INTERNATIONAL STANDARD

ISO 9327-5

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Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions —

Part 5:
Stainless steels

Pièces forgées et barres laminées ou forgées en acier pour appareils à pression — Conditions techniques de livraison —

Partie 5: Aciers inoxydables

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9327-5 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 10, *Steel for pressure purposes*.

This first edition, together with parts 1 to 4 of ISO 9327, cancels and replaces ISO 2604-1:1975.

ISO 9327 consists of the following parts, under the general title *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions*:

— *Part 1: General requirements*

— *Part 2: Non-alloy and alloy (Mo, Cr and CrMo) 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: Stainless steels*

Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions —

Part 5:
Stainless steels

1 Scope

1.1 This part of ISO 9327 applies to forgings and rolled or forged bars manufactured from the austenitic and austenitic-ferritics steels given in Table 1 and delivered according to the specifications given in ISO 9327-1.

1.2 This part of ISO 9327 covers the following data:

a) In Table 1 the limits for

   — the chemical composition according to the cast analysis;

   — the tensile properties at room temperature;

   — the indications on the usual heat treatment condition at the time of delivery;

b) in Table 2 the permissible deviations of the results of the product analysis from the specified limits for the cast analysis,

c) in Table 3 the minimum elevated temperature proof strength values;

d) in Table 4 the estimated average stress rupture properties.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9327. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9327 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 148:1983, *Steel — Charpy impact test (V-notch).*

ISO/TR 4949:1989, *Steel names based on letter symbols.*

ISO 9327-1, *Steel forgings and rolled or forged bars for pressure purposes — Technical delivery conditions — Part 1: General requirements*.

ISO/TR 15461:1997, *Steel forgings — Testing frequency, sampling conditions and test methods for mechanical tests.*

3 Terms and definitions

For the purposes of this part of ISO 9327, the terms and definitions given in ISO 9327-1 apply.

4 Ordering

See ISO 9327-1.

5 Requirements

See ISO 9327-1 and Tables 1 to 4.

6 Inspection, testing and conformity of products

See ISO 9327-1.

7 Marking

See ISO 9327-1.

Table 1 — Chemical composition, room temperature mechanical properties and heat treatment conditions of austenitic and austenitic-ferritic steels

Line No.	Steel type		Chemical composition[b] % by mass									Mechanical properties at room temperature[c]								Elevated temperature properties		Heat treatment		
	"new" designation[a] in accordance with ISO/TR 4949	"old" designation[a] in accordance with ISO 2604-1	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	Others	Thickness of the ruling section t_R max. mm	$R_{p0,2}$ min. N/mm²	$R_{p1,0}$ min. N/mm²	R_m N/mm²	A min. DIR: x %	A min. DIR: y %	KV[d] min. DIR: x-y J	KV[d] min. DIR: y-x J	R_p See Table	Creep properties See Table	Usual conditions of reference heat treatment: Symbol[e]	Solution temperature[f] °C	Cooling in[g]
1	X2CrNi18-10	F46	⩽ 0,030	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	—	250	180	215	480 to 680	30	30	85	55	3	—	Q	1000 to 1100 [h]	w, a
2	X2CrNiN18-10	—	⩽ 0,030	1,00	2,00	0,045	0,030	17,00 to 19,00	—	8,50 to 11,50	0,12 to 0,22 N	250	270	305	550 to 750	30	30	85	55	3	—	Q	1000 to 1100 [h]	w, a
3	X5CrNi18-9	F47	⩽ 0,07	1,00	2,00	0,045	0,030	17,00 to 19,00	—	8,00 to 11,00	—	250	195	230	500 to 700	30	30	85	55	3	—	Q	1000 to 1100 [h]	w, a
4	X7CrNi18-9	F48	0,04 to 0,10	1,00	2,00	0,045	0,030	17,00 to 19,00	—	8,00 to 11,00	—	250	195	230	490 to 690	30	30	85	55	3	4	Q	1050 to 1120 [i]	w, a
5	X6CrNiNb18-10	F50	⩽ 0,08	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	Nb ⩾ 10 × % C ⩽ 1,00[j]	450	205	240	510 to 710	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
6	X6CrNiTi18-10	F53	⩽ 0,08	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	Ti ⩾ 5 × % C ⩽ 0,80	450	200	235	510 to 710[k]	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
7	X7CrNiTi18-10	F54	0,04 to 0,10	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	Ti ⩾ 5 × % C ⩽ 0,80	450	175	210	490 to 690	30	30	85	55	3	4	Q	1020 to 1120 [i]	w, a
8	X7CrNiNb18-10	F51	0,04 to 0,10	1,00	2,00	0,045	0,030	17,00 to 19,00	—	9,00 to 12,00	Nb ⩾ 10 × % C ⩽ 1,20[j]	450	205	240	510 to 710	30	30	85	55	3	4	Q	1050 to 1120 [i]	w, a
9	X2CrNiMo17-12	F59	0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	11,00 to 14,00	—	250	190	225	490 to 690	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a

