BS EN 10222-5:2017

BSI Standards Publication

Steel forgings for pressure purposes

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

bsi.

National foreword

This British Standard is the UK implementation of EN 10222-5:2017. It supersedes BS EN 10222-5:2000, which is withdrawn.

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

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European foreword

This document (EN 10222-5:2017) has been prepared by Technical Committee ECISS/TC 111 “Steel castings and forgings”, the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by October 2017, and conflicting national standards shall be withdrawn at the latest by October 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10222-5:1999.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2014/68/EU.

For relationship with EU Directive 2014/68/EU, see informative Annex ZA, which is an integral part of this document.

EN 10222 consists of the following parts under the general title “*Steel forgings for pressure purposes*”:

— *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*

— *Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.*

Annex C provides details about significant technical changes to EN 10222-5:1999.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

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.

NOTE Once this standard is published in the EU Official Journal (OJEU) under Directive 2014/68/EU, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 2014/68/EU is limited to technical data of materials in this standard 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 Directive 2014/68/EU are satisfied, needs to be done. The series EN 10222–1 to EN 10222–5 is structured so that the data related to different materials is in the part allocated for that material. The presumption of conformity to the Essential Safety Requirements of Directive 2014/68/EU depends on both the text in part 1 and the data in part 2, 3, 4 or 5.

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

2 Normative references

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

EN 10088-1:2014, *Stainless steels - Part 1: List of stainless steels*

EN 10222-1:2017, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings*

EN ISO 3651-2:1998, *Determination of resistance to intergranular corrosion of stainless steels - Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels - Corrosion test in media containing sulfuric acid (ISO 3651-2:1998)*

3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 10222-1:2017 apply.

4 Classification and designation

4.1 Classification

The steel grades covered in this document are classified according to their structure into:

— martensitic steels;

— austenitic steels;

— austenitic-ferritic steels.

NOTE For more details see EN 10088–1.

4.2 Designation

See EN 10222-1:2017.

5 Information to be supplied by the purchaser

5.1 Mandatory information

Shall be in accordance with EN 10222-1.

5.2 Options

A number of options are specified in this European Standard and listed below. Additionally the relevant options of EN 10222-1 apply. If the purchaser does not give any information 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 also EN 10222-1).

1) test temperature for the tensile test at elevated temperature, if applicable (see 6.4.3);

2) test temperature of the impact test at low temperature (see 6.4.4);

3) controlled sulphur content (see Table 2, footnote b).

6 Requirements

6.1 Steelmaking process and manufacture of the product

Shall be in accordance with EN 10222-1.

6.2 Delivery condition

The products shall be delivered in the heat treatment condition specified in Table 1.

6.3 Chemical composition and chemical corrosion properties

6.3.1 Cast analysis

The chemical composition (cast analysis), determined in accordance with EN 10222-1 shall conform to the requirements of Table 2.

6.3.2 Product analysis

The product analysis shall not deviate from the specified cast analysis (see 6.3.1) by more than the values specified in Table 3.

6.3.3 Resistance to intergranular corrosion

The specifications in Table 4 apply in respect to resistance to intergranular corrosion as defined in EN ISO 3651-2, for austenitic and austenitic-ferritic steels.

See EN 10222-1:2017, 9.9, Table 1.

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 as certained through laboratory tests. It is therefore advisable to draw on the available experience of the use of the steels.

6.4 Mechanical properties

6.4.1 When heat treated in accordance with Table 1, the mechanical properties shall conform to the requirements of Table 4.

6.4.2 Elevated temperature proof strength ($R_{p0,2}$ and $R_{p1,0}$) values shall conform to the requirements of Table 5 and Table 6. Elevated temperature tensile strength (R_m) values shall conform to Table 7.

6.4.3 If verification of specified proof strength at elevated temperature is requested (see EN 10222-1:2017, Table 1), the testing temperature should be agreed at the time of enquiry and order. Otherwise, the test shall be carried out at 300 °C, except for the austenitic-ferritic steels, where the test shall be carried out at 250 °C.

6.4.4 The impact test, if applicable (see EN 10222-1:2017, Table 1), shall be carried out at 20 °C.

Where impact tests at low temperature have been agreed (see EN 10222-1:2017, Table 1), the test temperature shall also be agreed at the time of enquiry and order.

6.4.5 Reference data for 1 % (plastic) creep strain and creep rupture are given in Annex A.

6.5 Surface condition

See EN 10222-1.

6.6 Internal soundness

See EN 10222-1.

6.7 Physical properties

For reference data on physical properties, see EN 10088-1:2014, Annex E.

6.8 Post weld heat treatment

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

7 Inspection

See EN 10222-1.

8 Sampling

See EN 10222-1.

9 Test methods

See EN 10222-1.

10 Retests

See EN 10222-1.

11 Marking

See EN 10222-1.

