to 18,0	0,80 to 1,40	[7x(C+N) + 0,10] to 1,00	–	–
X2CrTiNb18	1.4509	0,030	1,00	1,00	0,040	0,015	–	17,5 to 18,5	–	[(3xC)+ 0,30] to 1,00	–	0,10 to 0,60

[a] Elements not listed in this table shall 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.

[b] The stabilisation may be made by use of titanium or niobium or zirconium. According to the atomic mass of these elements and the content of carbon and nitrogen, the equivalence shall be the following, in % by mass:

$$Nb = Zr = \frac{7}{4} Ti$$

Table 2 — Chemical composition (cast analysis) [a] of martensitic steels

Steel grade		% by mass								
Steel name	Steel number	C max.	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N min.
X3CrNiMo13-4	1.4313	0,05	0,70	1,50	0,040	0,015	12,0 to 14,0	0,30 to 0,70	3,5 to 4,5	0,020
X4CrNiMo16-5-1	1.4418	0,06	0,70	1,50	0,040	0,015	15,0 to 17,0	0,80 to 1,50	4,0 to 6,0	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.

Table 3 — Chemical composition (cast analysis) [a] of austenitic steels

Steel grade		% by mass												
Steel name	Steel number	C	Si	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
Austenitic corrosion resisting grades														
X2CrNiN18-7	1.4318	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,10 to 0,20	16,5 to 18,5	–	–	–	6,0 to 8,0	–	–
X2CrNi18-9	1.4307	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,10	17,5 to 19,5	–	–	–	8,0 to 10,5	–	–
X2CrNi19-11	1.4306	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,10	18,0 to 20,0	–	–	–	10,0 to 12,0	–	–
X5CrNiN19-9	1.4315	≤ 0,06	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	18,0 to 20,0	–	–	–	8,0 to 11,0	–	–
X2CrNiN18-10	1.4311	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	17,5 to 19,5	–	–	–	8,5 to 11,5	–	–
X5CrNi18-10	1.4301	≤ 0,07	≤ 1,00	2,00	0,045	0,015	≤ 0,10	17,5 to 19,5	–	–	–	8,0 to 10,5	–	–
X6CrNiTi18-10	1.4541	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	17,0 to 19,0	–	–	–	9,0 to 12,0	5 x C to 0,70	–
X6CrNiNb18-10	1.4550	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	17,0 to 19,0	–	–	10 x C to 1,00	9,0 to 12,0	–	–
X1CrNi25-21	1.4335	≤ 0,020	≤ 0,25	2,00	0,025	0,010	≤ 0,10	24,0 to 26,0	–	≤ 0,20	–	20,0 to 22,0	–	–
X2CrNiMo17-12-2	1.4404	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,10	16,5 to 18,5	–	2,00 to 2,50	–	10,0 to 13,0	–	–
X2CrNiMoN17-11-2	1.4406	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	–	2,00 to 2,50	–	10,0 to 12,5	–	–
X5CrNiMo17-12-2	1.4401	≤ 0,07	≤ 1,00	2,00	0,045	0,015	≤ 0,10	16,5 to 18,5	–	2,00 to 2,50	–	10,0 to 13,0	–	–
X1CrNiMoN25-22-2	1.4466	≤ 0,020	≤ 0,70	2,00	0,025	0,010	0,10 to 0,16	24,0 to 26,0	–	2,00 to 2,50	–	21,0 to 23,0	–	–
X6CrNiMoTi17-12-2	1.4571	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	16,5 to 18,5	–	2,00 to 2,50	–	10,5 to 13,5	5 x C to 0,70	–
X6CrNiMoNb17-12-2	1.4580	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	16,5 to 18,5	–	2,00 to 2,50	10 x C to 1,00	10,5 to 13,5	–	–
X2CrNiMo17-12-3	1.4432	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,10	16,5 to 18,5	–	2,50 to 3,00	–	10,5 to 13,0	–	–
X2CrNiMoN17-13-3	1.4429	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	–	2,50 to 3,00	–	11,0 to 14,0	–	–
X3CrNiMo17-13-3	1.4436	≤ 0,05	≤ 1,00	2,00	0,045	0,015	≤ 0,10	16,5 to 18,5	–	2,50 to 3,00	–	10,5 to 13,0	–	–
X2CrNiMo18-14-3	1.4435	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,10	17,0 to 19,0	–	2,50 to 3,00	–	12,5 to 15,0	–	–
X2CrNiMoN18-12-4	1.4434	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,10 to 0,20	16,5 to 19,5	–	3,0 to 4,0	–	10,5 to 14,0	–	–

(to be continued)

Table 3 (*concluded*)

Steel grade		% by mass												
Steel name	Steel number	C	Si	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
X2CrNiMo18-15-4	1.4438	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,10	17,5 to 19,5	–	3,0 to 4,0	–	13,0 to 16,0	–	–
X2CrNiMoN17-13-5	1.4439	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	–	4,0 to 5,0	–	12,5 to 14,5	–	–
X1NiCrMoCu31-27-4	1.4563	≤ 0,020	≤ 0,70	2,00	0,030	0,010	≤ 0,10	26,0 to 28,0	0,70 to 1,50	3,0 to 4,0	–	30,0 to 32,0	–	–
X1NiCrMoCu25-20-5	1.4539	≤ 0,020	≤ 0,70	2,00	0,030	0,010	≤ 0,15	19,0 to 21,0	1,20 to 2,00	4,0 to 5,0	–	24,0 to 26,0	–	–
X1CrNiMoCuN25-25-5	1.4537	≤ 0,020	≤ 0,70	2,00	0,030	0,010	0,17 to 0,25	24,0 to 26,0	1,00 to 2,00	4,7 to 5,7	–	24,0 to 27,0	–	–
X1CrNiMoCuN20-18-7	1.4547	≤ 0,020	≤ 0,70	1,00	0,030	0,010	0,18 to 0,25	19,5 to 20,5	0,50 to 1,00	6,0 to 7,0	–	17,5 to 18,5	–	–
X1NiCrMoCuN25-20-7	1.4529	≤ 0,020	≤ 0,50	1,00	0,030	0,010	0,15 to 0,25	19,0 to 21,0	0,50 to 1,50	6,0 to 7,0	–	24,0 to 26,0	–	–
Austenitic creep resisting grades														
X3CrNiMoBN17-13-3	1.4910	≤ 0,04	≤ 0,75	2,00	0,035	0,015	0,10 to 0,18	16,0 to 18,0		2,00 to 3,00	–	12,0 to 14,0	–	0,001 5 to 0,005 0 B
X6CrNiTiB18-10	1.4941	0,04 to 0,08	≤ 1,00	2,00	0,035	0,015	–	17,0 to 19,0	–	–	–	9,0 to 12,0	5 x C to 0,80	0,001 5 to 0,005 0 B
X6CrNi18-10	1.4948	0,04 to 0,08	≤ 1,00	2,00	0,035	0,015	≤ 0,10	17,0 to 19,0	–	–	–	8,0 to 11,0	–	–
X6CrNi23-13	1.4950	0,04 to 0,08	≤ 0,70	2,00	0,035	0,015	≤ 0,10	22,0 to 24,0	–	–	–	12,0 to 15,0	–	–
X6CrNi25-20	1.4951	0,04 to 0,08	≤ 0,70	2,00	0,035	0,015	≤ 0,10	24,0 to 26,0	–	–	–	19,0 to 22,0	–	–
X5NiCrAlTi31-20 (+RA)	1.4958 (+RA)	0,03 to 0,08	≤ 0,70	1,50	0,015	0,010	≤ 0,030	19,0 to 22,0	≤ 0,50	–	≤ 0,10	30,0 to 32,5	0,20 to 0,50	0,20 to 0,50 Al Al+Ti: ≤ 0,70 ≤ 0,50 Co Ni+Co: 30,0 to 32,5
X8NiCrAlTi32-21	1.4959	0,05 to 0,10	≤ 0,70	1,50	0,015	0,010	≤ 0,030	19,0 to 22,0	≤ 0,50	–	–	30,0 to 34,0	0,25 to 0,65	0,25 to 0,65 Al ≤ 0,50 Co Ni+Co: 30,0 to 34,0
X8CrNiNb16-13	1.4961	0,04 to 0,10	0,30 to 0,60	1,50	0,035	0,015	–	15,0 to 17,0	–	–	10 x C to 1,20	12,0 to 14,0	–	–