Table 1 *(continued)*

Line No.	Steel type		Chemical composition[b] % by mass									Mechanical properties at room temperature [c]								Elevated temperature properties		Heat treatment		
	"new"	"old"	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	Others	Thickness of the ruling section	$R_{p0,2}$ min.	$R_{p1,0}$ min.	R_m	A min. DIR:		KV [d] min. DIR:		R_p	Creep properties	Usual conditions of reference heat treatment		
	designation[a] in accordance with											t_R max.				x	y	x-y	y-x	See Table		Symbol[e]	Solution temperature [f]	Cooling in [g]
	ISO/TR 4949	ISO 2604-1										mm	N/mm²	N/mm²	N/mm²	%	%	J	J				°C	
10	X2CrNiMoN17-12	—	≤ 0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	10,50 to 13,50	0,12 to 0,22 N	160	280	315	580 to 780	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
11	X2CrNiMo17-13	F59	≤ 0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,50 to 3,00	11,50 to 14,50	—	250	190	225	490 to 690	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
12	X2CrNiMoN17-13	—	≤ 0,030	1,00	2,00	0,045	0,030	16,50 to 18,50	2,50 to 3,00	11,50 to 14,50	0,12 to 0,22 N	160	280	315	580 to 780	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
13	X5CrNiMo17-12	F62	≤ 0,07	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	10,50 to 13,50	—	250	205	240	510 to 710	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
14	X5CrNiMo17-13	F62	≤ 0,07	1,00	2,00	0,045	0,030	16,50 to 18,50	2,50 to 3,00	11,00 to 14,00	—	250	205	240	510 to 710	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
15	X7CrNiMo17-12	F64	0,04 to 0,10	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	10,50 to 13,50	—	250	205	240	510 to 710	30	30	85	55	3	4	Q	1020 to 1120 [i]	w, a
16	X6CrNiMoTi17-12	F66	≤ 0,08	1,00	2,00	0,045	0,030	16,50 to 18,50	2,00 to 2,50	11,00 to 14,00	Ti ≥ 5 × % C ≤ 0,80	450	210	245	510 to 710 [k]	30	30	85	55	3	—	Q	1020 to 1120 [h]	w, a
17	X6CrNi25-21	F68	≤ 0,08	1,50	2,00	0,045	0,030	24,00 to 26,00	—	19,00 to 23,00	—	160	210	250	500 to 700	30	30	85	55	3	—	Q	1000 to 1100 h	w, a

