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BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

भारतीय मानक

चमकीले इस्पात की छड़े - विशिष्टि

(IS 6528 *का दूसरा पुनरीक्षण*)

Draft Indian Standard

Stainless Steel Wire - Specification

(*Second Revision of* IS 6528)

ICS 77.140.20, 77.140.65

Alloy Steels and Forgings Sectional Committee, MTD 16	Last date of comments : **09 May 2024**

FOREWORD

(*Formal clauses will be added later*)

This standard was first published in 1972 and subsequently revise in 1995. While reviewing this standard in the light of experience gained in its usage, committee felt that the standard should be reviewed to bring it in line with the present national and international practices in the field. The grades of stainless steels and their designations have been aligned and rationalized with the present industry needs and practices.

In addition, following changes have been made:

a) Scope has been modified to include shaped wires also;
b) More grades have been added. New classes of steel, Austenitic-ferritic (duplex) steels and Precipitation-hardening steels have been added;
c) Clause 12 on Retest and Clause 14 on finish have been modified;
d) Treatment conditions of bars have been specified; and
e) For purpose of guidance, comparison of grades with other standards on the subject is given at Annex C.

An informative Annex B has been given for the benefit of the purchaser giving particulars to be specified by the purchaser while placing order for the steels covered in this standard.

In the formulation of this standard assistance has been derived from 'ISO 16143 (Part 3) : 2014 - Stainless Steels for General Purposes (Part 3) - Wire'.

For all the tests specified in this standard (chemical/physical/others), the method as specified in relevant ISO standard may also be followed as an alternate method.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

STAINLESS STEEL WIRE-SPECIFICATION

(*Second Revision*)

1 SCOPE

1.1 This standard covers the requirement for stainless steel wire for general corrosion resistance, supplied in the form of round, flat, and shaped wire (such as square, hexagonal, rectangular or any other shape wire). The wire can be supplied in coils or in straightened and cut lengths.

1.2 This standard shall not apply to wire used for manufacturing of welding electrodes.

2 REFERENCES

The following Indian Standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purposes of this document, in addition to the definitions given in IS 1956 (Part 3) the following shall apply.

4 SUPPLY OF MATERIAL

General requirements for the supply of material shall conform to IS 8910.

5 MANUFACTURE

Unless otherwise agreed in the order, the processes used in making the steel and the products are left to the discretion of the manufacturer. When so desired, the purchaser shall be informed of the steel making process. Unless otherwise agreed between the parties the wire processing shall be at the discretion of the wire drawer.

6 FREEDOM FROM DEFECTS

The surface of the wire shall be smooth and free from harmful surface defects. When required by the purchaser, the depth of longitudinal cracking, for example, hair seam at each end of the wire shall not exceed the limits given below:

Diameter, (mm)	*Depth of Cracking*, (mm)
2.00 Up to and including 8.00	0.07 and under
Over 8.00	To be agreed upon between the purchaser and supplier

7 CHEMICAL COMPOSITION

7.1 The ladle analysis of steels when carried out either by the method specified in relevant parts of IS 228 or any other established instrumental/chemical method, shall be as given in Table 1. In case of any dispute, the procedure given in relevant parts of IS 228 shall be the referee method. However, where the method is not given in relevant parts of IS 228, the referee method shall be agreed to between the purchaser and the manufacturer.

Table 1 Chemical composition (Ladle analysis)
(*Clause* 7.1, 7.2, *and Annex C*)

Sl. No.	Steel Designation		% (mass fraction)[a]									
	Grade	Numerical Symbol	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
Austenitic Steels												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1)	X15Cr18Ni8	301	0.15	2.00	2.00	0.045	0.030	16.0 to 19.0	0.80	6.0 to 9.5	0.10	—
2)	X02Cr19Ni10	304L	0.030	1.00	2.00	0.045	0.030	17.5 to 19.5	—	8.0 to 10.0[b]	0.10	—
3)	X10Cr18Ni9S	303	0.12	1.00	2.00	0.060	≥0.15	17.0 to 19.0	—	8.0 to 10.0	0.10	Cu: 1.00
4)	X02Cr18Ni9N	304LN	0.030	1.00	2.00	0.045	0.030	17.5 to 19.5	—	8.0 to 10.0	0.12 to 0.22	—
5)	X03Cr18Ni9Cu4	304Cu	0.04	1.00	2.00	0.045	0.030	17.0 to 19.0	—	8.0 to 10.5	0.10	Cu: 3.0 to 4.0
6)	X06Cr18Ni9Cu2S	303Cu	0.08	1.00	2.00	0.045	≥0.15	17.0 to 19.0	0.60	8.0 to 10.0	0.10	Cu: 1.40 to 1.80
7)	X05Cr19Ni9N	304N	0.08	1.00	2.50	0.045	0.030	18.0 to 20.0	—	7.0 to 10.5	0.10 to 0.30	[d]
8)	X04Cr19Ni9	304	0.08	1.00	2.00	0.045	0.030	17.5 to 20.0	—	8.0 to 10.5[b]	0.10	—
9)	X04Cr18Ni10Ti	321	0.08	1.00	2.00	0.045	0.030	17.0 to 19.0	—	9.0 to 12.0[b]	—	Ti: 5 × C to 0.80
10)	X04Cr18Ni10Nb	347	0.08	1.00	2.00	0.045	0.030	17.0 to 19.0	—	9.0 to 12.0[b]	—	Nb: 10 × C to 1.00
11)	X02Cr19Ni11	304LNi	0.030	1.00	2.00	0.045	0.030	18.0 to 20.0	—	10.0 to 12.0[b]	0.10	—
12)	X04Cr18Ni12	305	0.08	1.00	2.00	0.045	0.030	17.0 to 19.0	—	10.5 to 13.0	0.10	—
13)	X07Cr21Ni11SiNCe	308	0.05 to 0.10	1.40 to 2.00	0.80	0.040	0.030	20.0 to 22.0	—	10.0 to 12.0	0.14 to 0.20	Ce: 0.03 to 0.08
14)	X08Cr17Mn8Cu3N	204Cu	0.10	2.00	6.5 to 9.0	0.040	0.030	15.0 to 18.0	1.00	3.00	0.10 to 0.30	Cu: 2.00 to 3.5
15)	X03Cr15Mn8Ni5Cu3	201Cu	0.030	1.00	7.0 to 9.0	0.040	0.010	14.0 to 16.0	0.80	4.5 to 6.0	0.02 to 0.06	Cu: 2.0 to 4.0
16)	X12Cr18Mn9Ni5N	202	0.15	1.00	7.5 to 10.0	0.060	0.030	17.5 to 19.0	—	4.0 to 6.0	0.15 to 0.30	—
17)	X10Cr17Mn6Ni4N	201	0.15	1.00	5.5 to 7.5	0.060	0.030	16.0 to 18.0	—	3.5 to 5.5	0.05 to 0.25	—
18)	X11Cr19Ni8Mn6N	202S1	0.07 to 0.15	0.50 to 1.00	5.0 to 7.5	0.030	0.015	17.5 to 19.5	—	6.5 to 8.5	0.20 to 0.30	—
19)	X13Mn13Cr18N	—	0.15	1.00	11.0 to 14	0.045	0.030	16.5 to 19.0	—	0.5 to 2.5	0.20 to 0.45	—