[a] Elements not listed in this table shall 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) [a] of austenitic-ferritic steels

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

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 [a] % 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
Sulphur		≤	0,015	+	0,003
Nitrogen		≤	0,35	±	0,01
Aluminium		≤	0,65	±	0,10
Boron	≥ 0,001 5	≤	0,005 0	±	0,000 3
Chromium	≥ 10,5	<	15,0	±	0,15
	≥ 15,0	≤	20,0	±	0,20
	> 20,0	≤	28,0	±	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	≤	7,0	±	0,10
Niobium		≤	1,20	±	0,05
Nickel		≤	1,00	±	0,03
	> 1,00	≤	5,0	±	0,07
	> 5,0	≤	10,0	±	0,10
	> 10,0	≤	20,0	±	0,15
	> 20,0	≤	34,0	±	0,20
Cobalt		≤	0,50	+	0,05
Titanium		≤	0,80	±	0,05
Tungsten		≤	1,00	±	0,05

[a] If several product analyses are carried out on one cast and the contents of an individual element determined lie outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum value or to fall short of the permissible minimum value, but not both for one cast.

Table 6 — Type of process route of sheet, plate and strip [a]

	Abbreviation [b]	Type of treatment [c]	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 [d]	Smooth, bright, reflective	Smoother and brighter than 2B. Also common finish for further processing.
Special finishes	1G or 2G	Ground [e]	See footnote f.	Grade of grit or surface roughness can be specified. Unidirectional texture, not very reflective.
	1J or 2J	Brushed [e] or dull polished [e]	Smoother than ground. See footnote f	Grade of brush or surface roughness can be specified. Unidirectional texture, not very reflective.
	1K or 2K	Satin polished [e]	See footnote f	Additional specific requirements to a “J” type finish, in order to achieve adequate corrosion resistance for marine and external architectural applications. Transverse Ra < 0,5 µm with clean cut surface finish.
	1P or 2P	Bright polished [e]	See footnote f	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.

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

[b] First digit, 1 = hot rolled, 2 = cold rolled.

[c] The basic heat treatment condition specified in the relevant Table 7, 8, 9 or 10 applies.

[d] May be skin passed.

[e] One surface only, unless specifically agreed at the time of enquiry and order.

[f] 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 A.1) and resistance to intergranular corrosion

Steel grade		Product form [a]	Thick-ness	0,2 % proof strength		Tensile strength	Elongation after fracture		Resistance to inter-granular corrosion[d]		Impact en-ergy (ISO-V)
Steel name	Steel num-ber		mm max.	$R_{p0,2}$ MPa min. (long.)	(tr.)	R_m MPa	$A_{80\,mm}$ [b] < 3 mm thick % min. (long. + tr.)	A [c] ≥ 3 mm thick % min. (long. + tr.)	in the delivery condi-tion	In the welded condition	KV min. J (tr.)
X2CrNi12	1.4003	C	8	280	320	450 to 650	20		no	no	50
		H	13,5								
		P	25[e]	250	280		18				
X6CrNiTi12	1.4516	C	8	280	320	450 to 650	23		no	no	50
		H	13,5								
		P	25[e]	250	280		20				
X2CrTi17	1.4520	C	4	180	200	380 to 530	24		yes	yes	– [f]
X3CrTi17	1.4510	C	4	230	240	420 to 600	23		yes	yes	– [f]
X2CrMoTi17-1	1.4513	C	4	200	220	400 to 550	23		yes	yes	– [f]
X2CrMoTi18-2	1.4521	C	4	300	320	420 to 640	20		yes	yes	– [f]
X6CrMoNb17-1	1.4526	C	4	280	300	480 to 560	25		yes	yes	– [f]
X2CrTiNb18	1.4509	C	4	230	250	430 to 630	18		yes	yes	– [f]

a C = cold rolled strip; H = hot rolled strip; P = hot rolled plate.

b 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.

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

d When tested according to EN ISO 3651-2.

e ●● For thicknesses above 25 mm up to 75 mm, the mechanical properties may be agreed at the time of enquiry and order.

f Because of the small maximum product thickness t, no verifiable values can be specified (the requirement to prepare impact test pieces applies for $t \geq 6$ mm, see EN 10028-1:2007, 10.2.2.3 c)).

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

Steel grade		Product form [a]	Thickness	0,2 % proof strength $R_{p0.2}$	Tensile strength R_m	Elongation after fracture A [b] ≥ 3 mm thick	Impact energy (ISO-V) KV	
Steel name	Steel number		mm max.	MPa min.	MPa	% min. (long. + tr.)	J min. at 20 °C (long. + tr.)	J min. at –20 °C (long. + tr.)
X3CrNiMo13-4	1.4313	P	75	650	780 to 980	14	70	40
X4CrNiMo16-5-1	1.4418	P	75	680	840 to 980	14	55	40

[a] P = hot rolled plate.

[b] The values apply for test pieces with a gauge length of $5{,}65\sqrt{S_0}$.

