DEUTSCHE NORM **February 2000**

Steel forgings for pressure purposes

Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels

English version of DIN EN 10222-5

DIN EN 10222-5

ICS 23.020,30; 77.140.80; 77.140.85

Schmiedestücke aus Stahl für Druckbehälter – Teil 5: Martensitische, austenitische und austenitisch-ferritische nicht rostende Stähle

Supersedes parts of DIN 17440, September 1996 edition, and DIN 17460, September 1992 edition.

European Standard EN 10222-5 : 1999 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by ECISS/TC 28 “Steel forgings” (Secretariat: BSI, United Kingdom).

The responsible German body involved in its preparation was the *Normenausschuss Eisen und Stahl* (Iron and Steel Standards Committee), Working Committee AA 10 *Schmiedestücke* and Subcommittee 06/1 *Nichtrostende Stähle*.

This standard specifies requirements for chemical composition, mechanical properties at room (ambient), elevated and low temperatures, and the heat treatment of forgings made of martensitic, austenitic and austenitic-ferritic stainless steels, which are primarily used for pressure vessels. Additional guidance values are given for stress rupture properties of creep-resisting austenitic steels.

Together with DIN EN 10222-1, DIN EN 10250-1 and DIN EN 10250-4, this standard supersedes the specifications relating to forgings laid down in DIN 17440 and DIN 17460.

EN comprises 22 pages

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Amendments

This standard differs from DIN 17440:1996-09 and DIN 17460:1992-09 as follows:

a) The scope is now limited to stainless steel forgings for pressure purposes (general purpose stainless steel forgings are dealt with in DIN EN 10250-1 and DIN EN 10250-4).

b) General requirements for open die forgings are no longer covered (see DIN EN 10222-1).

c) Steel designations from DIN 17460 have been modified, although the material numbers have been retained.

d) The following steel grades specified in DIN 17440 and DIN 17460 are no longer covered here: all ferritic and martensitic grades and austenitic grades X2CrNi19-11 (1.4306), X6CrNiMoNb17-12-2 (1.4580), X2CrNiMo18-15-4 (1.4438) from DIN 17440 and the austenitic creep-resisting grades X3CrNiN18 11 (1.4949), X6CrNiMo17 13 (1.4919), X8CrNiNb16 13 (1.4961), X8CrNiMoNb16 16 (1.4981), X8CrNiMoVNb16 13 (1.4988), X5NiCrAlTi31 20 (1.4958) and X8NiCrAlTi32-21 (1.4959) from DIN 17460.

e) One martensitic, four austenitic and two austenitic-ferritic steel grades have been added, and X2CrNiMoN17-13-5 (1.4439), which is no longer covered in the main body of the EN, together with three additional austenitic grades, are given in a National Annex.

f) Specifications regarding chemical composition, mechanical properties and heat treatment have been revised.

Previous editions

DIN 17440: 1967-01, 1972-12, 1985-07, 1996-09
DIN 17460: 1992-09

National Annex NA
(informative)

Bibliography

DIN EN 10222-1, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings*

DIN EN 10250-1, *Open die steel forgings for general engineering purposes — Part 1: General requirements*

DIN EN 10250-4, *Open die steel forgings for general engineering purposes — Part 4: Stainless steels*

National Annex NB

(normative)

Non-conflicting national addition

(This Annex only applies to the German national version of this European Standard in accordance with the ECISS Internal Regulations of 1989.)

NB.1 General

This Annex describes steel grades X2CrNiMoN17-13-5 (1.4439), X1NiCrMoCu25-20-5 (1.4539), X1CrNiMoCuN20-18-7 (1.4547) and X1CrNiMoCuN25-20-7 (1.4529), which are available in Germany and are widely used there, notably for flanges.

NB.2 Status

The steel grade described in this Annex is included in the German national version of this European Standard only, with the aim of allowing its further use in that country.

NB.3 Delivery condition

The steel grades described in this Annex are usually delivered in the solution-annealed condition (see Table NB.1) with ruling diameters up to 160 mm.

NB.4 Chemical composition

The chemical composition of the steel grades described in this Annex are given in Table NB.1.

NB.5 Mechanical properties

Table NB.1 gives values for the mechanical properties at room (ambient) temperature. Mechanical properties at elevated temperatures are given in Tables NB.1 and NB.3.

NB.6 Other requirements

See DIN EN 10222-1 and DIN EN 10222-5.