Table 1 — (*continued*)

Sl. No.	Steel Designation		% (mass fraction)[a]									
	Grade	Numerical Symbol	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
20)	X18Cr23Ni13	309	0.20	1.00	2.00	0.045	0.030	22.0 to 24.0	—	12.0 to 15.0	0.10	—
21)	X01Cr25Ni21	310L	0.020	0.25	2.00	0.025	0.010	24.0 to 26.0	0.20	20.0 to 22.0	0.10	—
22)	X01Cr25Ni20	310LN	0.10	1.50	2.00	0.045	0.030	24.0 to 26.0	—	19.0 to 22.0	0.10	—
23)	X12Cr25Ni20	310	0.25	1.50	2.00	0.045	0.030	24.0 to 26.0	—	19.0 to 22.0	—	—
24)	X04Cr25Ni20	310S	0.08	1.50	2.00	0.045	0.030	24.0 to 26.0	—	19.0 to 22.0	—	—
25)	X15Cr25Ni21Si	314	0.25	1.5 to 3.0	2.00	0.045	0.030	23.0 to 26.0	—	19.0 to 22.0	—	—
26)	X02Cr17Ni12Mo2	316L	0.030	1.00	2.00	0.045	0.030	16.0 to 18.0	2.00 to 3.00	10.0 to 13.0[b]	0.10	—
27)	X04Cr17Ni12Mo2	316	0.07	1.00	2.00	0.045	0.030	16.0 to 18.0	2.00 to 3.00	10.0 to 13.0[b]	0.10	—
28)	X04Cr17Ni12Mo2Ti	316Ti	0.08	1.00	2.00	0.045	0.030	16.0 to 18.0	2.00 to 2.50	10.0 to 13.5[b]	—	Ti: 5 x C to 0.80
29)	X03CrNiCuMo17-11-3-2	316Cu	0.04	1.00	2.00	0.045	0.015	16.5 to 17.5	2.00 to 2.50	10.0 to 11.0	0.10	Cu: 3.0 to 3.5
30)	X02Cr17Ni12Mo3	—	0.030	1.00	2.00	0.045	0.030	16.5 to 18.5	2.50 to 3.00	10.5 to 13.0[b]	0.10	—
31)	X03Cr17Ni12Mo3	—	0.05	1.00	2.00	0.045	0.030	16.5 to 18.5	2.50 to 3.00	10.5 to 13.0[b]	0.10	—
32)	X02Cr17Ni12Mo2N	316LN	0.030	1.00	2.00	0.045	0.030	16.0 to 18.0	2.00 to 3.00	10.0 to 13.0[b]	0.12 to 0.22	—
33)	X02Cr18Ni14Mo3	316LNi	0.030	1.00	2.00	0.045	0.015	17.0 to 19.0	2.50 to 3.00	12.5 to 15.0	0.10	—
34)	X04Cr18Ni12Mo3	317	0.080	1.00	2.00	0.045	0.030	18.0 to 20.0	3.0 to 4.0	11.0 to 15.0	0.10	—
35)	X02Cr18Ni12Mo3N	—	0.030	1.00	2.00	0.045	0.030	16.5 to 19.5	3.0 to 4.0	10.5 to 14.0[b]	0.10 to 0.20	—
36)	X02Cr17Ni13Mo4	—	0.030	1.00	2.00	0.045	0.015	16.5 to 18.5	4.0 to 5.0	12.5 to 14.5	0.12 to 0.22	—
37)	X01Cr20Ni18Mo6CuN	312	0.020	0.70	1.00	0.035	0.015	19.5 to 20.5	6.0 to 7.0	17.5 to 18.5	0.18 to 0.25	Cu: 0.50 to 1.00
38)	X01Cr25Ni22Mo2	—	0.020	0.70	2.00	0.025	0.010	24.0 to 26.0	2.00 to 2.50	21.0 to 23.0	0.10 to 0.16	—
39)	X01Cr24Ni22Mo4CuNW	—	0.020	0.70	2.0 to 4.0	0.030	0.010	23.0 to 25.0	5.5 to 6.5	21.0 to 23.0	0.35 to 0.50	Cu: 1.00 to 2.00 W: 1.50 to 2.50
40)	X01Cr24Ni22Mo7CuN	326	0.020	0.50	2.0 to 4.0	0.030	0.005	23.0 to 25.0	7.0 to 8.0	21.0 to 23.0	0.45 to 0.55	Cu: 0.30 to 0.60
41)	X02Cr25Ni18Mn6Mo4N	345	0.030	1.00	5.0 to 7.0	0.030	0.010	24.0 to 26.0	4.0 to 5.0	16.0 to 19.0	0.30 to 0.60	Nb: 0.15
42)	X01Ni25Cr20Mo5Cu	904L	0.020	0.75	2.00	0.035	0.015	19.0 to 22.0	4.0 to 5.0	23.5 to 26.0	0.15	Cu: 1.20 to 2.00
43)	X01Ni25Cr20Mo7CuN	904LN	0.020	0.75	2.00	0.035	0.015	19.0 to 21.0	6.0 to 7.0	24.0 to 26.0	0.15 to 0.25	Cu: 0.50 to 1.50
44)	X8NiCrAlTi32-21	—	0.10	1.00	1.50	0.015	0.015	19.0 to 23.0	—	30.0 to 34.0	—	Al:0.15 to 0.60 Ti: 0.15 to 0.60 Cu: 0.70
45)	X01Ni31Cr27Mo4Cu	—	0.020	0.70	2.00	0.030	0.010	26.0 to 28.0	3.0 to 4.0	30.0 to 32.0	0.10	Cu: 0.70 to 1.50