Table 9 — Mechanical properties at room temperature and impact energy at –196 °C of austenitic steels in the solution annealed condition [a] and resistance to intergranular corrosion

Steel grade		Product-form [b]	Thick-ness	0,2 % proof strength	1,0 % proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) KV J min.			Resistance to intergranular corrosion [g]	
Steel name	Steel number		mm max.	$R_{p0,2}$ MPa min. (tr.) [c d]	$R_{p1,0}$ MPa min. (tr.) [c d]	R_m MPa	A_{80mm} [e] < 3 mm thick % min. (tr.) [c]	A [f] ≥ 3 mm thick % min. (tr.) [c]	at 20 °C (long.)	at 20 °C (tr.)	at –196°C (tr.)	in the delivery condition	in the sensitized condition
Austenitic corrosion resisting grades													
X2CrNiN18-7	1.4318	C	8	350	380	650 to 850	35	40	90	60	–	yes	yes
		H	13,5	330	370								
		P	75	330	370								
X2CrNi18-9	1.4307	C	8	220	250	520 to 700	45	45	100	60	60	yes	yes
		H	13,5	200	240								
		P	75	200	240	500 to 700							
X2CrNi19-11	1.4306	C	8	220	250	520 to 700	45	45	100	60	60	yes	yes
		H	13,5	200	240								
		P	75	200	240	500 to 700							
X5CrNiN19-9	1.4315	C	8	290	320	550 to 750	40	40	100	60	60	(yes) [i]	No [j]
		H	13,5	270	310								
		P	75	270	310								
X2CrNiN18-10	1.4311	C	8	290	320	550 to 750	40	40	100	60	60	yes	yes
		H	13,5	270	310								
		P	75	270	310								
X5CrNi18-10	1.4301	C	8	230	260	540 to 750	45 [h]	45 [h]	100	60	60	(yes) [i]	No [j]
		H	13,5	210	250	520 to 720							
		P	75	210	250		45	45					
X6CrNiTi18-10	1.4541	C	8	220	250	520 to 720	40	40	100	60	60	yes	yes
		H	13,5	200	240								
		P	75	200	240	500 to 700							
X6CrNiNb18-10	1.4550	H	13,5	200	240	520 to 720	40	40	100	60	40	yes	yes
		P	75	200	240	500 to 700							
X1CrNi25-21	1.4335	P	75	200	240	470 to 670	40	40	100	60	60	yes	yes

(to be continued)

Table 9 (*continued*)

Steel grade		Product-form [b]	Thickness	0,2 % proof strength	1,0 % proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) KV			Resistance to intergranular corrosion [g]	
				$R_{p0,2}$	$R_{p1,0}$	R_m	A_{80mm} [e]	A [f]	J min.				
Steel name	Steel number		mm max.	MPa min. (tr.) [c d]		MPa	< 3 mm thick % min. (tr.) [c]	≥ 3 mm thick % min. (tr.) [c]	at 20 °C (long.)	at 20 °C (tr.)	at –196°C (tr.)	in the delivery condition	in the sensitized condition
X2CrNiMo17-12-2	1.4404	C	8	240	270	530 to 680	40	40	100	60	60	yes	yes
		H	13,5	220	260								
		P	75	220	260	520 to 670	45	45					
X2CrNiMoN17-11-2	1.4406	C	8	300	330	580 to 780	40	40	100	60	60	yes	yes
		H	13,5	280	320								
		P	75	280	320								
X5CrNiMo17-12-2	1.4401	C	8	240	270	530 to 680	40	40	100	60	60	yes [i]	no [j]
		H	13,5	220	260								
		P	75	220	260	520 to 670	45	45					
X1CrNiMoN25-22-2	1.4466	P	75	250	290	540 to 740	40	40	100	60	60	yes	yes
X6CrNiMoTi17-12-2	1.4571	C	8	240	270	540 to 690	40	40	100	60	60	yes	yes
		H	13,5	220	260								
		P	75	220	260	520 to 670							
X6CrNiMoNb17-12-2	1.4580	P	75	220	260	520 to 720	40	40	100	60	–	yes	yes
X2CrNiMo17-12-3	1.4432	C	8	240	270	550 to 700	40	40	100	60	60	yes	yes
		H	13,5	220	260								
		P	75	220	260	520 to 670	45	45					
X2CrNiMoN17-13-3	1.4429	C	8	300	330	580 to 780	35	35	100	60	60	yes	yes
		H	13,5	280	320								
		P	75	280	320		40	40					

(to be continued)

Table 9 (*continued*)

Steel grade		Product-form [b]	Thickness	0,2 % proof strength	1,0 % proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) KV			Resistance to intergranular corrosion [g]	
				$R_{p0,2}$	$R_{p1,0}$	R_m	A_{80mm} [e]	A [f]	J min.				
Steel name	Steel number		mm max.	MPa min. (tr.) [c d]		MPa	< 3 mm thick % min. (tr.) [c]	≥ 3 mm thick % min. (tr.) [c]	at 20 °C (long.)	at 20 °C (tr.)	at –196°C (tr.)	in the delivery condition	in the sensitized condition
X3CrNiMo17-13-3	1.4436	C	8	240	270	550 to 700	40	40	100	60	60	(yes) [i]	no [j]
		H	13,5	220	260								
		P	75	220	260	530 to 730	40	40					
X2CrNiMo18-14-3	1.4435	C	8	240	270	550 to 700	40	40	100	60	60	yes	yes
		H	13,5	220	260								
		P	75	220	260	520 to 670	45	45					
X2CrNiMoN18-12-4	1.4434	C	8	290	320	570 to 770	35	35	100	60	60	yes	yes
		H	13,5	270	310								
		P	75	270	310	540 to 740	40	40					
X2CrNiMo18-15-4	1.4438	C	8	240	270	550 to 700	35	35	100	60	60	yes	yes
		H	13,5	220	260								
		P	75	220	260	520 to 720	40	40					
X2CrNiMoN17-13-5	1.4439	C	8	290	320	580 to 780	35	35	100	60	60	yes	yes
		H	13,5	270	310								
		P	75	270	310		40	40					
X1NiCrMoCu31-27-4	1.4563	P	75	220	260	500 to 700	40	40	100	60	60	yes	yes
X1NiCrMoCu25-20-5	1.4539	C	8	240	270	530 to 730	35	35	100	60	60	yes	yes
		H	13,5	220	260								
		P	75	220	260	520 to 720							
X1CrNiMoCuN25-25-5	1.4537	P	75	290	330	600 to 800	40	40	100	60	60	yes	yes
X1CrNiMoCuN20-18-7	1.4547	C	8	320	350	650 to 850	35	35	100	60	60	yes	yes
		H	13,5	300	340								
		P	75	300	340		40	40					
X1NiCrMoCuN25-20-7	1.4529	P	75	300	340	650 to 850	40	40	100	60	60	yes	yes

(to be continued)