Table 1 *(concluded)*

Line No.	Steel type		Chemical composition[b] % by mass									Mechanical properties at room temperature [c]								Elevated temperature properties		Heat treatment		
	"new"	"old"	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	Others	Thickness of the ruling section t_R max.	$R_{p0,2}$ min.	$R_{p1,0}$ min.	R_m	A min. DIR: x	A min. DIR: y	KV [d] min. DIR: x-y	KV [d] min. DIR: y-x	R_p	Creep properties	Usual conditions of reference heat treatment: Symbol[e]	Solution temperature [f]	Cooling in [g]
	designation[a] in accordance with ISO/TR 4949	ISO 2604-1										mm	N/mm²	N/mm²	N/mm²	%	%	J	J	See Table			°C	
18	X2NiCrMoCu25-20-5[l]	—	≤ 0,025	1,00	2,00	0,030	0,020	19,00 to 22,00	4,00 to 5,00	24,00 to 27,00	1,00 to 2,00 Cu, (≤ 0,15 N) [m]	160	220[m]	225[m]	520 to 720[m]	30	30	85	55	3	—	Q	1050 to 1150 [h]	w, a
19	X2CrNiN23-4	—	≤ 0,030	1,00	2,50	0,035	0,020	22,00 to 24,00	≤0,60	3,50 to 5,00	≤ 0,60 Cu 0,05 to 0,20 N	160	400		600 to 820	25	20	85	55	3	—	Q	970 to 1070	w, a
20	X2CrNiMoN22-5-3	—	≤ 0,030	1,00	2,00	0,035	0,020	21,00 to 23,00	2,50 to 3,50	4,50 to 6,50	0,08 to 0,20 N	250	450		600 to 860	25	20	85	55	3	—	Q	1020 to 1100	w, a

a All data on designations in this part of ISO 9327 are to be regarded as preliminary (see NOTE 2 of 4.1 in ISO 9327-1:1999).

b See 5.2.1.1 of ISO 9327-1:1999.

c $R_{p0,2}$ or $R_{p1,0}$ is the proof strength;

R_m is the tensile strength;

A is the percentage elongation after fracture on gauge length;

L_o is the gauge length = 5,65 $\sqrt{S_o}$;

KV is the Charpy V-notch impact energy.

DIR:x, DIR:x-y, DIR:y and DIR: y-x are the directions of the test piece in relation to the main direction of grain flow. For detailed explanations see Table 5 and Figures 9 and 10 of ISO/TR 15461:1997.

d Average of three tests. One of the individual values may be below the specified minimum average, provided it is not less than 70 % of this value. The values apply to standard 10 mm × 10 mm Charpy V-notch impact test pieces (see ISO 148). Austenitic stainless steels do not exhibit any transition range of impact values so that there is no important decrease in the impact values down to low temperatures.

e Q = quenched.

f For guidance only, except in cases where testing of reference test pieces is required.

g a = air – cooling sufficiently rapid; w = water.

h In the case of heat treatment in the course of processing after delivery, the lower part of the given solution temperature range shall be aimed for. If, in the course of hot working, the temperature is not below the specified lower limit of the solution temperature, the following temperatures are sufficient for repeat heat treatments: 980 °C in the case of Mo-free steels, 1 000 °C in the case of steels with ≤ 3 % Mo.

i For the steels for which stress rupture values are given in table 4, the treatment temperature shall not be less than the minimum of the reference temperature range.

j Niobium content including tantalum determined as niobium.

k For diameters above 100 mm, lower values are to be agreed.

l Since this steel is at the stage of development, small deviations in chemical composition are permitted, provided the other requirements are fulfilled.

m By agreement, nitrogen may be added up to a limit of 0,15 %. In this case higher proof strength and tensile strength values may also be agreed upon.

Table 2 — Permissible product analysis tolerances on the limiting values given in Table 1 for the cast analysis

Element	Specified limits, cast analysis % by mass	Permissible tolerance[a] % by mass
C	⩽ 0,30	+ 0,005
	> 0,030 ⩽ 0,10	± 0,01
Si	⩽ 1,50	+ 0,05
Mn	⩽ 2,50	+ 0,05
P	⩽ 0,045	+ 0,005
S	⩽ 0,030	+ 0,003
Cr	⩽ 26,00	± 0,20
Cu	⩽ 0,60	+ 0,05
	⩾ 0,60 ⩽ 2,00	± 0,07
Mo	⩽ 3,00	± 0,08
	> 3,00 ⩽ 5,00	± 0,10
N	⩽ 0,22	± 0,01
Nb	⩽ 1,20	± 0,05
Ni	⩽ 20,00	± 0,15
	> 20,00 ⩽ 27,00	± 0,20
Ti	⩽ 0,80	± 0,05

[a] The deviations, other than when maxima only are specified, apply either above or below the specified limits of the range but not both above and below for the same element from different sample products from the same cast. When maxima only are specified, the deviations are positive only. The values are valid only if the samples were selected according to C.5 of ISO 9327-1:1999.