Table 1 — (*continued*)

Sl. No.	Steel Designation		% (mass fraction)[a]									
	Grade	Numerical Symbol	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
	Austenitic-ferritic steels											
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
46)	X02Cr22Ni2N	—	0.030	1.00	2.00	0.040	0.010	21.5 to 24.0	0.45	1.00 to 2.90	0.16 to 0.28	—
47)	X02Cr21Mn5Ni1N	2101	0.040	1.00	4.0 to 6.0	0.040	0.015	21.0 to 22.0	0.10 to 0.80	1.35 to 1.90	0.20 to 0.25	Cu: 0.10 to 0.80
48)	X02Cr23Ni4N	2304	0.030	1.00	2.00	0.035	0.015	22.0 to 24.5	0.10 to 0.60	3.5 to 5.5	0.05 to 0.20	Cu: 0.10 to 0.60
49)	X02Cr22Ni5Mo3N	2205	0.030	1.00	2.00	0.035	0.015	21.0 to 23.0	2.5 to 3.5	4.5 to 6.5	0.10 to 0.22	—
50)	X02Cr21Mn5Ni3MoN	—	0,030	1.00	4.0 to 6.0	0.035	0.030	19.5 to 21.5	0.1 to 0.6	1.5 to 3.5	0.05 to 0.20	Cu: 1.00
51)	X02Cr24Ni4Mn3Mo2CuN	2441	0.030	0.70	2.50 to 4.0	0.035	0.005	23.0 to 25.0	1.00 to 2.00	3.0 to 4.5	0.20 to 0.30	Cu: 0.10 to 0.80
52)	X03Cr27Ni5Mo2N	—	0.050	1.00	2.00	0.035	0.015	25.0 to 28.0	1.30 to 2.00	4.5 to 6.5	0.05 to 0.20	—
53)	X02Cr25Ni6Mo3CuN	—	0.030	0.70	2.00	0.035	0.015	24.0 to 26.0	2.5 to 4.0	5.0 to 7.5	0.15 to 0.30	Cu: 1.00 to 2.50
54)	X02Cr25Ni7Mo4N	2507	0.030	1.00	2.00	0.035	0.015	24.0 to 26.0	3.0 to 4.5	6.0 to 8.0	0.24 to 0.35	—
55)	X02Cr25Ni7Mo4CuWN	2760	0.030	1.00	1.00	0.035	0.015	24.0 to 26.0	3.0 to 4.0	6.0 to 8.0	0.20 to 0.30	Cu: 0.50 to 1.00 W: 0.50 to 1.00
	Ferritic steels											
56)	X04Cr12Nb	409Nb	0.08	1.00	0.80	0.04	0.03	10.5 to 13.5	0.50	0.60	—	Nb: 10 X C - 0.75 Cu: 0.75 Max
57)	X04Cr13	—	0.080	1.00	1.00	0.040	0.030	11.5 to 13.5	—	1.00	—	Al: 0.10 to 0.30
58)	X04Cr12	410S	0.08[e)]	1.00	1.00	0.040	0.030[b]	11.5 to 14.0	—	0.75	—	—
59)	X02CrNi12	410L	0.030	1.00	1.50	0.040	0.030	10.5 to 12.5	—	0.30 to 1.00	0.030	—
60)	X04Cr17	430	0.08[e)]	1.00	1.00	0.040	0.030	16.0 to 18.0	—	—	—	—
61)	X05Cr17S	430F	0.09	1.50	1.50	0.040	≥0.15	16.0 to 18.0	0.60	—	—	—
62)	X03Cr17Nb	430Nb	0.05	1.00	1.00	0.040	0.015	16.0 to 18.0	—	—	—	Nb: 12 × C to 1.00
63)	X02Cr18TiNb	439	0.030	1.00	1.00	0.040	0.015	17.5 to 18.5	—	—	—	Ti: 0.10 to 0.60 Nb: 0.30 + 3 ×C to 1.00
64)	X04Cr17Mo1	434	0.08	1.00	1.00	0.040	0.030	16.0 to 18.0	0.90 to 1.40	—	—	—
65)	X15Cr26N	446	0.20	1.00	1.00	0.040	0.030	24.0 to 28.0	—	1.00	0.15 to 0.25	—
66)	X02Cr18Mo2TiS	—	0.030	1.00	0.50	0.040	≥0.15	17.5 to 19.0	2.00 to 2.50	—	—	Ti: 0.30 to 0.80 (C + N) ≤ 0.040