Table NB.1: Chemical composition, mechanical properties and heat treatment

Steel designation		Chemical composition % (cast analysis)								
		C max.	**Si** max.	**Mn** max.	**P** max.	**S** max.	**Cr**	**Mo**	**Ni**	**Others** [1), 2)]
Name	Number									
X2CrNiMoN17-13-5	1.4439	0,030	1,00	2,00	0,045	0,015	16,50 to 18,50	4,00 to 5,00	12,50 to 14,50	0,12 to 0,22 N
X1NiCrMoCu25-20-5	1.4539	0,020	0,70	2,00	0,030	0,010	19,00 to 21,00	4,00 to 5,00	24,00 to 26,00	max. 0,15 N, 1,20 to 2,00 Cu
X1CrNiMoCuN20-18-7	1.4547	0,020	0,70	1,00	0,030	0,010	19,50 to 2050	6,00 to 7,00	17,50 to 18,50	0,18 to 0,25 N, 0,50 to 1,00 Cu
X1CrNiMoCuN25-20-7	1.4529	0,020	0,50	1,00	0,030	0,010	19,00 to 21,00	6,00 to 7,00	24,00 to 26,00	0,15 to 1,25 N, 0,50 to 1,50 Cu

1) For all steel grades, the proportion of constituents that have not been added intentionally shall not exceed the following limits: 0,75 % for copper, 0,005 % for boron (see Footnote 2).

2) Limiting the boron content to not more than 0,001 5 % reduces the tendency to hot crack.

Table NB.1 *(concluded)*

Mechanical properties at room temperature									Heat treatment		
Ruling diameter	0,2% proof strength	1,0% proof strength	Tensile strength	Elongation[3]		Impact energy KV min. J			Conditions of reference treatment		
t_R	$R_{p0,2}$	$R_{p1,0}$	R_m	A[3]							
max.	min.	min.		min. %		at 20 °C*)		at –196 °C	Symbol[4]	Solution temp.	Cooling in
mm	N/mm²	N/mm²	N/mm²	l	tr, t	l	tr, t	tr, t		°C	[5]
160	285	315	580 to 800	40	35	100	60	42	Q	1060 to 1140	w, a
160	220	250	520 to 720	35	35	120	90	–	Q	1060 to 1140	w, a
160	300	340	650 to 850	35	35	200	60	–	Q	1140 to 1200	w, a
160	300	340	650 to 850	35	35	200	90	8ß	Q	1120 to 1180	w, a

[3] l = longitudinal
t = tangential
tr = transverse

[4] Q = quenched

[5] a = air
o = oil
w = water

*) Correction published in the *DIN-Anzeiger für technische Regeln 8/2004*.

Table NB.2: Minimum 0,2 % proof strength ($R_{p0,2}$) properties at elevated temperatures

Steel designation		$R_{p0,2}$ min in N/mm² at a temperature of								
Name	Number	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	500 °C
X2CrNiMoN17-13-5	1.4439	260	225	200	185	175	165	155	150	–
X1NiCrMoCu25-20-5	1.4539	200	175	165	155	145	130	130	125	110
X1CrNiMoCuN20-18-7	1.4547	270	230	205	190	180	170	165	160	148
X1CrNiMoCuN25-20-7	1.4529	270	230	210	190	180	170	165	160	120

Table NB.3: Minimum 1,0 % proof strength ($R_{p1,0}$) properties at elevated temperatures

Steel designation		$R_{p1.0}$ min in N/mm² at a temperature of								
Name	Number	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	500 °C
X2CrNiMoN17-13-5	1.4439	290	255	230	210	200	190	180	175	–
X1NiCrMoCu25-20-5	1.4539	240	205	195	185	175	165	160	155	140
X1CrNiMoCuN20-18-7	1.4547	310	270	245	225	212	200	195	190	180
X1CrNiMoCuN25-20-7	1.4529	310	270	245	225	215	205	195	195	150

Table NB.4: Minimum tensile strength (R_m) at elevated temperatures

Steel designation		R_m min in N/mm² at a temperature of								
Name	Number	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	500 °C
X2CrNiMoN17-13-5	1.4439	560	520	490	460	450	440	435	–	–
X1NiCrMoCu25-20-5	1.4539	500	440	420	400	390	380	370	360	350
X1CrNiMoCuN20-18-7	1.4547	640	615	585	560	540	525	515	510	495
X1CrNiMoCuN25-20-7	1.4529	630	600	575	555	535	520	515	510	–

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EN 10222-5

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English version

Steel forgings for pressure purposes
Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels

Pièces forgées en acier pour appareils à pression – Partie 5: Aciers inoxydables martensitiques, austénitiques et austéno-ferritiques

Schmiedestücke aus Stahl für Druckbehälter – Teil 5: Martensitische, austenitische und austenitisch-ferritische nicht rostende Stähle

This European Standard was approved by CEN on 1999-09-03.

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.

The European Standards exist 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, the Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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

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Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 28 "Steel forgings", the secretariat of which is held by BSI.

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 2000, and conflicting national standards shall be withdrawn at the latest by June 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(s).

For relationship with EU Directive(s), see informative Annex ZB, which is an integral part of this standard.