Table 9 (*continued*)

Steel grade		Pro-duct-form [b]	Thick-ness	0,2 % proof strength	1,0 % proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) KV J min.			Resistance to intergranular corrosion [g]	
				$R_{p0,2}$	$R_{p1,0}$	R_m	A_{80mm} [e] < 3 mm thick % min.	A [f] ≥ 3 mm thick % min.	at 20 °C		at –196°C (tr.)	in the delivery condition	in the sensitized condition
Steel name	Steel num-ber		mm max.	MPa min. (tr.) [c d]		MPa	(tr.) [c]	(tr.) [c]	(long.)	(tr.)			
Austenitic creep resisting grades													
X3CrNiMoBN 17-13-3	1.4910	C	8	300	330	580 to 780	35	40	100	60	–	yes	yes
		H	13,5	260	300	550 to 750							
		P	75	260	300								
X6CrNiTiB18-10	1.4941	C	8	220	250	510 to 710	40	40	100	60	–	yes	yes
		H	13,5	200	240								
		P	75	200	240	490 to 690							
X6CrNi18-10	1.4948	C	8	230	260	530 to 740	45 [h]	45 [h]	100	60	–	no	no
		H	13,5	210	250	510 to 710	45	45					
		P	75	190	230								
X6CrNi23-13	1.4950	C	8	220	250	530 to 730	35	35	100	60	–	no	no
		H	13,5	200	240	510 to 710							
		P	75	200	240								
X6CrNi25-20	1.4951	C	8	220	250	530 to 730	35	35	100	60	–	no	no
		H	13,5	200	240	510 to 710							
		P	75	200	240								
X5NiCrAlTi31-20	1.4958	P	75	170	200	500 to 750	30	30	120	80	–	yes	no

(to be continued)

Table 9 (*concluded*)

Steel grade		Product-form [b]	Thickness	0,2 % proof strength	1,0 % proof strength	Tensile strength	Elongation after fracture		Impact energy (ISO-V) KV			Resistance to intergranular corrosion [g]	
				$R_{p0,2}$	$R_{p1,0}$	R_m	A_{80mm} [e]	A [f]	J min.				
Steel name	Steel number		mm max.	MPa min. (tr.) [c d]		MPa	< 3 mm thick % min. (tr.) [c]	≥ 3 mm thick % min. (tr.) [c]	at 20 °C (long.)	at 20 °C (tr.)	at –196°C (tr.)	in the delivery condition	in the sensitized condition
X5NiCrAlTi31-20+RA[k]	1.4958 +RA [k]	P	75	210	240	500 to 750	30	30	120	80	–	yes	no
X8NiCrAlTi32-21	1.4959	P	75	170	200	500 to 750	30	30	120	80	–	yes	no
X8CrNiNb16-13	1.4961	P	75	200	240	510 to 690	35	35	100	60	–	yes	yes

NOTE Austenitic steels always have adequate toughness and do not need to be impact tested. In contrast, austenitic-ferritic steels need to be tested to the impact energy requirements In Table 10 to ensure that toughness is adequate.

a See Table A.3.

b C = cold rolled strip; H = hot rolled strip; P = hot rolled plate.

c 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 $R_{p0,2}$: minus 15 MPa
– elongation for constant gauge length $A_{80\,mm}$: minus 5 %
– elongation for proportional gauge length A: minus 2 %.

d ●● For continuously hot rolled products, 20 MPa higher minimum values of $R_{p0,2}$ and 10 MPa higher minimum values of $R_{p1,0}$ may be agreed at the time of enquiry and order.

e 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.

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

g When tested according to EN ISO 3651-2.

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

i Normally for thicknesses up to 6 mm.

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

k +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 A.4) and resistance to intergranular corrosion

Steel grade		Product form a	Thickness	0,2 % proof strength $R_{p0,2}$ MPa [b] min. strip width		Tensile strength R_m	Elongation after fracture		Impact energy(ISO-V) KV J min.			Resistance to intergranular corrosion [e]	
				(long.)	(tr.)		A_{80mm} < 3 mm thick [c] % min.	A ≥ 3 mm thick [d] % min.	at 20 °C		at -40 °C	in the delivery condition	in the sensitized condition
Steel name	Steel number		mm max.	< 300 mm	≥ 300 mm	MPa	(long. + tr.)	(long. + tr.)	(long.)	(tr.)	(tr.)		
X2CrNiN23-4	1.4362	C	8	405	420	600 to 850	20	20	120	90	40	yes	yes
		H	13,5	385	400								
		P	50	385	400	630 to 800	25	25					
X2CrNiMoN22-5-3	1.4462	C	8	485	500	700 to 950	20	20	150	100	40	yes	yes
		H	13,5	445	460		25	25					
		P	75	445	460	640 to 840	25	25					
X2CrNiMoCuN25-6-3	1.4507	C	8	495	510	690 to 940	20	20	150	90	40	yes	yes
		H	13,5	475	490								
		P	50	475	490	690 to 890	25	25					
X2CrNiMoN25-7-4	1.4410	C	8	535	550	750 to 1 000	20	20	150	90	40	yes	yes
		H	13,5	515	530								
		P	50	515	530	730 to 930	20	20					
X2CrNiMoCuWN25-7-4	1.4501	P	50	515	530	730 to 930	25	25	150	90	40	yes	yes

NOTE Austenitic-ferritic steels need to be tested to the above impact energy requirements to ensure that toughness is adequate. In contrast, austenitic steels always have adequate toughness and do not need to be tested.

a C = cold rolled strip; H = hot rolled strip; P = hot rolled plate.

b •• For continuously hot rolled products, 20 MPa higher minimum values of $R_{p0,2}$ may be agreed at the time of enquiry and order.

c 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.

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

e 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 A.1)

Steel grade		Minimum 0,2 % proof strength $R_{p0,2}$, MPa at a temperature (in °C) of							
Steel name	Steel number	50 [a]	100	150	200	250	300	350	400
X2CrNi12	1.4003	265	240	235	230	220	215	–	–
X6CrNiTi12	1.4516	–	300	270	250	245	225	215	–
X2CrTi17	1.4520	198	195	180	170	160	155	–	–
X3CrTi17	1.4510	223	195	190	185	175	165	155	–
X2CrMoTi17-1	1.4513	–	250	240	230	220	210	205	200
X2CrMoTi18-2	1.4521	294	250	240	230	220	210	205	–
X6CrMoNb17-1	1.4526	289	270	265	250	235	215	205	–
X2CrTiNb18	1.4509	242	230	220	210	205	200	180	–
[a] Determined by linear interpolation.									