Table 1 — Heat treatment

Steel grade		**Heat treatment[a]**	**Solution annealing** ° C	**Cooling in[b]**
Steel name	Steel number			
Martensitic steel				
X3CrNiMo13–4	1.4313	+QT or +T	950 to 1 050 (for quenching)	a, o[c]
		+QT		a, o[d]
Austenitic steels[e]				
X2CrNi18–9	1.4307	+AT	1 025 to 1 100	w, a
X2CrNi19–11	1.4306	+AT	1 000 to 1 100	w, a
X2CrNiN18–10	1.4311	+AT	1 000 to 1 100	w, a
X5CrNi18–10	1.4301	+AT	1 000 to 1 100	w, a
X6CrNiTi18–10	1.4541	+AT	1 020 to 1 120	w, a
X6CrNiNb18–10	1.4550	+AT	1 020 to 1 120	w, a
X6CrNi18–10	1.4948	+AT	1 050 to 1 120	w, a
X6CrNiTiB18–10	1.4941	+AT	1 070 to 1 140	w, a
X7 CrNiNb18–10	1.4912	+AT	1 070 to 1 125	w, a
X2CrNiMo17–12–2	1.4404	+AT	1 020 to 1 120	w, a
X2CrNiMoN 17–11–2	1.4406	+AT	1 020 to 1 120	w, a
X5CrNiMo17–12–2	1.4401	+AT	1 020 to 1 120	w, a
X6CrNiMoTi 17–12–2	1.4571	+AT	1 020 to 1 120	w, a
X2 CrNiMo17–12–3	1.4432	+AT	1 020 to 1 120	w, a
X2CrNiMoN 17–13–3	1.4429	+AT	1 020 to 1 120	w, a
X3CrNiMo17–13–3	1.4436	+AT	1 020 to 1 120	w, a
X2CrNiMo18–14–3	1.4435	+AT	1 020 to 1 120	w, a
X3CrNiMoN17–13–3	1.4910	+AT	1 020 to 1 100	w, a
X2CrNiMoN17–13–5	1.4439	+AT	1 060 to 1 120	w, a
X1NiCrMoCu25–20–5	1.4539	+AT	1 060 to 1 120	w, a
X1CrNiMoCuN20–18–7	1.4547	+AT	1 020 to 1 120	w, a
X1CrNiMoCuN25–20–7	1.4529	+AT	1 020 to 1 100	w, a
X2CrNiCu19–10	1.4650	+AT	1 050 to 1 125	w, a
X3CrNiMo18–12–3	1.4449	+AT	1 050 to 1 125	w, a

Steel grade		**Heat treatment[a]**	**Solution annealing** ° C	**Cooling in[b]**
Steel name	Steel number			
Austenitic-ferritic steels[e]				
X2CrNiN23–4	1.4362	+AT	950 to 1 100	w, a
X2CrNiMoN22–5–3	1.4462	+AT	1 020 to 1 100	–
X2CrNiMoCuN25–6–3	1.4507	+AT	1 040 to 1 120	w, a
X2CrNiMoN25–7–4	1.4410	+AT	1 040 to 1 120	w, a
X2CrNiMoCuWN25–7–4	1.4501	+AT	1 040 to 1 120	w, a

a +AT solution annealed, +T tempered, +QT quenched and tempered.

b a = air ; o = oil ; w = water or water based medium.

c Double tempered at 600 °C to 620 °C.

d Tempered at 570 °C to 600 °C.

e 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.

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

Steel grade		% by mass									
Steel name	Steel number	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Others
Martensitic steels											
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	–
Austenitic steels											
X2CrNi18–9	1.4307	≤ 0,030	1,00	2,00	0,045	0,015[b]	17,5 to 19,5	–	8,0 to 10,5	≤ 0,10	–
X2CrNi19–11	1.4306	≤ 0,030	1,00	2,00	0,045	0,015[b]	18,0 to 20,0	–	10,0 to 12,0	≤ 0,10	–
X2CrNiN18–10	1.4311	≤ 0,030	1,00	2,00	0,045	0,015[b]	17,5 to 19,5	–	8,5 to 11,5	0,12 to 0,22	–
X5CrNi18–10	1.4301	≤ 0,07	1,00	2,00	0,045	0,015[b]	17,5 to 19,5	–	8,0 to 10,5	≤ 0,10	–
X6CrNiTi18–10	1.4541	≤ 0,08	1,00	2,00	0,045	0,015[b]	17,0 to 19,0	–	9,0 to 12,0	–	Ti:5 x C to 0,70
X6CrNiNb18–10	1.4550	≤ 0,08	1,00	2,00	0,045	0,015[b]	17,0 to 19,0	–	9,0 to 12,0	–	Nb:10 x C to 1,00
X6CrNi18–10	1.4948	0,04 to 0,08	1,00	2,00	0,035	0,015[b]	17,0 to 19,0	–	8,0 to 11,0	≤ 0,10	–
X6CrNiTiB18–10	1.4941	0,04 to 0,08	1,00	2,00	0,035	0,015[b]	17,0 to 19,0	–	9,0 to 12,0	–	Ti: 5 x C to 0,80 B:0,0015 to 0,0050
X7CrNiNb18–10	1.4912	0,04 to 0,10	1,00	2,00	0,045	0,015[b]	17,0 to 19,0	–	9,0 to 12,0	–	Nb:10 x C to 1,20
X2CrNiMo17–12–2	1.4404	≤ 0,030	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,00 to 2,50	10,0 to 13,0	≤ 0,10	–
X2CrNiMoN17–11–2	1.4406	≤ 0,030	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,00 to 2,50	10,0 to 12,5	0,12 to 0,22	–