Table 3 — Minimum 0,2 % ($R_{p0,2}$) and 1,0 % ($R_{p1,0}$) proof strength values at elevated temperatures for the quenched condition (see Table 1)

Line No.	Steel type	$R_{p0,2}$ [a] N/mm² min.										$R_{p1,0}$ [a] N/mm² min.									
		Temperature, °C										Temperature, °C									
		150	200	250	300	350	400	450	500	550	600	150	200	250	300	350	400	450	500	550	600
1	X2CrNi18-10	116	104	96	88	84	81	78	76	74	72	150	137	128	122	116	110	108	106	102	100
2	X2CrNiN18-10	169	155	143	135	129	123	119	115	113	110	201	182	172	163	156	149	144	140	136	131
3	X5CrNi18-9	126	114	106	98	93	89	86	84	81	79	160	147	139	132	125	120	117	115	112	109
4	X7CrNi18-9	126	114	106	98	93	89	86	84	81	79	160	147	139	132	125	120	117	115	112	109
5	X6CrNiNb18-10	162	153	147	139	133	129	126	124	122	121	192	182	172	166	162	159	157	155	153	151
6	X6CrNiTi18-10	149	144	139	135	129	124	119	116	111	108	179	172	164	158	152	148	143	140	138	135
7	X7CrNiTi18-10	123	117	114	110	105	100	95	93	90	88	155	147	141	133	129	126	121	118	116	115
8	X7CrNiNb18-10	162	153	147	139	133	129	126	124	122	121	192	182	172	166	162	159	157	155	153	151
9	X2CrNiMo17-12	130	120	109	101	96	90	87	84	81	79	161	149	139	133	127	123	119	115	112	110
10	X2CrNiMoN17-12	178	164	154	146	140	136	132	129	126	124	208	192	180	172	166	161	157	152	149	144
11	X2CrNiMo17-13	130	120	109	101	96	90	87	84	81	79	161	149	139	133	127	123	119	115	112	110
12	X2CrNiMoN17-13	178	164	154	146	140	136	132	129	126	124	208	192	180	172	166	161	157	152	149	144
13	X5CrNiMo17-12	144	132	121	113	107	101	98	95	92	90	172	159	150	143	137	133	129	125	121	119
14	X5CrNiMo17-13	144	132	121	113	107	101	98	95	92	90	172	159	150	143	137	133	129	125	121	119
15	X7CrNiMo17-12	144	132	121	113	107	101	98	95	92	90	172	159	150	143	137	133	129	125	121	119
16	X6CrNiMoTi17-12	(148)	(137)	(126)	(117)	(111)	(105)	(102)	(99)	(95)	(93)	(183)	(169)	(159)	(152)	(147)	(142)	(138)	(133)	(129)	(127)
17	X6CrNi25-21	(128)	(116)	(108)	(100)	(94)	(91)	(86)	(85)	(84)	(82)	(167)	(154)	(146)	(139)	(132)	(126)	(123)	(121)	(118)	(114)
18	X2NiCrMoCu25-20-5 [b]	(165)	(155)	(145)	(135)	(130)	(125)	—	—	—	—	(195)	(185)	(175)	(165)	(160)	(155)	—	—	—	—
19	X2CrNiN23-4 [c]	300	280	265	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	X2CrNiMoN22-5-3 [c]	335	310	295	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

[a] The values were derived, as far as possible, from the regression lines given in various TC 17/SC 18 documents. Values given in parentheses were derived from the regression lines for the nearest appropriate steels.

[b] The values shown for steel type X2NiCrMoCu25-20-5 come from a German specification.

[c] The values shown for steel types X2CrNiN23-4 and X2CrNiMoN22-5-3 where not derived in accordance with ISO 2605-1; the values are provisional.