Attention is drawn to annex ZA which is an A-deviation requested by Sweden.

Attention is drawn to the non-conflicting national addition requested by Germany. This addition is only to appear as a national annex to the German edition of this European Standard.[*)]

The titles of the other Parts of this European Standard are:

Part 1: General requirements for open die forgings

Part 2: Ferritic and martensitic steels with specified elevated temperature properties

Part 3: Nickel steels with specified low temperature properties

Part 4: Weldable fine grain steels with high proof strength

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.

[*)] Corrigendum from EN 10222-5:1999/AC:2000, issued by CEN and published in the *DIN-Anzeiger für technische Regeln 7/2004*.

1 Scope

This Part of this European Standard specifies the technical delivery conditions for forgings for pressure purposes made of stainless steels, including creep resisting steels. Chemical composition and mechanical properties are specified.

General information on technical delivery conditions is given in EN 10021.

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 10021	General technical delivery requirements for iron and steel products
EN 10222-1:1998	Steel forgings for pressure purposes - Part 1: General requirements for open die forgings

3 Chemical composition

3.1 Cast analysis

The chemical composition (cast analysis), determined in accordance with EN 10222-1, shall conform to table 1.

3.2 Product analysis

The product analysis shall not deviate from the specified cast analysis (see table 1) by more than the values specified in table 2 (see 9.2 to EN 10222-1:1998).

4 Heat treatment and mechanical properties

When heat treated in accordance with table 1, the mechanical properties determined in accordance with EN 10222-1, shall conform to the requirements of table 1.

Verification of the impact properties of martensitic and austenitic-ferritic stainless steels shall be mandatory and for austenitic stainless steels shall be by agreement.

Elevated temperature 0,2 % proof strength ($R_{p0,2}$) values shall conform to table 3.

Elevated temperature 1,0 % proof strength ($R_{p1,0}$) values shall conform to table 4.

Elevated temperature tensile strength (R_m) values shall conform to the requirements of table 5.

The testing temperature for impact properties and elevated temperature properties shall be agreed at the time of enquiry and order.

Reference data for stress rupture properties are given in annex A for information.

Table 1: Chemical composition, mechanical properties and heat treatment

Steel designation		Chemical composition % (cast analysis) [1]										Mechanical properties at room temperature										Heat treatment		
Name	Number	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Others [8]	Thickness of the ruling section t_R mm max.	0,2% proof strength $R_{p0,2}$ min. N/mm²	1,0% proof strength $R_{p1,0}$ min. N/mm²	Tensile strength R_m N/mm²	Elongation [3] A l	Elongation [3] A tr,t	Impact energy (ISO-V) KV > 10 mm thick J min. at 20 °C (l)	Impact energy (ISO-V) KV > 10 mm thick J min. at 20 °C (tr)	Impact energy (ISO-V) KV > 10 mm thick J min. at - 196°C (tr)	Conditions of reference heat treatment: Symbol [4]	Solution temp. °C	Cooling in [5]
Martensitic steel																								
X3 CrNiMo 13-4	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 min	-	350	550	-	750 to 900	17	16	100	80	-	QT+T	950 to 1050	a,o [7]
												250	650	-	780 to 930	17	15	90	70	-	QT	950 to 1050	a,o [8]
Austenitic steels																								
X2 CrNi 18-9	1.4307	≤ 0,030	1,00	2,00	0,045	0,015 [2]	17,50 to 19,50	-	8,00 to 10,00	0,11 max	-	250	200	230	500 to 700	45	35	100	60	60	AT	1025 to 1100	w,a
X2 CrNiN 18-10	1.4311	≤ 0,030	1,00	2,00	0,045	0,015 [2]	17,00 to 19,50	-	8,50 to 11,50	0,12 to 0,22	-	250	270	305	550 to 750	45	35	100	60	60	AT	1000 to 1100	w,a
X5 CrNi 18-10	1.4301	≤ 0,07	1,00	2,00	0,045	0,015 [2]	17,00 to 19,50	-	8,00 to 10,50	0,11 max	-	250	200	230	500 to 700	45	35	100	60	60	AT	1000 to 1100	w,a
X6 CrNiTi 18-10	1.4541	≤ 0,08	1,00	2,00	0,045	0,015 [2]	17,00 to 19,00	-	9,00 to 12,00	-	Ti 5x %C to 0,70	450	200	235	510 to 710	40	30	100	60	60	AT	1020 to 1120	w,a
X6 CrNiNb 18-10	1.4550	≤ 0,08	1,00	2,00	0,045	0,015 [2]	17,00 to 19,00	-	9,00 to 12,00	-	Nb 10x%C to 1,00	450	205	240	510 to 710	40	30	100	60	40	AT	1020 to 1120	w,a
X6 CrNi 18-10	1.4948	0,04 to 0,08	1,00	2,00	0,035	0,015 [2]	17,00 to 19,00	-	8,00 to 11,00	0,11 max	-	250	195	230	490 to 690	45	35	100	60	-	AT	1050 to 1120	w,a
X6 CrNiTiB 18-10	1.4941	0,04 to 0,08	1,00	2,00	0,035	0,015 [2]	17,00 to 19,00	-	9,00 to 12,00	-	Ti 5x%C to 0,80 B 0,0015 to 0,0050	450	175	210	490 to 690	40	30	100	60	-	AT	1070 to 1140	w,a

[1] Elements not listed 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.