Steel grade		% by mass									
Steel name	Steel number	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Others
X5CrNiMo17–12–2	1.4401	≤ 0,07	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,00 to 2,50	10,0 to 13,0	≤ 0,10	–
X6CrNiMoTi17–12–2	1.4571	≤ 0,08	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,00 to 2,50	10,5 to 13,5	–	Ti:5 x C to 0,70
X2CrNiMo17–12–3	1.4432	≤ 0,030	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0	≤ 0,10	–
X2CrNiMoN17–13–3	1.4429	≤ 0,030	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,50 to 3,00	11,0 to 14,0	0,12 to 0,22	–
X3CrNiMo17–13–3	1.4436	≤ 0,05	1,00	2,00	0,045	0,015[b]	16,5 to 18,5	2,50 to 3,00	10,5 to 13,0	≤ 0,10	–
X2CrNiMo18–14–3	1.4435	≤ 0,030	1,00	2,00	0,045	0,015[b]	17,0 to 19,0	2,50 to 3,00	12,5 to 15,0	≤ 0,10	–
X3CrNiMoBN17–13–3	1.4910	≤ 0,04	0,75	2,00	0,035	0,015	16,0 to 18,0	2,00 to 3,00	12,0 to 14,0	0,10 to 0,18	B:0,0015 to 0,0050
X2CrNiMoN17–13–5	1.4439	≤ 0,030	1,00	2,00	0,045	0,015	16,5 to 18,5	4,00 to 5,00	12,5 to 14,5	0,12 to 0,22	–
X1NiCrMoCu25–20–5	1.4539	≤ 0,020	0,70	2,00	0,030	0,010	19,0 to 21,0	4,00 to 5,00	24,0 to 26,0	≤ 0,15	Cu: 1,20 to 2,00
X1CrNiMoCuN20–18–7	1.4547	≤ 0,020	0,70	1,00	0,030	0,010	19,5 to 20,5	6,00 to 7,00	17,5 to 18,5	0,18 to 0,25	Cu: 0,50 to 1,00
X1CrNiMoCuN25–20–7	1.4529	≤ 0,020	0,50	1,00	0,030	0,010	19,0 to 21,0	6,00 to 7,00	24,0 to 26,0	0,15 to 0,25	Cu: 0,50 to 1,50
X2CrNiCu19–10	1.4650	≤ 0,030	1,00	2,00	0,045	0,015	18,5 to 20,0	–	9,0 to 10,0	≤ 0,08	Cu ≤ 1,0
X3CrNiMo18–12–3	1.4449	≤ 0,035	1,00	2,00	0,045	0,015	17,0 to 18,2	2,25 to 2,75	11,5 to 12,5	≤ 0,08	Cu ≤ 1,0

Steel grade		% by mass									
Steel name	Steel number	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N	Others
Austenitic-ferritic steels											
X2CrNiN23–4	1.4362	≤ 0,030	1,00	2,00	0,035	0,015	22,0 to 24,0	0,10 to 0,60	3,5 to 5,5	0,05 to 0,20	Cu: 0,10 to 0,60
X2CrNiMoN22–5–3	1.4462	≤ 0,030	1,00	2,00	0,035	0,015	21,0 to 23,0	2,50 to 3,5	4,5 to 6,5	0,10 to 0,22	–
X2CrNiMoCuN25–6–3	1.4507	≤ 0,030	0,70	2,00	0,035	0,015	24,0 to 26,0	3,00 to 4,0	6,0 to 8,0	0,20 to 0,30	Cu: 1,00 to 2,50
X2CrNiMoN25–7–4	1.4410	≤ 0,030	1,00	2,00	0,035	0,015	24,0 to 26,0	3,00 to 4,5	6,0 to 8,0	0,24 to 0,35	–
X2CrNiMoCuWN25–7–4	1.4501	≤ 0,030	1,00	1,00	0,035	0,015	24,0 to 26,0	3,00 to 4,0	6,0 to 8,0	0,20 to 0,30	W: 0,50 to 1,00 Cu: 0,50 to1,00

[a] 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.