Table 1 — (*concluded*)

Sl. No.	Steel designation		% (mass fraction)[a]									
	Grade	Numerical Symbol	C	Si	Mn	P	S	Cr	Mo	Ni	N	Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Martensitic steels											
67)	X12Cr12	410	0.08 to 0.15	1.00	1.50	0.040	0.030	11.5 to 13.5	—	0.75	—	—
68)	X12Cr13S	416	0.08 to 0.15	1.00	1.50	0.040	≥0.15	12.0 to 14.0	0.60	—	—	—
69)	X20Cr13	420	0.16 to 0.25	1.00	1.50	0.040	0.030	12.0 to 14.0	—	—	—	—
70)	X30Cr13	420B	0.26 to 0.35	1.00	1.50	0.040	0.030	12.0 to 14.0	—	—	—	—
71)	X46Cr13	420C	0.43 to 0.50	1.00	1.50	0.040	0.030	12.5 to 14.5	—	—	—	—
72)	X17Cr16Ni2	431	0.12 to 0.22	1.00	1.50	0.040	0.030	15.0 to 17.0	—	1.25 to 2.50	—	—
73)	X14Cr17S	430F	0.10 to 0.17	1.00	1.50	0.040	≥0.15	16.0 to 18.0	0.60	—	—	—
74)	X110Cr17	440C	0.95 to1.20	1.00	1.00	0.040	0.030	16.0 to 18.0	0.75	0.60	—	—
75)	X50Cr15MoV	420V	0.45 to 0.55	1.00	1.00	0.040	0.015	14.0 to 15.0	0.50 to 0.80	—	—	V: 0.10 to 0.20
76)	X03Cr13Ni4Mo	415	0.05	0.70	0.50 to 1.00	0.040	0.015	12.0 to 14.0	0.30 to 1.00	3.5 to 4.5	—	—
77)	X04Cr16Ni5Mo1	431N	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	—
78)	X39Cr17Mo1	434C	0.33 to 0.45	1.00	1.50	0.040	0.015	15.5 to 17.5	0.80 to 1.30	1.00	—	—
	Precipitation-hardening steels											
79)	X05Cr16Ni4CuNb	630	0.07	0.70	1.50	0.040	0.030	15.0 to 17.0	0.60	3.0 to 5.0	—	Cu: 3.0 to 5.0 Nb: 5 × C to 0.45
80)	X07Cr17Ni7Al	631	0.09	0.70	1.00	0.040	0.015	16.0 to 18.0	—	6.5 to 7.8[f]	—	Al: 0.70 to 1.50

[a] Maximum values unless indicated otherwise.

[b] Where, for special reasons (e.g. hot workability or low magnetic permeability), it is necessary to minimize the ferrite content, the maximum nickel mass fraction can be increased by the following amounts:

- by 0.50 % for steels X02Cr19Ni10, X04Cr19Ni9, and X04Cr17Ni12Mo2Ti;
- by 1.00 % for steels X04Cr18Ni10Ti, X04Cr18Ni10Nb, X02Cr19Ni11, X04Cr17Ni12Mo2, X03Cr17Ni12Mo3, X02Cr17Ni12Mo2N and X02Cr18Ni12Mo3;
- by 1.50 % for steels X02Cr17Ni12Mo2 and X02Cr17Ni12Mo3.

[c] Copper can be added up to 1 %.

[d] Nb can be added up to 0.15%.

[e] For certain applications, e.g. weldability or high strength wire, a maximum of 0.12 % C can be agreed upon.

[f] By special agreement, the steel, when intended for cold deformation, can also be ordered with 7.0 % to 8.3 %Ni.

NOTE — Elements not listed in this table cannot be intentionally added to the steel without the agreement of the purchaser, except for finishing the heat.

7.2 Product Analysis

Permissible variation in case of product analysis on the limits specified in Table 1 shall be as given in Table 2.

Table 2 Permissible Variation in Product Analysis

(*Clause* 7.2)

Sl. No.	**Element**	**Specified limits, Ladle analysis** % (mass fraction)		**Permissible deviation**[a] % (mass fraction)
(1)	(2)	(3)	(4)	(5)
i)	Carbon		≤0.030	+0.005
		>0.030	≤0.20	±0.01
		>0.20	≤0.60	±0.02
		>0.60	≤1.20	±0.03
ii)	Silicon		≤1.00	+0.05
		>1.00	≤3.00	±0.10
		>3.00	≤6.00	±0.15
iii)	Manganese		≤1.00	+0.03
		>1.00	≤2.00	±0.04
		>2.00	≤15.0	±0.10
iv)	Phosphorus		≤0.045	+0.005
		>0.045	0.070	±0.010
v)	Sulfur		≤0.015	+0.003
		>0.015	≤0.030	±0.005
		≥0.10	≤0.50	±0.02
vi)	Chromium	≥10.5	≤15.0	±0.15
		>15.0	≤20.0	±0.20
		>20.0	≤35.0	±0.25
vii)	Molybdenum		≤0.60	+0.03
		>0.60	≤1.75	±0.05
		>1.75	≤8.0	±0.10
viii)	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	≤38.0	±0.20
ix)	Nitrogen		≤0.10	+0.01
		≥0.10	≤0.60	±0.02
x)	Aluminum	≥0.05	≤0.30	±0.05
		>0.30	≤1.50	±0.10
xi)	Boron		≤0.010	+0.000 5
xii)	Copper		≤1.00	+0.04

		>1.00	≤5.0	±0.10
xiii)	Niobium		≤1.00	+0.05
ix)	Titanium		≤1.00	+0.05
		>1.00	≤3.0	±0.07
x)	Tungsten		≤3.00	+0.05
xi)	Vanadium		≤0.50	+0.03
a ± means that in one cast the deviation can occur over the upper value or under the lower value of the specified range in Table 3 but not both at the same time.				