Table 12 — Minimum values for the 0,2 % proof strength of martensitic steels at elevated temperatures in the quenched and tempered condition (see Table A.2)

Steel grade		Minimum 0,2 % proof strength $R_{p0,2}$, MPa at a temperature (in °C) of						
Steel name	Steel number	50 [a]	100	150	200	250	300	350
X3CrNiMo13-4	1.4313	627	590	575	560	545	530	515
X4CrNiMo16-5-1	1.4418	672	660	640	620	600	580	—
[a] Determined by linear interpolation.								

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 A.3)

Steel grade		Minimum 0,2 % proof strength $R_{p0,2}$, MPa												Minimum 1,0 % proof strength $R_{p1,0}$, MPa											
Steel name	Steel number	at a temperature (in °C) of												at a temperature (in °C) of											
		50[a]	100	150	200	250	300	350	400	450	500	550	600	50[a]	100	150	200	250	300	350	400	450	500	550	600
Austenitic corrosion resisting grades																									
X2CrNiN18-7	1.4318	309	265	200	185	180	170	165	–	–	–	–	–	–	–	235	215	210	200	195	–	–	–	–	–
X2CrNi18-9	1.4307	180	147	132	118	108	100	94	89	85	81	80	–	218	181	162	147	137	127	121	116	112	109	108	–
X2CrNi19-11	1.4306	180	147	132	118	108	100	94	89	85	81	80	–	218	181	162	147	137	127	121	116	112	109	108	–
X5CrNiN19-9	1.4315	246	205	175	157	145	136	130	125	121	119	118	–	284	240	210	187	175	167	161	156	152	149	147	–
X2CrNiN18-10	1.4311	246	205	175	157	145	136	130	125	121	119	118	–	284	240	210	187	175	167	161	156	152	149	147	–
X5CrNi18-10	1.4301	190	157	142	127	118	110	104	98	95	92	90	–	228	191	172	157	145	135	129	125	122	120	120	–
X6CrNiTi18-10	1.4541	191	176	167	157	147	136	130	125	121	119	118	–	228	208	196	186	177	167	161	156	152	149	147	–
X6CrNiNb18-10-	1.4550	191	177	167	157	147	136	130	125	121	119	118	–	229	211	196	186	177	167	161	156	152	149	147	–
X1CrNi25-21	1.4335	181	150	140	130	120	115	110	105	–	–	–	–	217	180	170	160	150	140	135	130	–	–	–	–
X2CrNiMo17-12-2	1.4404	200	166	152	137	127	118	113	108	103	100	98	–	237	199	181	167	157	145	139	135	130	128	127	–
X2CrNiMoN17-11-2	1.4406	254	211	185	167	155	145	140	135	131	128	127	–	292	246	218	198	183	175	169	164	160	158	157	–
X5CrNiMo17-12-2	1.4401	204	177	162	147	137	127	120	115	112	110	108	–	242	211	191	177	167	156	150	144	141	139	137	–
X1CrNiMoN25-22-2	1.4466	229	195	170	160	150	140	135	–	–	–	–	–	266	225	205	190	180	170	165	–	–	–	–	–
X6CrNiMoTi17-12-2	1.4571	207	185	177	167	157	145	140	135	131	129	127	–	244	218	206	196	186	175	169	164	160	158	157	–
X6CrNiMoNb17-12-2	1.4580	207	185	177	167	157	145	140	135	131	129	127	–	244	218	206	196	186	175	169	164	160	158	157	–
X2CrNiMo17-12-3	1.4432	200	166	152	137	127	118	113	108	103	100	98	–	237	199	181	167	157	145	139	135	130	128	127	–
X2CrNiMoN17-13-3	1.4429	254	211	185	167	155	145	140	135	131	129	127		292	246	218	198	183	175	169	164	160	158	157	–
X3CrNiMo17-13-3	1.4436	204	177	162	147	137	127	120	115	112	110	108	–	252	211	191	177	167	156	150	144	141	139	137	–
X2CrNiMo18-14-3	1.4435	199	165	150	137	127	119	113	108	103	100	98	–	237	200	180	165	153	145	139	135	130	128	127	–

(to be continued)

Table 13 (*concluded*)

Steel grade		Minimum 0,2 % proof strength $R_{p0,2}$, MPa												Minimum 1,0 % proof strength $R_{p1,0}$, MPa											
		at a temperature (in °C) of												at a temperature (in °C) of											
Steel name	Steel number	50[a]	100	150	200	250	300	350	400	450	500	550	600	50[a]	100	150	200	250	300	350	400	450	500	550	600
X2CrNiMoN18-12-4	1.4434	248	211	185	167	155	145	140	135	131	129	127	–	286	246	218	198	183	175	169	164	160	158	157	–
X2CrNiMo18-15-4	1.4438	202	172	157	147	137	127	120	115	112	110	108	–	240	206	188	177	167	156	148	144	140	138	136	–
X2CrNiMoN17-13-5	1.4439	253	225	200	185	175	165	155	150	–	–	–	–	289	255	230	210	200	190	180	175	–	–	–	–
X1NiCrMoCu31-27-4	1.4563	209	190	175	160	155	150	145	135	125	120	115	–	245	220	205	190	185	180	175	165	155	150	145	–
X1NiCrMoCu25-20-5	1.4539	214	205	190	175	160	145	135	125	115	110	105	–	251	235	220	205	190	175	165	155	145	140	135	–
X1CrNiMoCuN25-25-5	1.4537	271	240	220	200	190	180	175	170	–	–	–	–	307	270	250	230	220	210	205	200	–	–	–	–
X1CrNiMoCuN20-18-7	1.4547	274	230	205	190	180	170	165	160	153	148	–	–	314	270	245	225	212	200	195	190	184	180	–	–
X1NiCrMoCuN25-20-7	1.4529	274	230	210	190	180	170	165	160	130	120	105	–	314	270	245	225	215	205	195	190	160	150	135	–
Austenitic creep resisting grades																									
X3CrNiMoBN17-13-3	1.4910	239	205	187	170	159	148	141	134	130	127	124	121	277	240	220	200	189	178	171	164	160	157	154	151
X6CrNiTiB18-10	1.4941	186	162	152	142	137	132	127	123	118	113	108	103	225	201	191	181	176	172	167	162	157	152	147	142
X6CrNi18-10	1.4948	178	157	142	127	117	108	103	98	93	88	83	78	215	191	172	157	147	137	132	127	122	118	113	108
X6CrNi23-13	1.4950	177	140	128	116	108	100	94	91	86	85	84	82	219	185	167	154	146	139	132	126	123	121	118	114
X6CrNi25-20	1.4951	177	140	128	116	108	100	94	91	86	85	84	82	219	185	167	154	146	139	132	126	123	121	118	114
X5NiCrAlTi31-20	1.4958	159	140	127	115	105	95	90	85	82	80	75	75	185	160	147	135	125	115	110	105	102	100	95	95
X5NiCrAlTi31-20+RA	1.4958+RA	199	180	170	160	152	145	137	130	125	120	115	110	227	205	193	180	172	165	160	155	150	145	140	135
X8NiCrAlTi32-21	1.4959	159	140	127	115	105	95	90	85	82	80	75	75	185	160	147	135	125	115	110	105	102	100	95	95
X8CrNiNb16-13	1.4961	191	175	166	157	147	137	132	128	123	118	118	113	227	205	195	186	176	167	162	157	152	147	147	142

[a] Determined by linear interpolation.