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

Table 3 — Permissible deviations of the product analysis above the maximum or below the minimum limits of the requirement of cast analysis

Element	Specified range %	Permissible deviations[a] %
C	≤ 0,030	+ 0,005
	> 0,030 to ≤ 0,10	±0,01
Si	≤ 1,00	+ 0,05
Mn	≤ 1,00	+ 0,03
	> 1,00 to ≤ 2,00	+ 0,04
P	≤ 0,045	+ 0,005
S	≤ 0,015	+ 0,003
	> 0,015 to ≤ 0,030	+ 0,005
N	≤ 0,35	+0,01
Cr	< 15,0	+0,15
	≥ 15,0 to < 20,0	±0,20
	≥ 20,0 to ≤ 26,0	±0,25
Mo	≤ 0,70	+0,03
	> 0,70 to < 2,50	±0,05
	≥ 2,50 to ≤ 7,0	±0,10
Ni	> 3,5 to < 5,0	±0,07
	≥ 5,0 to < 10,0	±0,10
	≥ 10,0 to ≤ 20,0	±0,15
	> 20,0 to ≤ 26,0	±0,20
Nb	≤ 1,20	+0,05
Ti	≤ 0,80	+0,05
Cu	≤ 2,50	+0,07
B	≤ 0,0050	+0,0005
W	≤ 1,00	+0,05

[a] If several product analyses are carried out for one cast and if, in this case, values for individual elements 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 4 — Mechanical properties at room temperature and for impact energy test at 20°C and −196°C

Steel grade		Heat treatment	Thickness of the ruling section t_R mm max.	0,2 % proof strength $R_{p0,2}$ MPa min.	1,0 % proof strength $R_{p1,0}$ MPa min.	Tensile strength R_m MPa	Elongation after fracture[a] A % min.		Impact energy[a] KV_2 J min.			Resistance to intergranular corrosion[b]	
Steel name	Steel number								at 20 °C		at −196 °C	in the delivery condition	in the sensitized condition
							l	tr, t	l	tr, t	tr		
Martensitic steel													
X3CrNiMo13–4	1.4313	+QT or +T	350	550	–	750 to 900	17	16	100	80	–	–	–
		+QT	250	650	–	780 to 930	17	15	90	70	–	–	–
Austenitic steels													
X2CrNi18–9	1.4307	+AT	250	200	230	500 to 700	45	35	100	60	60	yes	yes
X2CrNi19–11	1.4306	+AT	250	180	215	460 to 680	45	35	100	60	60	yes	yes
X2CrNiN18–10	1.4311	+AT	250	270	305	550 to 750	45	35	100	60	60	yes	yes
X5 rNi18–10	1.4301	+AT	250	200	230	500 to 700	45	35	100	60	60	yes	no
X6CrNiTi18–10	1.4541	+AT	450	200	235	510 to 710	40	30	100	60	60	yes	yes
X6CrNiNb18–10	1.4550	+AT	450	205	240	510 to 710	40	30	100	60	40	yes	yes
X6CrNi18–10	1.4948	+AT	250	195	230	490 to 690	45	35	100	60	–	no	no
X6CrNiTiB18–10	1.4941	+AT	450	175	210	490 to 690	40	30	100	60	–	yes	yes
X7CrNiNb18–10	1.4912	+AT	450	205	240	510 to 710	40	30	100	60	40	(yes)	(yes)
X2CrNiMo17–12–2	1.4404	+AT	250	190	225	490 to 690	45	35	100	60	60	yes	yes
X2CrNiMoN17–11–2	1.4406	+AT	160	280	315	580 to 780	45	35	100	60	60	yes	yes
X5CrNiMo17–12–2	1.4401	+AT	250	205	240	510 to 710	45	35	100	60	60	yes	no

Steel grade		Heat treatment	Thickness of the ruling section t_R mm max.	0,2 % proof strength $R_{p0,2}$ MPa min.	1,0 % proof strength $R_{p1,0}$ MPa min.	Tensile strength R_m MPa	Elongation after fracture[a] A % min.		Impact energy[a] KV_2 J min.			Resistance to intergranular corrosion[b]	
Steel name	Steel number								at 20 °C		at −196 °C	in the delivery condition	in the sensitized condition
							l	tr, t	l	tr, t	tr		
X6CrNiMoTi17–12–2	1.4571	+AT	450	210	245	510 to 710	45	35	100	60	60	yes	yes
X2CrNiMo17–12–3	1.4432	+AT	250	190	225	490 to 690	45	35	100	60	60	yes	yes
X2CrNiMoN17–13–3	1.4429	+AT	160	280	315	580 to 780	45	35	100	60	60	yes	yes
X3CrNiMo17–13–3	1.4436	+AT	250	205	240	510 to 710	45	35	100	60	60	yes	no
X2CrNiMo18–14–3	1.4435	+AT	160	200	235	520 to 670	45	35	100	60	60	yes	yes
X2CrNiMoN17–13–5	1.4439	+AT	160	285	315	580 to 800	40	35	100	60	42	–	–
X1NiCrMoCu25–20–5	1.4539	+AT	160	220	250	520 to 720	35	35	120	90	–	–	–
X1CrNiMoCuN20–18–7	1.4547	+AT	160	300	340	650 to 850	40	35	100	60	–	–	–
X1CrNiMoCuN25–20–7	1.4529	+AT	160	300	340	650 to 850	40	35	120	90	80	–	–
X3CrNiMoBN17–13–3	1.4910	+AT	75	260	300	550 to 750	45	40	100	60	–	yes	yes
X2CrNiCu19–10	1.4650	+AT	450	210	245	520 to 720	45	40	100	60	60	(yes)	(yes)
X3CrNiMo18–12–3	1.4449	+AT	450	220	255	520 to 720	45	40	100	60	60	(yes	(yes)
Austenitic-ferritic steels													
X2CrNiN23–4	1.4362	+AT	160	400	–	600 to 830	25	20	120	90	–	yes	yes
X2CrNiMoN22–5–3	1.4462	+AT	350	450	–	680 to 880	30	25	200	100	–	yes	yes