8 HEAT TREATMENT

8.1 Steels may be supplied in any one of the condition from Solution Annealed, Hardened and Tempered, or Softened (Soft Annealed).

8.2 Recommended heat treatment for steels covered in this standard is given in Annex B.

9 DIMENSIONAL TOLERANCES

9.1 Unless otherwise agreed, dimensional tolerances for steels shall be as given in Table 3 to Table 6. Also, the purchaser may specify restricted tolerance (R) instead of normal tolerance (N) given in Table 3. For other shaped or sized wires, for which tolerances are not covered in Table 4 to Table 6, the tolerances shall be agreed upon at the time of ordering.

9.1.1 The cross section shall be perpendicular to the longitudinal wire axis. The out-of- roundness shall not exceed half the total diameter tolerance specified for round wires.

9.2 Length tolerances shall be mutually agreed to between the manufacturer and the purchaser.

Table 3 — Size tolerance for round wire

(*Clauses* 9.1, *and table* 2)

Dimensions in millimeters

Sl No.	**Diameter** *d*	**Normal tolerances** (N)			**Restricted tolerances** (R)		
		Wire in coils	**Wire in cut lengths**		**Wire in coils**	**Wire in cut lengths**	
			Minus tolerance	Plus tolerance		Minus tolerance	Plus tolerance
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i.	$0.050 < d \leq 0.070$	±0.003	0.003	—	±0.002	0.002	—
ii.	$0.070 < d \leq 0.10$	±0.004	0.004	—	±0.003	0.003	—
iii.	$0.10 < d \leq 0.16$	±0.005	0.005	—	±0.004	0.004	—
iv.	$0.16 < d \leq 0.25$	±0.006	0.006	0.008	±0.004	0.004	0.006
v.	$0.25 < d \leq 0.40$	±0.008	0.008	0.010	±0.006	0.006	0.010
vi.	$0.40 < d \leq 0.60$	±0.010	0.010	0.015	±0.008	0.008	0.010
vii.	$0.60 < d \leq 0.70$	±0.010	0.010	0.015	±0.008	0.008	0.015
viii.	$0.70 < d \leq 0.80$	±0.015	0.015	0.020	±0.010	0.010	0.020

ix.	$0.80 < d \leq 1.00$	±0.015	0.015	0.025	±0.010	0.010	0.020
x.	$1.00 < d \leq 1.20$	±0.020	0.020	0.030	±0.015	0.015	0.025
xi.	$1.20 < d \leq 1.60$	±0.020	0.020	0.035	±0.015	0.015	0.030
xii.	$1.60 < d \leq 1.70$	±0.030	0.030	0.040	±0.015	0.015	0.030
xiii.	$1.70 < d \leq 2.40$	±0.030	0.030	0.050	±0.015	0.015	0.035
xiv.	$2.40 < d \leq 2.80$	±0.030	0.030	0.060	±0.015	0.015	0.040
xv.	$2.80 < d \leq 3.50$	±0.040	0.040	0.070	±0.020	0.020	0.050
xvi.	$3.50 < d \leq 4.50$	±0.040	0.040	0.080	±0.020	0.020	0.060
xvii.	$4.50 < d \leq 5.00$	±0.040	0.040	0.090	±0.020	0.020	0.070
xviii.	$5.00 < d \leq 5.50$	±0.050	0.050	0.100	±0.025	0.025	0.080
xix.	$5.50 < d \leq 6.35$	±0.050	0.050	0.110	±0.025	0.025	0.090
xx.	$6.35 < d \leqslant 6.50$	±0.050	0.050	0.110	±0.030	0.030	0.090
xxi.	$6.50 < d \leqslant 7.50$	±0.050	0.050	0.120	±0.030	0.030	0.100
xxii.	$7.50 < d \leq 9.00$	±0.050	0.050	0.130	±0.030	0.030	0.110
xxiii.	$9.00 < d \leq 11.00$	±0.060	0.060	0.150	±0.035	0.035	0.130
xxiv.	$11.00 < d \leq 12.00$	±0.060	0.060	0.180	±0.035	0.035	0.150
xxv.	$12.00 < d \leq 16.00$	±0.070	0.070	0.200	±0.040	0.040	0.170

Table 4 — Permissible Deviation in size of Drawn Stainless Steel Wire – (Square, Hexagon & Octagon)

(*Clause* 9.1)

Sl No.	**Size** (mm)	**Permissible Deviation** (mm)
(1)	(2)	(3)
i.	From 3.15 up to and excluding 8.00	± 0.050
ii.	From 8.00 up to and excluding 12.50	± 0.080
iii.	From 12.50 and above	± 0.100
NOTE — Size of stainless steel wire is defined as distance across flats.		

10 MECHANICAL PROPERTIES

10.1 Tensile Test

The tensile properties for steels supplied in various conditions shall confirm to those given in Table 7 and Table 8. The tensile test shall be carried out in accordance with IS 1608 (Part 1).

10.1.1 Tensile properties for grades/sizes other than that mentioned in Table 7 shall be mutually agreed to between the purchaser and the supplier.