[2] For products to be machined a controlled sulfur content of 0,015 % to 0,030 % is recommended and permitted by agreement.

[3] l = longitudinal; t = tangential; tr = transverse

[4] AT = solution treated; QT = quenched and tempered; T = tempered

[5] a = air; o = oil; w = water

[6] Patented grade.

[7] Double temper at 600 °C to 620 °C.

[8] Temper at 570 °C to 600 °C.

Table 1: Chemical composition, mechanical properties and heat treatment (continued)

Steel designation		Chemical composition % (cast analysis) [1]										Mechanical properties at room temperature									Heat treatment		
Name	Number	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Others [8]	Thickness of the ruling section t_R mm max.	0,2% proof strength $R_{p0.2}$ min. N/mm²	1,0% proof strength $R_{p1.0}$ min. N/mm²	Tensile strength R_m N/mm²	Elongation [3] A l	Elongation [3] A tr,t	Impact energy (ISO-V) KV > 10 mm thick J min. at 20 °C (l)	Impact energy (ISO-V) KV > 10 mm thick J min. at 20 °C (tr)	Impact energy (ISO-V) KV > 10 mm thick J min. at - 196°C (tr)	Conditions of reference heat treatment: Symbol [4]	Solution temp. °C	Cooling in [5]
X7 CrNiNb 18-10	1.4912	0,04 to 0,10	1,00	2,00	0,045	0,015 [2]	17,00 to 19,00	-	9,00 to 12,00	-	Nb 10x%C to 1,20	450	205	240	510 to 710	40	30	100	60	40	AT	1070 to 1125	w,a
X2 CrNiMo 17-12-2	1.4404	≤ 0,030	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,00 to 2,50	10,00 to 13,00	0,11 max	-	250	190	225	490 to 690	45	35	100	60	60	AT	1020 to 1120	w,a
X2 CrNiMoN 17-11-2	1.4406	≤ 0,030	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,00 to 2,50	10,00 to 12,00	0,12 to 0,22	-	160	280	315	580 to 780	45	35	100	60	60	AT	1020 to 1120	w,a
X5 CrNiMo 17-12-2	1.4401	≤ 0,07	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,00 to 2,50	10,00 to 13,00	0,11 max	-	250	205	240	510 to 710	45	35	100	60	60	AT	1020 to 1120	w,a
X6 CrNiMoTi 17-12-2	1.4571	≤ 0,08	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,00 to 2,50	10,50 to 13,50	-	Ti 5x%C to 0,70	450	210	245	510 to 710	45	35	100	60	60	AT	1020 to 1120	w,a
X2 CrNiMo 17-12-3	1.4432	≤ 0,030	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,50 to 3,00	10,50 to 13,00	0,11 max	-	250	190	225	490 to 690	45	35	100	60	60	AT	1020 to 1120	w,a
X2 CrNiMoN 17-13-3	1.4429	≤ 0,030	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,50 to 3,00	11,00 to 14,00	0,12 to 0,22	-	160	280	315	580 to 780	45	35	100	60	60	AT	1020 to 1120	w,a
X3 CrNiMo 17-13-3	1.4436	≤ 0,05	1,00	2,00	0,045	0,015 [2]	16,50 to 18,50	2,50 to 3,00	10,50 to 13,00	0,11 max	-	250	205	240	510 to 710	45	35	100	60	60	AT	1020 to 1120	w,a
X2 CrNiMo 18-14-3	1.4435	≤ 0,030	1,00	2,00	0,045	0,015 [2]	17,00 to 19,00	2,50 to 3,00	12,50 to 15,00	0,11 max	-	75	200	235	520 to 670	-	45	100	60	60	AT	1020 to 1120	w,a
X3 CrNiMoN 17-13-3	1.4910	≤ 0,04	0,75	2,00	0,035	0,015	16,00 to 18,00	2,00 to 3,00	12,00 to 14,00	0,10 to 0,18	B 0,0015 to 0,0050	75	260	300	550 to 750	-	40	100	60	-	AT	1020 to 1100	w,a

[1] Elements not listed 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.

[2] For products to be machined a controlled sulfur content of 0,015 % to 0,030 % is recommended and permitted by agreement.