Steel grade		Heat treatment	Thickness of the ruling section	0,2 % proof strength	1,0 % proof strength	Tensile strength	Elongation after fracture[a]		Impact energy[a]			Resistance to intergranular corrosion[b]	
Steel name	Steel number		t_R mm max.	$R_{p0,2}$ MPa min.	$R_{p1,0}$ MPa min.	R_m MPa	A % min.		KV_2 J min.			in the delivery condition	in the sensitized condition
									at 20 °C		at −196 °C		
							l	tr, t	l	tr, t	tr		
X2CrNiMoCuN25–6–3	1.4507	+AT	160	500	–	700 to 900	25	20	150	90	–	yes	yes
X2CrNiMoN25–7–4	1.4410	+AT	160	500	–	800 to 1000	30	25	200	100	–	yes	yes
X2CrNiMoCuWN25–7–4	1.4501	+AT	160	530	–	730 to 930	25	20	150	90	–	yes	yes

a l = longitudinal to main forging direction, t = tangential, tr = transverse to main forging direction.

b When tested in accordance with EN ISO 3651-2.

Table 5 — Minimum 0,2 % proof strength ($R_{p0,2}$) at elevated temperatures

Steel grade		$R_{p0,2,min.}$ in MPa at a temperature in ° C of:									
Steel name	Steel number	50	100	150	200	250	300	350	400	500	600
Martensitic steel											
X3CrNiMo13–4	1.4313	–	590	575	560	545	530	515	–	–	–
Austenitic steels											
X2CrNi18–9	1.4307	–	147	132	118	108	100	94	89	81	–
X2CrNi19–11	1.4306	–	147	132	118	108	100	94	89	81	–
X2CrNiN18–10	1.4311	–	205	175	157	145	136	130	125	119	–
X5CrNi18–10	1.4301	–	157	142	127	118	110	104	98	92	–
X6CrNiTi18–10	1.4541	–	176	167	157	147	136	130	125	119	–
X6CrNiNb18–10	1.4550	–	177	167	157	147	136	130	125	119	–
X6CrNi18–10	1.4948	–	157	142	127	117	108	103	98	88	78
X6CrNiTiB18–10	1.4941	–	162	152	142	137	132	127	123	113	103
X7CrNiNb18–10	1.4912	–	171	162	153	147	139	133	129	124	121
X2CrNiMo17–12–2	1.4404	–	166	152	137	127	118	113	108	100	–
X2CrNiMoN17–11–2	1.4406	–	211	185	167	155	145	140	135	128	–
X5CrNiMo17–12–2	1.4401	–	177	162	147	137	127	120	115	110	–
X6CrNiMoTi17–12–2	1.4571	–	185	177	167	157	145	140	135	129	–
X2CrNiMo17–12–3	1.4432	–	166	152	137	127	118	113	108	100	–
X2CrNiMoN17–13–3	1.4429	–	211	185	167	155	145	140	135	129	–
X3CrNiMo17–13–3	1.4436	–	177	162	147	137	127	120	115	110	–
X2CrNiMo18–14–3	1.4435	–	165	150	137	127	119	113	108	100	–
X3CrNiMoBN17–13–3	1.4910	–	205	187	170	159	148	141	134	127	121
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	–
X2CrNiCu19–10	1.4650	–	155	140	127	118	110	104	98	92	–
X3CrNiMo18–12–3	1.4449	–	175	158	145	135	127	120	115	110	100

Steel grade		$R_{p0,2,min.}$ in MPa at a temperature in ° C of:									
Steel name	Steel number	50	100	150	200	250	300	350	400	500	600
Austenitic-ferritic steels											
X2CrNiN23–4	1.4362	–	330	300	280	265	–	–	–	–	–
X2CrNiMoN22–5–3	1.4462	–	360	335	315	300	–	–	–	–	–
X2CrNiMoCuN25–6–3	1.4507	–	450	420	400	380	–	–	–	–	–
X2CrNiMoN25–7–4	1.4410	–	450	420	400	380	–	–	–	–	–
X2CrNiMoCuWN25–7–4	1.4501	–	450	420	400	380	–	–	–	–	–

Table 6 — Minimum 1,0 % proof strength ($R_{p1,0}$) for austenitic steels at elevated temperatures