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

Steel grade		Minimum 0,2 % proof strength $R_{p0,2}$, MPa at a temperature (in °C) of				
Steel name	Steel number	50 [a]	100	150	200	250
X2CrNiN23-4	1.4362	374	330	300	280	265
X2CrNiMoN22-5-3	1.4462	422	360	335	315	300
X2CrNiMoCuN25-6-3	1.4507	475	450	420	400	380
X2CrNiMoN25-7-4	1.4410	500	450	420	400	380
X2CrNiMoCuWN25-7-4	1.4501	500	450	420	400	380

[a] Determined by linear interpolation.

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

Steel grade		Minimum tensile strength R_m, MPa at a temperature (in °C) of											
Steel name	Steel number	50[a]	100	150	200	250	300	350	400	450	500	550	600
Austenitic corrosion resisting grades													
X2CrNiN18-7	1.4318	605	530	490	460	450	440	430	–	–	–	–	–
X2CrNi18-9	1.4307	466	410	380	360	350	340	340	–	–	–	–	–
X2CrNi19-11	1.4306	466	410	380	360	350	340	340	–	–	–	–	–
X5CrNiN19-9	1.4315	527	490	460	430	420	410	410	–	–	–	–	–
X2CrNiN18-10	1.4311	527	490	460	430	420	410	410	–	–	–	–	–
X5CrNi18-10	1.4301	494	450	420	400	390	380	380	380	370	360	330	–
X6CrNiTi18-10	1.4541	477	440	410	390	385	375	375	375	370	360	330	–
X6CrNiNb18-10	1.4550	476	435	400	370	350	340	335	330	320	310	300	–
X1CrNi25-21	1.4335	459	440	425	410	390	385	380	–	–	–	–	–
X2CrNiMo17-12-2	1.4404	486	430	410	390	385	380	380	380	–	360	–	–
X2CrNiMoN17-11-2	1.4406	557	520	490	460	450	440	435	–	–	–	–	–
X5CrNiMo17-12-2	1.4401	486	430	410	390	385	380	380	–	–	–	–	–
X1CrNiMoN25-22-2	1.4466	521	490	475	460	450	440	435	–	–	–	–	–
X6CrNiMoTi17-12-2	1.4571	490	440	410	390	385	375	375	375	370	360	330	–
X6CrNiMoNb17-12-2	1.4580	490	440	410	390	385	375	375	375	370	360	330	–
X2CrNiMo17-12-3	1.4432	486	430	410	390	385	380	380	380	–	360	–	–
X2CrNiMoN17-13-3	1.4429	557	520	490	460	450	440	435	435	–	430	–	–
X3CrNiMo17-13-3	1.4436	504	460	440	420	415	410	410	410	–	390	–	–
X2CrNiMo18-14-3	1.4435	482	420	400	380	375	370	370	–	–	–	–	–
X2CrNiMoN18-12-4	1.4434	525	500	470	440	430	420	415	415	415	410	390	-
X2CrNiMo18-15-4	1.4438	486	430	410	390	385	380	380	–	–	–	–	–
X2CrNiMoN17-13-5	1.4439	557	520	490	460	450	440	435	–	–	–	–	–
X1NiCrMoCu31-27-4	1.4563	485	460	445	430	410	400	395	–	–	–	–	–
X1NiCrMoCu25-20-5	1.4539	512	500	480	460	450	440	435	–	–	–	–	–
X1CrNiMoCuN25-25-5	1.4537	581	550	535	520	500	480	475	–	–	–	–	–
X1CrNiMoCuN20-18-7	1.4547	637	615	587	560	542	525	517	510	502	495	–	–
X1NiCrMoCuN25-20-7	1.4529	612	550	535	520	500	480	475	–	–	–	–	–
Austenitic creep resisting grades													
X3CrNiMoBN17-13-3	1.4910	529	495	472	450	440	430	425	420	410	400	385	365
X6CrNiTiB18-10	1.4941	460	410	390	370	360	350	345	340	335	330	320	300
X6CrNi18-10	1.4948	484	440	410	390	385	375	375	375	370	360	330	300
X6CrNi23-13	1.4950	495	470	450	430	420	410	405	400	385	370	350	320
X6CrNi25-20	1.4951	495	470	450	430	420	410	405	400	385	370	350	320
X5NiCrAlTi31-20[b]	1.4958	487	465	445	435	425	420	418	415	415	415	–	–
X8NiCrAlTi32-21	1.4959	487	465	445	435	425	420	418	415	415	415	–	–
X8CrNiNb16-13	1.4961	493	465	440	420	400	385	375	370	360	350	340	320

[a] Determined by linear interpolation.

[b] 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 [a]	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 [b]		
Tensile test at room temperature	m	Cast, thickness ± 10 %, heat treatment batch	1 test sample from each coil	a) Plates ≤ 20 mm (≤ 15 mm [c]) 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 [c]) 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 [d]	o		To be agreed at the time of enquiry and order.		1
Impact test at room temperature	m [e]		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.			

[a] 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.

[b] A product analysis may be agreed at the time of enquiry and order (see EN 10028-1:2007, Table 1).

[c] Limit value for martensitic, ferritic and austenitic-ferritic steels.

[d] See EN 10028-1:2007, 11.3.

[e] 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 (see EN 10028-1:2007, Table 1).

Annex A
(informative)

Guidelines for further treatment (including heat treatment in fabrication)

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

Table A.1 — Guidelines on the temperatures for hot forming and heat treatment [a] of ferritic stainless steels

Steel grade		Hot forming		Heat-treatment-symbol [b]	Annealing	
Steel name	Steel number	Temperature °C	Type of cooling		Temperature [c] °C	Type of cooling
X2CrNi12	1.4003	1 100 to 800	air	+A	700 to 750	air, water
X6CrNiTi12	1.4516				790 to 850	
X2CrTi17	1.4520				820 to 880	
X3CrTi17	1.4510				770 to 830	
X2CrMoTi17-1	1.4513				790 to 850	
X2CrMoTi18-2	1.4521				820 to 880	
X6CrMoNb17-1	1.4526				800 to 860	
X2CrTiNb18	1.4509				870 to 930	

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

b +A = annealed.