[3] l = longitudinal; t = tangential; tr = transverse

[4] AT = solution treated; QT = quenched and tempered; T = tempered

[5] a = air; o = oil; w = water

[6] Patented grade.

[7] Double temper at 600 °C to 620 °C.

[8] Temper at 570 °C to 600 °C.

Table 1: Chemical composition, mechanical properties and heat treatment (concluded)

Steel designation		Chemical composition % (cast analysis) [1]										Mechanical properties at room temperature									Heat treatment		
Name	Number	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Others [8]	Thickness of the ruling section t_R mm max.	0,2% proof strength $R_{p0.2}$ min. N/mm²	1,0% proof strength $R_{p1.0}$ min. N/mm²	Tensile strength R_m N/mm²	Elongation [3] A l	Elongation [3] A tr,t	Impact energy (ISO-V) KV > 10 mm thick J min. at 20 °C (l)	Impact energy (ISO-V) KV > 10 mm thick J min. at 20 °C (tr)	Impact energy (ISO-V) KV > 10 mm thick J min. at - 196°C (tr)	Conditions of reference heat treatment: Symbol [4]	Solution temp. °C	Cooling in [5]
X2 CrNiCu 19-10	1.4650	≤ 0,030	1,00	2,00	0,045	0,015	18,50 to 20,00	-	9,00 to 10,00	0,08 max	Cu 1,0 max	450	210	245	520 to 720	45	40	100	60	60	AT	1050 to 1125	w,a
X3 CrNiMo 18-12-3	1.4449	≤ 0,035	1,00	2,00	0,045	0,015	17,00 to 18,20	2,25 to 2,75	11,50 to 12,50	0,08 max	Cu 1,0 max	450	220	255	520 to 720	45	40	100	60	60	AT	1050 to 1125	w,a
Austenitic-ferritic steels																							
X2 CrNiMoN 22-5-3	1.4462	≤ 0,030	1,00	2,00	0,035	0,015	21,00 to 23,00	2,50 to 3,50	4,50 to 6,50	0,10 to 0,22	-	350	450	-	680 to 880	30	25	200	100	-	AT	1020 to 1100	-
X2 CrNiMoN 25-7-4 [6]	1.4410	≤ 0,030	1,00	2,00	0,035	0,015	24,00 to 26,00	3,00 to 4,50	6,00 to 8,00	0,20 to 0,35	-	160	500	-	800 to 1000	30	25	200	100	-	AT	1040 to 1120	w,a

[1] Elements not listed 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.

[2] For products to be machined a controlled sulfur content of 0,015 % to 0,030 % is recommended and permitted by agreement.

[3] l = longitudinal; t = tangential; tr = transverse

[4] AT = solution treated; QT = quenched and tempered; T = tempered

[5] a = air; o = oil; w = water

[6] Patented grade.

[7] Double temper at 600 °C to 620 °C.

[8] Temper at 570 °C to 600 °C.

Table 2: Permissible deviations of the product analysis from specified values of the cast analysis

Element	Specified value in the cast analysis according to table 1 %		Permissible deviations[1)] of the product analysis %
C		≤ 0,030	+ 0,005
	> 0,030	≤ 0,10	± 0,01
Si		≤ 1,00	+ 0,05
Mn		≤ 2,00	+ 0,04
P		≤ 0,045	+ 0,005
S		≤ 0,15	+ 0,003
	> 0,015	≤ 0,030	+ 0,005
N		≤ 0,35	± 0,01
Cr		< 15,00	± 0,15
	≥ 15,00	< 20,00	± 0,20
	≥ 20,00	≤ 26,00	± 0,25
Mo		≤ 0,70	± 0,03
	> 0,70	< 2,50	± 0,05
	≥ 2,50	≤ 4,50	± 0,10
Ni	> 3,50	< 5,00	± 0,07
	≥ 5,00	< 10,0	± 0,10
	≥ 10,0	≤ 15,0	± 0,15
Nb		≤ 1,20	± 0,05
Ti		≤ 0,80	± 0,05
Cu		≤ 1,00	± 0,07
B		≤ 0,0050	± 0,0005

[1)] If several product analyses are carried out for one cast and if, in this case, values for an individual element are established which fall outside the permitted range for the chemical composition, then it is only permissible that the values either exceed the maximum permitted value or fall short of the minimum permitted value. It is not acceptable for both to apply for one cast.