Steel grade		$R_{p1,0,min.}$ in MPa at a temperature in ° C of:									
Steel name	Steel number	50	100	150	200	250	300	350	400	500	600
X2CrNi18–9	1.4307	–	181	162	147	137	127	121	116	109	–
X2CrNi19–11	1.4306	–	181	162	147	137	127	121	116	109	–
X2CrNiN18–10	1.4311	–	240	210	187	175	167	161	156	149	–
X5CrNi18–10	1.4301	–	191	172	157	145	135	129	125	120	–
X6CrNiTi18–10	1.4541	–	208	196	186	177	167	161	156	149	–
X6CrNiNb18–10	1.4550	–	211	196	186	177	167	161	156	149	–
X6CrNi18–10	1.4948	–	191	172	157	147	137	132	127	118	108
X6CrNiTiB18–10	1.4941	–	201	191	181	176	172	167	162	152	142
X7CrNiNb18–10	1.4912	–	204	192	182	172	166	162	159	155	151
X2CrNiMo17–12–2	1.4404	–	199	181	167	157	145	139	135	128	–
X2CrNiMoN17–11–2	1.4406	–	246	218	198	183	175	169	164	158	–
X5CrNiMo17–12–2	1.4401	–	211	191	177	167	156	150	144	139	–
X6CrNiMoTi17–12–2	1.4571	–	218	206	196	186	175	169	164	158	–
X2CrNiMo17–12–3	1.4432	–	199	181	167	157	145	139	135	128	–
X2CrNiMoN17–13–3	1.4429	–	246	218	198	183	175	169	164	158	–
X3CrNiMo17–13–3	1.4436	–	211	191	177	167	156	150	144	139	–
X2CrNiMo18–14–3	1.4435	–	200	180	165	153	145	139	135	128	–

Steel grade		$R_{p1,0,\ min.}$ in MPa at a temperature in ° C of:									
Steel name	Steel number	50	100	150	200	250	300	350	400	500	600
X3CrNiMoBN17–13–3	1.4910	–	240	220	200	189	178	171	164	157	151
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	190	150	–
X2CrNiCu19–10	1.4650	–	190	170	155	145	135	129	125	120	–
X3CrNiMo18–12–3	1.4449	–	210	190	175	165	155	150	144	139	129

Table 7 — Minimum tensile strength (R_m) at elevated temperatures

Steel grade		$R_{m,\ min.}$ in MPa at a temperature in ° C of:									
Steel name	Steel number	50	100	150	200	250	300	350	400	500	600
Martensitic steel											
X3CrNiMo13–4	1.4313	–	710	695	680	665	650	635	–	–	–
Austenitic steels											
X2CrNi18–9	1.4307	–	410	380	360	350	340	340	–	–	–
X2CrNi19–11	1.4306	–	410	380	360	350	340	340	–	–	–
X2CrNiN18–10	1.4311	–	490	460	430	420	410	410	–	–	–
X5CrNi18–10	1.4301	–	450	420	400	390	380	380	380	360	–
X6CrNiTi18–10	1.4541	–	440	410	390	385	375	375	375	360	–
X6CrNiNb18–10	1.4550	–	435	400	370	350	340	335	330	310	–
X6CrNi18–10	1.4948	–	440	410	390	385	375	375	375	360	300
X6CrNiTiB18–10	1.4941	–	410	390	370	360	350	345	340	330	300
X7CrNiNb18–10	1.4912	–	410	390	370	360	350	345	340	330	300
X2CrNiMo17–12–2	1.4404	–	430	410	390	385	380	380	380	360	–
X2CrNiMoN17–11–2	1.4406	–	520	490	460	450	440	435	–	–	–
X5CrNiMo17–12–2	1.4401	–	430	410	390	385	380	380	–	–	–
X6 CrNiMoTi17–12–2	1.4571	–	440	410	390	385	375	375	375	360	–
X2CrNiMo17–12–3	1.4432	–	430	410	390	385	380	380	380	360	–
X2CrNiMoN17–13–3	1.4429	–	520	490	460	450	440	435	435	430	–
X3CrNiMo17–13–3	1.4436	–	460	440	420	415	410	410	410	390	–

X2CrNiMo18–14–3	1.4435	–	420	400	380	375	370	370	–	–	–
X3CrNiMoBN17–13–3	1.4910	–	495	472	450	440	430	425	420	400	365
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	–	–
X2CrNiCu19–10	1.4650	–	450	420	400	390	380	380	380	360	–
X3CrNiMo18–12–3	1.4449	–	460	440	420	415	410	410	410	390	350
Austenitic-ferritic steels											
X2CrNiN23–4	1.4362	–	540	520	500	490	–	–	–	–	–
X2CrNiMoN22–5–3	1.4462	–	590	570	550	540	–	–	–	–	–
X2CrNiMoCuN25–6–3	1.4507	–	660	640	620	610	–	–	–	–	–
X2CrNiMoN25–7–4	1.4410	–	680	660	640	630	–	–	–	–	–
X2CrNiMoCuWN25–7–4	1.4501	–	680	660	640	630	–	–	–	–	–

Annex A
(informative)

Reference data for creep rupture strength

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 can also be taken into account.