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

Table A.2 — Guidelines on the temperatures for hot forming and heat treatment [a] of martensitic stainless steels

Steel grade		Hot forming		Heat treatment symbol [b]	Quenching		Tempering
Steel name	Steel number	Temperature °C	Type of cooling		Temperature [c] °C	Type of cooling	Temperature °C
X3CrNiMo13-4	1.4313	1150 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

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

b +QT = quenched and tempered.

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

Table A.3 —Guidelines on the temperatures for hot forming and heat treatment [a] of austenitic stainless steels

Steel grade		Hot forming		Heat treatment symbol [b]	Solution annealing [c] (but see footnote g)	
Steel name	Steel number	Temperature °C	Type of cooling		Temperature [d e] °C	Type of cooling
Austenitic corrosion resisting grades						
X2CrNiN18-7	1.4318	1 150 to 850	air	+AT	1 020 to 1 100	water, air [f]
X2CrNi18-9	1.4307				1 000 to 1 100	
X2CrNi19-11	1.4306				1 000 to 1 100	
X5CrNiN19-9	1.4315				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				1 000 to 1 100	
X6CrNiNb18-10	1.4550				1 020 to 1 120	
X1CrNi25-21	1.4335				1 030 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	
X1CrNiMoN25-22-2	1.4466				1 070 to 1 150	
X6CrNiMoTi17-12-2	1.4571				1 030 to 1 110	
X6CrNiMoNb17-12-2	1.4580				1 030 to 1 110	
X2CrNiMo17-12-3	1.4432				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	
X2CrNiMo18-14-3	1.4435				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	
X2CrNiMoN17-13-5	1.4439				1 060 to 1 140	
X1NiCrMoCu31-27-4	1.4563				1 070 to 1 150	
X1NiCrMoCu25-20-5	1.4539				1 060 to 1 140	
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	
Austenitic creep resisting grades						
X3CrNiMoBN17-13-3	1.4910	1 150 to 850	air	+AT	1 020 to 1 100	water, air [f]
X6CrNiTiB18-10	1.4941				1 050 to 1 110	
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	
X5NiCrAlTi31-20	1.4958				1 100 to 1 200	
X5NiCrAlTi31-20+RA	1.4958 (+RA)			+RA	920 to 1 000 [g]	
X8NiCrAlTi32-21	1.4959			+AT	1 100 to 1 200 [h]	
X8CrNiNb16-13	1.4961				1 050 to 1 110	

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

b +AT = solution annealed, +RA = re-crystallizing annealed.

c 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 and provided these requirements are met even after appropriate subsequent solution annealing.

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

e 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 %.

f Cooling sufficiently rapid.

g Re-crystallizing annealing.

h After solution annealing the grain size according to EN ISO 643 shall be 1 to 5.

Table A.4 — Guidelines on the temperatures for hot forming and heat treatment [a] of austenitic-ferritic stainless steels

Steel grade		Hot forming		Heattreat-ment	Solution annealing[c]	
Steel name	Steel number	Temperature °C	Type of cooling	Symbol [b]	Temperature [d] °C	Type of cooling
X2CrNiN23-4	1.4362	1 150 to 950	air	+AT	1 000 ± 50	water, air
X2CrNiMoN22-5-3	1.4462				1 060 ± 40	
X2CrNiMoCuN25-6-3	1.4507	1 150 to1 000	air	+AT	1 080 ± 40	water, air
X2CrNiMoN25-7-4	1.4410					
X2CrNiMoCuWN25-7-4	1.4501					

[a] The temperatures of annealing, should be agreed for simulated heat treated test pieces.

[b] +AT = Solution annealed.

[c] Solution annealing in the range specified followed by sufficiently rapid cooling to avoid precipitation of deleterious phases is essential after hot forming these steels.

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

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

A.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.

A.4 For further information see EN 1011-3 [1].

Annex B
(informative)

Post weld heat treatment

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

— 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 A.1 and A.2.

B.2 During heating of high chromium and molybdenum austenitic-ferritic or austenitic steel weldments containing some ferrite, intermetallic phases may be formed which need to 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 Tables A.3 and A.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.

B.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 B.1 by holding at an intermediate stage below the usual solution temperature (see Table A.3) and is defined as stabilizing annealing for the niobium or titanium bearing grades and as stress-relieving for the un-stabilized low carbon grades.

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

B.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 °C 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 °C and 200 °C according to the particular steel and thickness should be applied.

The same is advisable for complex welds of austenitic steels.

Table B.1 — Guideline on post weld heat treatment of austenitic steels

Steel grade		Temperature [a]	Type of cooling
Steel name	Steel 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			
X5CrNiN19-9	1.4315	not recommended	
X5CrNi18-10	1.4301		
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 [c]	forced air
X2CrNiMoN17-11-2	1.4406		
X2CrNiMo17-12-3	1.4432		
X2CrNiMoN17-13-3	1.4429		
X2CrNiMo18-14-3	1.4435		
X2CrNiMoN18-12-4	1.4434		
X2CrNiMo18-15-4	1.4438		
X2CrNiMoN17-13-5	1.4439		
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			
X3CrNiMoBN17-13-3	1.4910	900 to 950 [b]	air
X6CrNiTiB18-10	1.4941		
X6CrNi18-10	1.4948	not recommended	
X6CrNi23-13	1.4950		
X6CrNi25-20	1.4951		
X5NiCrAlTi31-20 (+RA)	1.4958 (+RA)	900 to 950 [b]	air
X8NiCrAlTi32-21	1.4959		
X8CrNiNb16-13	1.4961		

[a] Minimum holding time: 30 min.

[b] Recommended for components with greater wall thickness.

[c] Not recommended if welded with stabilized filler metal.

Annex C
(informative)

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

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

Steel grade		Minimum tensile strength, MPa at a temperature (in °C) of				
Steel name	Steel number	50 [a]	100	150	200	250
X2CrNiN23-4	1.4362	577	540	520	500	490
X2CrNiMoN22-5-3	1.4462	621	590	570	550	540
X2CrNiMoCuN25-6-3	1.4507	679	660	640	620	610
X2CrNiMoN25-7-4	1.4410	711	680	660	640	630
X2CrNiMoCuWN25-7-4	1.4501	711	680	660	640	630

[a] Determined by linear interpolation.

Annex D
(informative)

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

NOTE 1 The values given in Tables D.1 and D.2 are mean values of the scatter band considered until now. If these are referred to in regulations however, they will be binding for calculation purposes. According to experience with long-time creep-testing it seems apparent that scattering of data is about ± 20 % in the long-range endurance of about 10^5 h up to 700 °C to 800 °C. Above that temperature, scattering may be gradually more or less enlarged and be summarized with about 35 % to 40 % at 1 000 °C testing temperature. However, individual deviations need to be presumed.