Table 4 — Stress rupture properties at elevated temperatures for the quenched condition (see Table 1)

Line No.	Steel type	Rupture time	Estimated average stresses for rupture [a] N/mm²																			
			Temperature °C																			
		h	540	550	560	570	580	590	600	610	620	630	640	650	660	670	680	690	700	710	720	730
4	X7CrNi18-9	10 000	—	176	164	152	142	131	122	113	104	95	87	79	73	67	61	55	48	—	—	—
		30 000	—	147*	135*	126*	115*	105*	96*	88*	80*	74	67	61	55	50	44*	(40)*	(35)*	—	—	—
		50 000	—	134*	123*	113*	103*	94*	85*	78*	72*	65*	58*	52*	47*	41*	(36)*	(32)*	(27)*	—	—	—
		100 000	—	115*	105*	98*	89*	81*	74*	68*	61*	55*	50*	45*	(40)*	(35)*	(30)*	(26)*	(23)*	—	—	—
		150 000	—	108*	99*	89*	81*	74*	67*	60*	54*	49*	43*	(39)*	(34)*	(30)*	(26)*	(23)*	(20)*	—	—	—
		200 000	—	102*	93*	84*	76*	69*	62*	56*	50*	45*	(40)*	(35)*	(31)*	(27)*	(24)*	(21)	—	—	—	—
		250 000	—	97*	88*	79*	73*	66*	59*	53*	47*	42*	(37)*	(33)*	(29)*	(25)*	(22)*	—	—	—	—	—
7	X7CrNiTi18-10	10 000	—	230	220	210	190	170	160	140	130	120	110	100	90	82	74	66	60	—	—	—
		30 000	—																	—	—	—
		50 000																		—	—	—
		100 000	—	170	150	140	120	110	100	92	84	76	68	62	56	50	44	39	35	—	—	—
		150 000	—																			
		200 000	—	150	130	120	110	100	90	82	74	66	60	54	48	43	40	38	29	—	—	—
		250 000	—																	—	—	—
8	X7CrNiNb18-10	10 000	243	228	215	200	186	173	159	146	134	124	114	104	95	86	77	69	61	54	46	—
		30 000	210*	197	184	172	159	146	133	123	112	102	92	83	74	66	58	51	44	38	(33)	—
		50 000	198*	185*	172*	159*	146	133	123	111	101	91	82	74	66	58	51	44	39	(33)	(28)	—
		100 000	181*	168*	154*	142*	129	118	106	96	86	77	69	61	53	46	40*	35*	(30)*	(25)*	(22)*	—
		150 000	171*	158*	145*	132*	121	109	98	88	79	71*	63*	55*	48*	42*	36*	(32)*	(28)*	(24)*	—	—
		200 000	164*	151*	138*	127*	114*	103*	93*	83*	75*	66*	58*	51*	44*	38*	(33)*	(29)*	(25)*	(22)*	—	—
		250 000	159*	146*	133*	122*	110*	99*	88*	79*	71*	63*	55*	48*	41*	36*	(31)*	(27)*	(25)*	—	—	—
15	X7CrNiMo17-12	10 000	247	233	220	206	193	180	167	155	142	130	119	108	97	87	78	70	63	57	52	47
		30 000	222	208	195	181	168	155	143	131	119	107	97	87	78	69	62	56	51	46	(42)	—
		50 000	210	197	183*	170	157	144	132	120	108	97	87	78	70	62	56	51	46	(42)	—	—
		100 000	194*	181*	167*	154*	141	128	116	105	94	84	75	67	60	54	49*	(44)*	—	—	—	—
		150 000	189*	172*	158*	145*	132	120	108	97	86	77*	69*	61*	55*	50*	(45)*	—	—	—	—	—
		200 000	178*	164*	151*	138*	125	113	102	91	81	72*	65*	58*	52*	47*	(43)*	—	—	—	—	—
		250 000	173*	159*	146*	133*	120*	108*	97*	87*	77*	69*	61*	55*	50*	(45)*	—	—	—	—	—	—

[a] Values with an asterisk have involved extended time extrapolation; values in parentheses have involved extended stress estrapolation.

Bibliography

[1] ISO 2604-1:1975[1)], *Steel products for pressure purposes — Quality requirements — Part 1: Forgings.*

[2] ISO 2605-2:1976, *Steel products for pressure purposes — Derivation and verification of elevated temperature properties — Part 2: Proof stress of austenitic steel products.*

1) To be replaced by ISO 9327 parts 1 to 5.

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