Table A.1 — Creep rupture strength

Steel grade		**Temperature**	**Creep rupture strength** MPa		
Steel name	Steel number	°C	10 000 h	100 000 h	200 000 h
X5CrNi18–10[a]	1.4301[c]	550	156	92	–
		560	138	85	–
		570	124	78	–
		580	113	72	–
		590	104	65	–
		600	97	59	–
		610	90	54	–
		620	83	49	–
		630	76	45	–
		640	70	40	–
		650	64	36	–
		660	59	32	–
		670	54	28	–
		680	49	25	–
		690	43	21	–
		700	38	18	–
X2CrNi18–9[b]	1.4307[c]	550	156	92	–
		560	138	85	–
		570	124	78	–
		580	113	72	–
		590	104	65	–
		600	97	59	–
		610	90	54	–
		620	83	49	–
		630	76	45	–
		640	70	40	–
		650	64	36	–
		660	59	32	–
		670	54	28	–
		680	49	25	–
		690	43	21	–
		700	38	18	–

Steel grade		**Temperature** °C	**Creep rupture strength** MPa		
Steel name	Steel number		10 000 h	100 000 h	200 000 h
X6CrNi18–10	1.4948[d]	550	191	140	125
		560	177	128	114
		570	165	117	104
		580	154	107	95
		590	143	98	86
		600	132	89	78
		610	122	81	70
		620	113	73	62
		630	104	65	55
		640	95	58	49
		650	87	52	43
X6CrNi18–10	1.4948 [d]	660	80	47	38
		670	73	42	34
		680	67	37	30
		690	61	32	26
		700	55	28	22
X6CrNiNb18–10[a]	1.4550[e]	540	258	174*	154*
		550	236	161*	142*
		560	218	148*	131*
		570	202	137*	120*
		580	187	127*	110*
		590	174	117*	101*
		600	162	107*	92*
		610	151	98*	82*
		620	140	89*	72*
		630	131	80*	61*
		640	121	71*	–
		650	113	58*	–
		660	104	–	–
		670	96	–	–
		680	88	–	–
		690	80	–	–
		700	71	–	–
X7CrNiNb18–10	1.4912[e]	540	253	18*	169*
		550	237	172*	156*
		560	221	159*	144*
		570	206	147*	132*
		580	192	135*	122*
		590	178	125*	112*
		600	166	115*	102*
		610	154	106*	94*
		620	142	97*	86*
		630	132	89*	78*
		640	122	81*	71*
		650	112	74*	64*

Steel grade		**Temperature** °C	**Creep rupture strength** MPa		
Steel name	Steel number		10 000 h	100 000 h	200 000 h
		660 670 680 690 700	104 96 88 81 74	67* 61* 54* – –	59* (51)* – – –
X6CrNiTi18–10[a]	1.4541[e]	540 550	222 206	154* 142*	136* 123*
		560 570 580 590 600	192 178 165 152 140	129* 118* 107* 96* 86*	112* 101* 91* 81* 72*
		610 620 630 640 650	129 118 108 98 88	77* 68* 60* 53* 46*	63* 55* 48* 42* 36*
		660 670 680 690 700	79 71 63 56 49	40* 35* 31* (27)* –	32* (28)* – – –
X6CrNiTiB18–10	1.4941[d]	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
X6CrNiMoTi17–12–2[a]	1.4571[c]	540 550	247 233	194 181	178* 164*
		560 570 580 590 600	220 206 193 180 167	167 154 141 128 116	151* 138* 125 113 102

Steel grade		**Temperature** °C	**Creep rupture strength** MPa		
Steel name	Steel number		10 000 h	100 000 h	200 000 h
		610 620 630 640 650	155 142 130 119 108	105 94 84 75 67	91 81 72* 65* 58*
		660 670 680 690 700	97 87 78 70 63	60 54 49 44 –	52* 47* (43) * – –
X2CrNiMoN17–11–2, X2CrNiMoN17–13–3	1.4406[c], 1.4429[c]	550	300	234*	213*
		560 570 580 590 600	284 267 250 236 221	217* 199* 182* 166v 151*	195* 179* 162* 145* 130*
		610 620 630 640 650	205 189 173 157 143	135* 119* 105* 92v 80*	114* 100* 87* 76* 66*
		660 670 680 690 700	128 115 102 90 78	71* 62* 55* 48* 42*	58* 51* 45* 40* 35*
X5CrNiMo17–12–2[a], X3CrNiMo17–13–3[a, b]	1.4401[c], 1.4436[c]	540 550	265 247	205 188	188 172
		560 570 580 590 600	230 213 189 183 168	172 158 144 130 118	157 142 129 117 105
		610 620 630 640 650	155 142 130 119 109	107 96 87 78 70	94 85 76 68 61
		660 670 680 690 700	99 90 82 75 68	63 56 50 45 40	54 48 43 38 34