NOTE 2 The strength values for 1 % (plastic) creep strain and creep rupture given up to the elevated temperatures listed in Tables D.1 and D.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 it is important that the oxidation conditions are taken into account.

Table D.1 — Strength for 1 % (plastic) creep strain of austenitic creep resisting steels in the solution annealed condition (see Table A.3)

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

(to be continued)

Table D.1 (*continued*)

Steel grade		Temperature	Strength for 1 % (plastic) creep strain [a] in MPa for	
Steel name	Steel number	°C	10 000 h	100 000 h
X5NiCrAlTi31-20 +RA [b]	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 [b]	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
		1000	3,5	1,4

(to be continued)

Table D.1 (*concluded*)

Steel grade		Temperature	Strength for 1 % (plastic) creep strain [a] in MPa for	
Steel name	Steel number	°C	10 000 h	100 000 h
X8CrNiNb16-13 [b]	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

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

b Values were taken from DIN 17460 [3].

c Those preliminary values were taken from NFA 36-209 [4].

Table D.2 — Creep rupture strength of austenitic creep-resisting steels in the solution annealed condition (see Table A.3)

Steel grade		Tempe-rature	Strength for rupture [a] in MPa for						
Steel name	Steel number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X3CrNiMoBN17-13-3 [b]	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*	
X6CrNiTiB18-10 [b]	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	

(to be continued)

Table D.2 (*continued*)

Steel grade		Tempe-rature	Strength for rupture [a] in MPa for						
Steel name	Steel 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 [b]	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 [c]	1.4950	550 600 650 700 750 800	160 120 70 36 18			90 65 35 16 7,5			
X6CrNi25-20 [d]	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*

(to be continued)

Table D.2 (continued)

Steel grade		Tempe-rature	Strength for rupture [a] in MPa for						
Steel name	Steel number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X6CrNi25-20 [d]	1.4951	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						
X5NiCrAlTi31-20	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 [b]	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)	

(to be continued)

Table D.2 (*continued*)

Steel grade		Tempe-rature	Strength for rupture [a] in MPa for						
Steel name	Steel number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X5NiCrAlTi31-20+RA [b]	1.4958 +RA	660 670 680 690 700	73 67 61 55 50			46 42 38 34 30		(40) (36) (33) (29) (26)	
X8NiCrAlTi32-21 [e]	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 1000	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*	

(to be continued)

Table D.2 (*concluded*)

Steel grade		Tempe-rature	Strength for rupture [a] in MPa for						
Steel name	Steel number	°C	10 000 h	30 000 h	50 000 h	100 000 h	150 000 h	200 000 h	250 000 h
X8CrNiNb16-13[b]	1.4961	580	182			129		115	
		590	170			119		105	
		600	157			108		94	
		610	145			98		85	
		620	134			89		77	
		630	124			80		69	
		640	113			72		61	
		650	103			64		53	
		660	93			57		47	
		670	84			50		41	
		680	76			44		36	
		690	70			39		31	
		700	64			34		27	
		710	59			30		25	
		720	55			27		22	
		730	51			25		19	
		740	47			22		17	
		750	44			20		15	

a Values in parantheses involved time and/or stress extrapolation; values with asterisk involved time extrapolation.

b Values were taken from DIN 17460 [3].

c Those preliminary values were taken from NFA 36-209 [4].

d Values were taken from BS PD 6525 Part 1 [5].

e Values were prepared by ECCC, WG 3.3 [6].

Annex E
(informative)

Reference data on mechanical properties of austenitic steels at room temperature and at low temperatures

Table E.1 — Tensile properties at room temperature and at low temperatures

Steel grade		20 °C				- 80 °C				- 150 °C				- 196 °C			
Steel name	Steel number	0,2 % proof strength $R_{p0,2}$ min. MPa	1,0 % proof strength $R_{p1,0}$ min. MPa	Tensile strength R_m min. MPa	Elongation after fracture A min. %	0,2 % proof strength $R_{p0,2}$ min. MPa	1,0 % proof strength $R_{p1,0}$ min. MPa	Tensile strength R_m min. MPa	Elongation after fracture A min. %	0,2 % proof strength $R_{p0,2}$ min. MPa	1,0 % proof strength $R_{p1,0}$ min. MPa	Tensile strength R_m min. MPa	Elongation after fracture A min. %	0,2 % proof strength $R_{p0,2}$ min. MPa	1,0 % proof strength $R_{p1,0}$ min. MPa	Tensile strength R_m min. MPa	Elongation after fracture A min. %
X2CrNi18-9	1.4307	200	240	500	45	220	290	830	35	225	325	1070	30	300	400	1200	30
X5CrNiN19-9	1.4315	270	310	550	40	385	455	890	40	450	550	1180	35	550	650	1350	35
X2CrNiN18-10	1.4311	270	310	550	40	350	420	850	40	450	550	1050	35	550	650	1250	35
X5CrNi18-10	1.4301	210	250	520	45	270	350	860	35	315	415	1100	30	300	400	1250	30
X6CrNiTi18-10	1.4541	200	240	500	40	260	290	855	35	350	420	1100	35	390	470	1200	30
X2CrNiMo17-12-2	1.4404	220	260	520	45	275	355	840	40	315	415	1070	40	350	450	1200	35
X2CrNiMoN17-11-2	1.4406	280	320	580	40	380	450	800	35	500	600	1000	35	600	700	1150	30
X2CrNiMoN17-13-3	1.4429	280	320	580	35	380	450	800	30	500	600	1000	30	600	700	1150	30
NOTE For any temperature between 20 °C and -196 °C, mechanical properties may be estimated by linear interpolation.																	

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC.

Once this standard is cited in the Official Journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 97/23/EC

Clauses/subclauses of this European Standard	Essential Requirements (ERs) of Directive 97/23/EC Annex I	Content
8.4	4.1a	Appropriate material properties
8.3.3	4.1b	Chemical resistance [a]
8.2	4.1c	Ageing
8.2 and 8.6	4.1d	Suitable for processing procedures
9.1	4.3	Documentation
[a] But see Tables 7 and 9, column "Resistance to intergranular corrosion", where this resistance is, for several steel grades, restricted or even excluded.		

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 1011-3, *Welding — Recommendation for welding of metallic materials — Arc welding — Part 3: Arc welding of stainless steels*

[2] EN 10204:2004, *Metallic products — Types of inspection documents*

[3] 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)*

[4] NFA 36-209:1990, *Produits sidérurgiques — Tôles en aciers inoxydables austénítiques et austénoferritiques pour chaudières et appareils à pression (Iron and steel — Austenitic and austenitic-ferritic stainless steel plates for boilers and pressure vessels)*

[5] BS PD 6525 Part 1:1990, *Elevated temperature properties for steels for pressure purposes — Part 1: Stress rupture properties*

[6] 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)