Table 3: Minimum 0,2 % proof strength ($R_{p0,2}$) at elevated temperatures

Steel designation		$R_{p0,2}$ min in N/mm² at a temperature of:								
Name	Number	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	500 °C	600 °C
Martensitic steel										
X3 CrNiMo 13-4	1.4313	590	575	560	545	530	515	-	-	-
Austenitic steels										
X2 CrNi 18-9	1.4307	147	132	118	108	100	94	89	81	-
X2 CrNiN 18-10	1.4311	205	175	157	145	136	130	125	119	-
X5 CrNi 18-10	1.4301	157	142	127	118	110	104	98	92	-
X6 CrNiTi 18-10	1.4541	176	167	157	147	136	130	125	119	-
X6 CrNiNb 18-10	1.4550	177	167	157	147	136	130	125	119	-
X6 CrNi 18-10	1.4948	157	142	127	117	108	103	98	88	78
X6 CrNiTiB 18-10	1.4941	162	152	142	137	132	127	123	113	103
X7 CrNiNb 18-10	1.4912	171	162	153	147	139	133	129	124	121
X2 CrNiMo 17-12-2	1.4404	166	152	137	127	118	113	108	100	-
X2 CrNiMoN 17-11-2	1.4406	211	185	167	155	145	140	135	128	-
X5 CrNiMo 17-12-2	1.4401	177	162	147	137	127	120	115	110	-
X6 CrNiMoTi 17-12-2	1.4571	185	177	167	157	145	140	135	129	-
X2 CrNiMo 17-12-3	1.4432	166	152	137	127	118	113	108	100	-
X2 CrNiMoN 17-13-3	1.4429	211	185	167	155	145	140	135	129	-
X3 CrNiMo 17-13-3	1.4436	177	162	147	137	127	120	115	110	-
X2 CrNiMo 18-14-3	1.4435	165	150	137	127	119	113	108	100	-
X3 CrNiMoN 17-13-3	1.4910	205	187	170	159	148	141	134	127	121
X2 CrNiCu 19-10	1.4650	155	140	127	118	110	104	98	92	-
X3 CrNiMo 18-12-3	1.4449	175	158	145	135	127	120	115	110	100
Austenitic-ferritic steels										
X2 CrNiMo 22-5-3	1.4462	360	335	315	300	-	-	-	-	-
X2 CrNiMoN 25-7-4	1.4410	450	420	400	380	-	-	-	-	-

Table 4: Minimum 1,0 % proof strength ($R_{p1,0}$) for austenitic steels at elevated temperatures

Steel designation		$R_{p1,0}$ min in N/mm^2 at a temperature of								
Name	Number	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	500 °C	600 °C
X2 CrNi 18-9	1.4307	181	162	147	137	127	121	116	109	-
X2 CrNiN 18-10	1.4311	240	210	187	175	167	161	156	149	-
X5 CrNi 18-10	1.4301	191	172	157	145	135	129	125	120	-
X6 CrNiTi 18-10	1.4541	208	196	186	177	167	161	156	149	-
X6 CrNiNb 18-10	1.4550	211	196	186	177	167	161	156	149	-
X6 CrNi 18-10	1.4948	191	172	157	147	137	132	127	118	108
X6 CrNiTiB 18-10	1.4941	201	191	181	176	172	167	162	152	142
X7 CrNiNb 18-10	1.4912	204	192	182	172	166	162	159	155	151
X2 CrNiMo 17-12-2	1.4404	199	181	167	157	145	139	135	128	-
X2 CrNiMoN 17-11-2	1.4406	246	218	198	183	175	169	164	158	-
X5 CrNiMo 17-12-2	1.4401	211	191	177	167	156	150	144	139	-
X6 CrNiMoTi 17-12-2	1.4571	218	206	196	186	175	169	164	158	-
X2 CrNiMo 17-12-3	1.4432	199	181	167	157	145	139	135	128	-
X2 CrNiMoN 17-13-3	1.4429	246	218	198	183	175	169	164	158	-
X3 CrNiMo 17-13-3	1.4436	211	191	177	167	156	150	144	139	-
X2 CrNiMo 18-14-3	1.4435	200	180	165	153	145	139	135	128	-
X3 CrNiMoN 17-13-3	1.4910	240	220	200	189	178	171	164	157	151
X2 CrNiCu 19-10	1.4650	190	170	155	145	135	129	125	120	-
X3 CrNiMo 18-12-3	1.4449	210	190	175	165	155	150	144	139	129