Steel grade		Temperature	Creep rupture strength MPa		
Steel name	Steel number	°C	10 000 h	100 000 h	200 000 h
X3CrNiMoBN17–13–3	1.4910[d]	550	290	220	(200)
		560	272	202	(184)
		570	254	186	(166)
		580	237	170	(151)
		590	220	155	(137)
		600	205	141	(122)
		610	190	127	(113)
		620	174	114	(100)
		630	162	102	(91)
		640	148	92	(81)
		650	135	83	(73)
		660	122	75	(65)
		670	112	68	(58)
		680	102	61	(52)
		690	93	56	(46)
		700	84	52	(42)
		710	78	48	(39)
		720	71	45	(36)
		730	65	41	(34)
		740	58	37	(31)
		750	52	34	(28)
		800	33	20	(17)
X2CrNi18–9[b]	1.4307[c]	550	156	92	–
		560	138	85	–
		570	124	78	–
		580	113	72	–
		590	104	65	–
		600	97	59	–
		610	90	54	–
		620	83	49	–
		630	76	45	–
		640	70	40	–
		650	64	36	–
		660	59	32	–
		670	54	28	–
		680	49	25	–
		690	43	21	–
		700	38	18	–

() Extended stress extrapolation.

* Extended time extrapolation.

a Values apply only for a minimum carbon content of 0,04 %.

b Values apply only for a minimum nitrogen content of 0,06 %.

c These data are based on recommendations of the European Creep Collaborative Committee, ECCC, WG 3.3·

d These data are taken from DIN 17460.

e These data are taken from BS PD 6525–1.

Annex B
(informative)

Post weld heat treatment

B.1 In general, welded assemblies of stainless steels covered by this document are not subjected to any heat treatment with the exception that martensitic grades are tempered, if there is any risk of residual martensite in the heat affected zone; for appropriate temperatures, see Table 1.

B.2 During heating of high chromium and molybdenum austenitic or austenitic-ferritic steel weldments containing some ferrite, intermetallic phases may be formed which shall be re-dissolved during post weld heat treatment. As most filler metals are overalloyed in comparison with the equivalent basic grades, minimum solution temperatures higher than those given in Table 1 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 document.

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 1) and is defined as stabilizing annealing for the niobium or titanium bearing grades and as stress-relieving for the unstabilized low carbon grades.

In some cases, post weld heat treatment may also be performed as solution annealing according to Table 1 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.

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	
Steels with ≤ 0,07 % C			
X5CrNi18–10	1.4301	not recommended	
X5CrNiMo17–12–2	1.4401		
X3CrNiMo17–13–3	1.4436		
Steels with ≤ 0,03 % C			
X2CrNi18–9	1.4307	900 to 940	air
X2CrNi19–11	1.4306		
X2CrNiN18–10	1.4311		
X2CrNiMo17–12–2	1.4404	960 to 1 040[b]	forced air
X2CrNiMoN17–11–2	1.4406		
X2CrNiMo17–12–3	1.4432		
X2CrNiMoN17–13–3	1.4429		
X2CrNiMo18–14–3	1.4435		
X3CrNiMoN18–12–3	1.4449		
X2CrNiMoN17–13–5	1.4439		
X1NiCrMoCu25–20–5	1.4539		
X1CrNiMoCuN20–18–7	1.4547		
X1CrNiMoCuN25–20–7	1.4529		
Creep resisting steels			
X3CrNiMoBN17–13–3	1.4910	900 to 950[c]	air
X6CrNiTiB18–10	1.4941		
X7CrNiNb18–10	1.4912		
X6CrNi18–10	1.4948	not recommended	

a Minimum holding time: 30 min.

b Recommended if welded with stabilized filler metal.

c Recommended for components with greater wall thickness.

Annex C
(informative)

Significant technical changes to the version EN 10222-5:1999

Significant technical changes to the previous version EN 10222-5:1999 are listed below:

1) updating of the normative references;
2) addition of a new Annex B (informative);
3) updating of steel designations;
4) updating of the mandatory and optional information's in chapter 5.2;
5) new statements concerning steelmaking process and delivery conditions;
6) Table 1 containing values and statements on the heat treatment of the steels updated;
7) new Table 4 containing values for the mechanical properties at room temperature;
8) updating of Annex ZA in relationship with EU Directive 2014/68/EU (previous Annexes ZA and ZB).

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU

This European Standard has been prepared under a Commission's standardization request M/071 to provide one voluntary means of conforming to Essential Requirements of Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative 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 Directive 2014/68/EU, and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU

Requirements of Directive 2014/68/EU	Clause(s)/subclause(s) of this EN	Remarks/Notes
4.1a	6.4	Appropriate material properties
4.1d	6.2, 6.5, 6.6	Suitable for the processing procedures
4.3	Clause 7 (EN 10222–1:2017, 7.1)	Inspection Documentation

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 10021, *General technical delivery conditions for steel products*

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