10.1.2 As the Mechanical properties of hard-drawn wire given in Table 8 will depend on the degree of work hardening, the specific type of steel, and the processing of the material and not that all the tensile strength levels can be achieved for all grades, the required tensile-strength level as per Table 8 shall be agreed between the manufacturer and the purchaser at the time of ordering.

10.2 Reverse Bend Test

If required by the purchaser, reverse bend test for steel wire shall be carried out in accordance with IS 1716.

10.3 Torsion Test

If required by the purchaser, torsion test shall be carried out in accordance with IS 1717.

10.4 Wrapping Test

If required by the purchaser, the wrapping test shall be carried out in accordance with IS 1755.

10.5 The requirements of test specified in **10.2**, **10.3,** and **10.4** shall be as agreed to between the purchaser and the manufacturer.

Table 5 — Permissible Deviation in Size of Cold Finished Stainless Steel Flat Wire

(*Clause* 9.1)

All dimensions in millimeters.

Sl No.	Specified Width	Thickness Tolerance over and under for given Thickness			Width Tolerence	
		Under 0.75	0.75 up to But not including 0.90	0.90 to but not including 4.75	Over	Under
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i.	Above 1.5 upto and excluding 9.5	0.03	0.04	0.05	0.13	0.15

Table 6 — Permissible deviation in size of wire for which the final operation is surface treatment for the purpose of removing Scale or Drawing Lubricant

(*Clause* 9.1, *and* 14.3)

All dimensions in millimeters

Sl No.	**Specified size** mm		**Tolerance**
	From	up to and excluding	
(1)	(2)	(3)	**(4)**
i.	0.600	0.850	± 0.02
ii.	0.850	1.120	± 0.03
iii.	1.120	8.00	± 0.06

iv.	8.00	12.5	± 0.08
v.	12.5	—	± 0.10

11 SAMPLING

11.1 Sampling for Chemical Analysis

For product analysis, the selection of samples shall be carried out in accordance with IS 14284.

11.2 Sampling for Mechanical Tests

11.2.1 Unless otherwise specified, for the purpose of mechanical tests, one sample shall be tested from the following process:

a) Each cast, heat treatment and cold drawn (one sample per size); and

b) Each cast, heat treatment and cold-rolled (one sample per size).

11.2.2 If the product is continuously heat-treated, the sampling for mechanical testes shall be as agreed to between the purchaser and the manufacturer.

11.2.3 General conditions for selection and preparation of samples and test pieces shall be in accordance with IS 3711. The samples shall be taken from the products in the delivery condition.

12 RETESTS

12.1 Retests for Product Analysis

If the results of the product analysis do not conform to the requirements given in Table 1 and Table 2, unless otherwise agreed to between the purchaser and manufacturer, two new samples shall be taken from different pieces from the same cast. Should the two determinations satisfy the requirements the lot represented shall be accepted. If either of the samples fails, the material shall be taken as not complying with this standard.

12.2 Retests for Mechanical Properties

Should any of the original test pieces fail to satisfy that requirement of the mechanical properties specified in the Table 7 or Table 8, two further samples shall be selected for retest for each test which failed. The mechanical properties obtained from the test pieces prepared from the two additional test samples shall comply with the specified requirements. Should either of the retests fails to meet the specified requirements, the material shall be taken as not complying with this standard, except that the manufacturer may re-heat-treat (not more than twice) the material represented and resubmit it for testing.

13 CONDITION OF SUPPLY

The stainless steel wire may be supplied in any one of the conditions (+A), (+AT) or (+C) as per the tensile strength levels given in Table 7 and Table 8. The details of supplying condition, depending on the structure are as follows:

— Condition +A: The wire is annealed as the final heat treatment. Please note that the product may be slightly deformed due to straightening, cold working, size control, or finish. This will slightly increase the tensile strength.

— Condition +AT: The wire is solution annealed as the final heat treatment. Please note that the product may be slightly deformed by straightening, cold working, size control, or finish. This will slightly increase the tensile strength.

— Condition +C: The wire is cold drawn as the final operation, in order to achieve higher strength.

Table 7 — Mechanical properties at room temperature for steel grades in the form of round wire[a] in the solution-annealed (+AT) or annealed (+A) condition

(*Clause* 10.1, 10.1.1, *and* 13)

Name	**ISO number**	**Wire diameter**[b] mm	**Tensile strength (*R*m)**[c] max. MPa[e]	**Elongation**[cd] min. %
Austenitic steels (+AT)				
All austenitic steels except X03Cr18Ni9Cu4 and X08Cr17Mn8Cu3N		$0.050 < d \leq 0.10$	1 100	20
		$0.10 < d \leq 0.20$	1 070	20
		$0.20 < d \leq 0.50$	1 020	30
		$0.50 < d \leq 1.00$	970	30
		$1.00 < d \leq 3.00$	920	30
		$3.00 < d \leq 5.00$	870	35
		$5.00 < d \leq 16.00$	820	35
X03Cr18Ni9Cu4 X08Cr17Mn8Cu3N	4567-304-30-I 4597-204-76-I	$0.50 < d \leq 1.00$	850	30
		$1.00 < d \leq 3.00$	820	30
		$3.00 < d \leq 5.00$	780	35
		$5.00 < d \leq 16.00$	750	35
Austenitic-ferritic (duplex) steels (+AT)				
All austenitic-ferritic steels		$0.50 < d \leq 1.00$	1 050	20
		$1.00 < d \leq 3.00$	1 000	20
		$3.00 < d \leq 5.00$	950	25
		$5.00 < d \leq 16.00$	900	25
Ferritic steels (+A)				
All ferritic steels		$0.50 < d \leq 1.00$	850	15
		$1.00 < d \leq 3.00$	800	15
		$3.00 < d \leq 5.00$	760	15
		$5.00 < d \leq 16.00$	740	20
Martensitic steels (+A)				
X12Cr13 X12Cr13S	4006-410-00-I 4005-416-00-I	$0.50 < d \leq 1.00$	950	10
		$1.00 < d \leq 3.00$	900	10
		$3.00 < d \leq 5.00$	840	10
		$5.00 < d \leq 16.00$	800	15