Table 5: Minimum tensile strength (R_m) at elevated temperature

Steel designation		**R_m min in N/mm^2 at a temperature of:**								
Name	Number	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	500 °C	600 °C
Martensitic steels										
X3 CrNiMo 13-4	1.4313	710	695	680	665	650	635	-	-	-
Austenitic steels										
X2 CrNi 18-9	1.4307	410	380	360	350	340	340	-	-	-
X2 CrNiN 18-10	1.4311	490	460	430	420	410	410	-	-	-
X5 CrNi 18-10	1.4301	450	420	400	390	380	380	380	360	-
X6 CrNiTi 18-10	1.4541	440	410	390	385	375	375	375	360	-
X6 CrNiNb 18-10	1.4550	435	400	370	350	340	335	330	310	-
X6 CrNi 18-10	1.4948	440	410	390	385	375	375	375	360	300
X6 CrNiTiB 18-10	1.4941	410	390	370	360	350	345	340	330	300
X7 CrNiNb 18-10	1.4912	410	390	370	360	350	345	340	330	300
X2 CrNiMo 17-12-2	1.4404	430	410	390	385	380	380	380	360	-
X2 CrNiMoN 17-11-2	1.4406	520	490	460	450	440	435	-	-	-
X5 CrNiMo 17-12-2	1.4401	430	410	390	385	380	380	-	-	-
X6 CrNiMoTi 17-12-2	1.4571	440	410	390	385	375	375	375	360	-
X2 CrNiMo 17-12-3	1.4432	430	410	390	385	380	380	380	360	-
X2 CrNiMoN 17-13-3	1.4429	520	490	460	450	440	435	435	430	-
X3 CrNiMo 17-13-3	1.4436	460	440	420	415	410	410	410	390	-
X2 CrNiMo 18-14-3	1.4435	420	400	380	375	370	370	-	-	-
X3 CrNiMoN 17-13-3	1.4910	495	472	450	440	430	425	420	400	365
X2 CrNiCu 19-10	1.4650	450	420	400	390	380	380	380	360	-
X3 CrNiMo 18-12-3	1.4449	460	440	420	514	410	410	410	390	350
Austenitic-ferritic steels										
X2 CrNiMo 22-5-3	1.4462	590	570	550	540	-	-	-	-	-
X2 CrNiMoN 25-7-4	1.4410	680	660	640	630	-	-	-	-	-

Annex A (informative)

Reference data for stress-rupture properties

Table A.1: Stress-rupture properties

Steel designation		Rupture time	Estimated average stress in N/mm² for rupture at a temperature of:																
Name	Number	h	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C	610 °C	620 °C	630 °C	640 °C	650 °C	660 °C	670 °C	680 °C	690 °C	700 °C
X5 CrNi 18-10 [1]	1.4301 [3]	100000	-	156	138	124	113	104	97	90	83	76	70	64	59	54	49	43	38
		100,000	-	92	85	78	72	65	59	54	49	45	40	36	32	28	25	21	18
X2 CrNi 18-9 [2]	1.4307 [3]	100000	-	156	138	124	113	104	97	90	83	76	70	64	59	54	49	43	38
		100,000	-	92	85	78	72	65	59	54	49	45	40	36	32	28	25	21	18
X6 CrNi 18-10	1.4948 [4]	10,000	-	191	177	165	154	143	132	122	113	104	95	87	80	73	67	61	55
		100,000	-	140	128	117	107	98	89	81	73	65	58	52	47	42	37	32	28
		200,000	-	125	114	104	95	86	78	70	62	55	49	43	38	34	30	26	22
X6 CrNiNb 18-10 [1]	1.4550 [5]	10,000	258	236	218	202	187	174	162	151	140	131	121	113	104	96	88	80	71
		100,000	174*	161*	148*	137*	127*	117*	107*	98*	89*	80*	71*	58*	-	-	-	-	-
		200,000	154*	142*	131*	120*	110*	101*	92*	82*	72*	61*	-	-	-	-	-	-	-
X7 CrNiNb 18-10	1.4912 [5]	10,000	253	237	221	206	192	178	166	154	142	132	122	112	104	96	88	81	74
		100,000	186*	172*	159*	147*	135*	125*	115*	106*	97*	89*	81*	74*	67*	61*	54*	-	-
		200,000	169*	156*	144*	132*	122*	112*	102*	94*	86*	78*	71*	64*	59*	(51)*	-	-	-
X6 CrNiTi 18-10 [1]	1.4541 [5]	10,000	222	206	192	178	165	152	140	129	118	108	98	88	79	71	63	56	49
		100,000	154*	142*	129*	118*	107*	96*	86*	77*	68*	60*	53*	46*	40*	35*	31*	(27)*	-
		200,000	136*	123*	112*	101*	91*	81*	72*	63*	55*	48*	42*	36*	32*	(28)*	-	-	-
X6 CrNiTiB 18-10	1.4941 [4]	10,000	-	223	210	196	182	170	156	142	130	119	108	98	89	80	73	66	60
		100,000	-	170	154	140	127	114	102	92	84	76	68	62	56	50	44	39	35
		200,000	-	150	135	122	110	100	91	82	74	67	60	54	49	43	39	33	29
X6 CrNiMoTi 17-12-2 [1]	1.4571 [3]	10,000	247	233	220	206	193	180	167	155	142	130	119	108	97	87	78	70	63
		100,000	194	181	167	154	141	128	116	105	94	84	75	67	60	54	49	44	-
		200,000	178*	164*	151*	138*	125	113	102	91	81	72*	65*	58*	52*	47*	(43)*	-	-
X2 CrNiMoN 17-11-2	1.4406 [3]	10,000	-	300	284	267	250	236	221	205	189	173	157	143	128	115	102	90	78
		100,000	-	234*	217*	199*	182*	166*	151*	135*	119*	105*	92*	80*	71*	62*	55*	48*	42*
X2CrNiMoN 17-13-3	1.4429 [3]	200,000	-	213*	195*	179*	162*	145*	130*	114*	100*	87*	76*	66*	58*	51*	45*	40*	35*

* Extended time extrapolation.