X20Cr13 X30Cr13 X17Cr16Ni2 X14Cr17S	4021-420-00-I	0.50 < d ≤ 1.00	1 000	10
	4028-420-00-I	1.00 < d ≤ 3.00	950	10
	4057-431-00-X	3.00 < d ≤ 5.00	920	10
	4019-430-20-I	5.00 < d ≤ 16.00	850	15
Precipitation-hardening steel (+AT)				
X05Cr16Ni4CuNb X07Cr17Ni7Al	4542-174-00-I 4568-177-00-I	—	850	—

[a] Properties for non-round wire to be agreed upon at the time of ordering.

[b] Other sizes can be specified after agreement between the manufacturer and the purchaser at the time of ordering.

[c] Without skin pass.

[d] For d < 4 mm, the gauge length shall be 100 mm, and for $d \geq 4$ mm, the gauge length shall be $5 \times d$.

[e] 1 MPa = 1 N/mm^2.

Table 8 — Tensile-strength levels and corresponding tensile-strength ranges

(*Clauses* 10.1, 10.1.2 *and* 13)

Sl No.	**Steel grades**	**Tensile-strength level**	**Range of tensile strength** MPa[b]
(1)	**(2)**	**(3)**	**(4)**
i.	Austenitic steels	+C600	600 to 800
		+C700	700 to 900
		+C800	800 to 1 000
		+C900	900 to 1 100
		+C1000	1 000 to 1 250
		+C1100	1 100 to 1 350
		+C1200	1 200 to 1 450
		+C1400	1 400 to 1 650
		+C1600	1 600 to 1 900
		+C1800	1 800 to 2 100
		+C2000	2 000 to 2 300
ii.	Austenitic-ferritic steels	+C700	700 to 900
		+C800	800 to 1 000

		+C1000	1 000 to 1 250
		+C1200	1 200 to 1 450
		+C1400	1 400 to 1 650
		+C1600	1 600 to 1 900
		+C1800	1 800 to 2 100
		+C2000	2 000 to 2 300
iii.	Ferritic and martensitic steels	+C500	500 to 700
		+C600	600 to 800
		+C700	700 to 900
		+C800	800 to 1 000
		+C900	900 to 1 100
		+C1000	1 000 to 1 250
iv.	Precipitation-hardening steels	a	a

[a] Not relevant.

[b] 1 MPa = 1 N/mm^2.

14 FINISH

14.1 Surface finish

If not specified otherwise, the surface finish of the wire is one of the following, depending on previous processing steps.

14.1.1 *Cold drawn*

This is the natural finish resulting from the drawing to final size, generally with cold-drawing lubricant left on. The finish will be duller for dry-drawn wire or shinier for wire that is wet drawn. Fine sizes are commonly wet drawn, whereas coarser sizes are commonly dry drawn. Special bright finishes, lubricant removal, etc. required for special end-use shall be negotiated with the manufacturer.

14.1.2 *Annealed*

This is a dull matt appearance, necessarily associated with the dead soft condition of annealed wire when no final drawing is permitted. With an additional surface treatment, a bright appearance can be realized.

14.1.3 *Polished finish*

This is a smooth and uniform bright finish of cold-drawn (+C) material obtained by mechanical smoothing, burnishing, abrading, or grinding.

14.2 Wire, cold finished to size, may be supplied with one of the following finishes:

a) Cold drawn;

b) Centreless ground (round wire in straight length only); and

c) Centreless ground and polished (round wire in straight length only).

14.3 Wire annealed or heat-treated and pickled or polished as final operation shall be furnished to the tolerances given in Table 6.

15 CORROSION RESISTANCE

If required by the purchaser, the material shall be tested for corrosion resistance in accordance with IS 10461 (Part 1) and IS 10461 (Part 2) or any other method as agreed to between the manufacturer and the purchaser.

16 PACKING AND MARKING

16.1 Packing

Each coil or bundle of wire (when supplied in straight lengths) shall be suitably bound and packed as agreed to between the purchaser and the manufacturer.

16.2 Marking

Each coil or bundle of wire shall be legibly marked with the following information:

a) Indication of the source of manufacture;

b) Designation of steel;

c) Condition of supply and finish;

d) Wire diameter;

e) Cast or batch no; and

f) Date of manufacture.