( ) Extended stress extrapolation.

[1] Values apply only for a minimum carbon content of 0,04 %

[2] Values apply only for a minimum nitrogen content of 0,06 %.

[3] These data are based on recommendations of the European Creep Collaborative Committee, ECCC, WG 3.3

[4] These data are taken from DIN 17460

[5] These data are taken from BS PD 6525-1

Table A.1: Stress-rupture properties (continued)

Steel designation		Rupture time	Estimated average stress in N/mm² for rupture at a temperature of:																
Name	Number	h	540 °C	550 °C	560 °C	570 °C	580 °C	590 °C	600 °C	610 °C	620 °C	630 °C	640 °C	650 °C	660 °C	670 °C	680 °C	690 °C	700 °C
X5 CrNiMo 17-12-2 [1]	1.4401 [3]	10,000	265	247	230	213	189	183	168	155	142	130	119	109	99	90	82	75	68
		100,000	205	188	172	158	144	130	118	107	96	87	78	70	63	56	50	45	40
X3 CrNiMo 17-13-3 [1] [2]	1.4436 [3]	200,000	188	172	157	142	129	117	105	94	85	76	68	61	54	48	43	38	34
X3 CrNiMoN 17-13-3	1.4910 [4]	10,000	-	290	272	254	237	220	205	190	174	162	148	135	122	112	102	93	84
		100,000	-	220	202	186	170	155	141	127	114	102	92	83	75	68	61	56	52
		200,000	-	(200)	(184)	(166)	(151)	(137)	(122)	(113)	(100)	(91)	(81)	(73)	(65)	(58)	(52)	(46)	(42)

* Extended time extrapolation.

( ) Extended stress extrapolation.

[1] Values apply only for a minimum carbon content of 0,04 %

[2] Values apply only for a minimum nitrogen content of 0,06 %.

[3] These data are based on recommendations of the European Creep Collaborative Committee, ECCC, WG 3.3

[4] These data are taken from DIN 17460

Table A.1: Stress-rupture properties (concluded)

Steel designation		Rupture time	Estimated average stress in N/mm² for rupture at a temperature of:					
Name	Number	h	710 °C	720 °C	730 °C	740 °C	750 °C	800 °C
X3 CrNiMoN 17-13-3	1.4910 [4]	10,000	78	71	65	58	52	33
		100,000	48	45	41	37	34	20
		200,000	(39)	(36)	(34)	(31)	(28)	(17)

[4] These data are taken from DIN 17460

NOTE 1: The values given in table A.1 are mean values of the scatter band considered until now.

NOTE 2: The strength values given for the elevated temperatures listed in table A.1 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.

Annex ZA

A-deviations

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

This European Standard falls under Directive 97/23/EEC (Pressure equipment)

NOTE: (from CEN/CENELEC IR Part 2,3.1.9): Where standards fall under EC Directives, it is the view of the Commission of the European Communities (OJ No C 59, 1982-03-09) that the effect of the decision of the Court of Justice in case 815/79 Cremoninl/Vrankovich (European Court Reports 1980, p. 3583) is that compliance with A-deviations is not longer mandatory and that the free movement of products complying with such a standard should not be restricted except under the safeguard procedure provided for in the relevant Directive.

A-deviations in an EFTA-country are valid instead of the relevant provisions of the European Standard in that country until they have been removed.

Clause	Deviation
	Sweden (Ordinance AFS 1994: 39 Chapter 3, Section 1)
General	Only the following grades are regarded as adequately validated and documented according to Swedish regulations:
	Martensitic steels: none;
	Austenitic steels: 1,4307, 1,4311, 1,4541, 1,4550, 1,4941, 1,4912, 1,4404, 1,4406, 1,4571, 1,4432, 1,4429, 1,4436, 1,4435;
	Austenitic-ferritic steels: 1,4462;

Annex ZB

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.

Bibliography

DIN 17460:1992	High temperature austenitic steel plate and sheet, cold and hot rolled strip, bars and forgings; technical delivery conditions
BS PD 6525-1:1990	Elevated temperature properties for steels for pressure purposes. Stress rupture properties