16.3 BIS Certification Marking

The Product (s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act,* 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

Annex A

(LIST OF REFERENCES)

(*Clause* 2)

IS No.	*Title*
IS 228	Method of chemical analysis of steel (in various parts)
IS 1608 (Part 1) : 2022	Metallic materials - Tensile testing – (Part 1) : Method of test at room temperature
ISO 6892-1 : 2019	
IS 1716 :2023/	Metallic materials wire reverse bend test (*third revision*)
ISO 7801:1984	
IS 1717 : 2018	Metallic materials - wire - simple torsion test (*fourth revision*)
IS 1755 :2018/	Metallic materials - wire - wrapping test (*second revision*)
ISO 7802 : 2013	
IS 1762 (Part 1): 1974	Code for designation of steels – (Part 1) : Based on letter symbols (*first revision*)
IS 1956 (Part 3) : 2019	Glossary of terms relating to iron and steel – (Part 3) : long products (including bars, rods, sections and wires) (*second revision*)
IS 3711:2020/ ISO 377:2017	Steel and steel products — location and preparation of samples and test pieces for mechanical testing (*third revision*)
IS 8910:2022/ ISO 404:2013	Steel and steel products — general technical delivery requirements (*second revision*)
IS/ISO 10474:2013	Steel and steel products — inspection documents (*first revision*)
IS 10461	Resistance to inter-granular corrosion of austenitic stainless steels - Method for determination
(Part 1) : 1994	Corrosion test in nitric acid medium by measurement of loss in mass (Huey Test) (*first revision*)
(Part 2) : 1994	Corrosion test in a sulphuric acid/copper sulphate medium in the presence of copper turnings (Monypenny Strauss Test)) (*first revision*)
IS/ISO 14284:1996	Steel and iron — Sampling and preparation of samples for the determination of chemical composition

Annex B

(Clause 8.2)

RECOMMENDED HEAT TREATMENT FOR STAINLESS STEELS

Austenitic Steels

Sl No.	Steel Designation	Heat Treatment Symbols	Solution Annealing	
			Temperature[b,c,d] ^{0}C	Type of Cooling
(1)	(2)	(3)	(4)	(5)
i.	X10CrNi18-8	+AT	1 000 to 1 100	Water, air[a]
ii.	X07Cr18Ni9		1 000 to 1 100	
iii.	X02CrNi18-9		1 000 to 1 100	
iv.	X02CrNiN18-9		1 000 to 1 100	
v.	X10CrNiS18-9		1 000 to 1100	
vi.	X3CrNiCu18-9-4		1 000 to 1 100	
vii.	X6CrNiCuS18-9-2		1 000 to 1 100	
viii.	X5CrNiN19-9		1 000 to 1 100	
ix.	X04Cr18Ni10		1 000 to 1 100	
x.	X04Cr19Ni9		1 000 to 1 100	
xi.	X04Cr18Ni10Ti		1 020 to 1 120	
xii.	X02Cr19Ni11		1 000 to 1 100	
xiii.	X04Cr18Ni12		1 000 to 1 100	
xiv.	X04Cr18Ni10Nb		1 020 to 1 120	
xv.	X7CrNiSiNCe21-11c		1 020 to 1 120	
xvi.	X08Cr17Mn8Cu3N		1 000 to 1 100	
xvii.	X03Cr15Mn8Ni5Cu3		1 000 to 1 100	
xviii.	X10Cr17Mn6Ni4N		1 000 to 1 100	
xix.	X12Cr18Mn9Ni5N		1 000 to 1 100	
xx.	X11Cr19Ni8Mn6N		1 000 to 1 100	
xxi.	X13Mn13Cr18N		1 050 to 1 080	
xxii.	X18CrNi23-13c		1 020 to 1 120	
xxiii.	X01Cr25Ni21		1 020 to 1 120	
xxiv.	X04Cr25Ni20		1 020 to 1 120	
xxv.	X12Cr25Ni20		1 020 to 1 120	

xxvi.	X15Cr25Ni21Si21		1 020 to 1 120
xxvii.	X02Cr17Ni12Mo2		1 020 to 1 120
xxviii.	X04Cr17Ni12Mo2		1 020 to 1 120
xxix.	X04Cr17Ni12Mo2 Ti		1 020 to 1 120
xxx.	X03CrNiCuMo17-11-3-2		1 000 to 1 100
xxxi.	X02Cr17Ni12Mo3		1 020 to 1 120
xxxii.	X03Cr17Ni12Mo3		1 020 to 1 120
xxxiii.	X02Cr17Ni12Mo2 N		1 020 to 1 120
xxxiv.	X02Cr18Ni14Mo3		1 020 to 1 120
xxxv.	X04Cr18Ni12Mo3		1 020 to 1 120
xxxvi.	X02Cr18Ni12Mo3		1 020 to 1 120
xxxvii.	X02Cr17Ni13Mo5		1 020 to 1 120
xxxviii.	X01Cr20Ni18Mo6 CuN		1 140 to 1 200
xxxix.	X01Cr25Ni22Mo2		1 070 to 1 150
xl.	X01Cr24Ni22Mo4 CuNW		1 150 to 1 200
xli.	X01Cr24Ni22Mo7 CuN		1 150 to 1 200
xlii.	X02Cr25Ni18Mn6 Mo4N		1 120 to 1 170
xliii.	X01Ni25Cr20Mo5 Cu		1 050 to 1 150
xliv.	X01Ni25Cr20Mo7 CuN		1 120 to 1 180
xlv.	X01Ni31Cr27Mo4 Cu		1 050 to 1 150

[a] Temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.

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

[c] Solution annealing 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 IS 10461 (Part 2) are obtained.

[d] Lower end of the range specified for solution annealing should be aimed at the heat treatment as part of further processing, because otherwise the mechanical properties might be affected.

[e] Cooling sufficiently rapidly in order to avoid the occurrence of intergranular corrosion as defined in IS 10461 (Part 2).

Austenitic-ferritic Steels

Sl No.	Steel Designation	Heat Treatment Symbols	Solution Annealing	
			Temperature[b,c] ^{0}C	Type of Cooling
(1)	(2)	(3)	(4)	(5)
i.	X02Cr22Ni2N	+AT	980 to 1100	water, air[d]
ii.	X02Cr21Mn5Ni1N[f]		1020 to 1080	water, air[d]
iii.	X02Cr23Ni4N		950 to 1050	water, air
iv.	X02Cr22Ni5Mo3N		1020 to 1100	water, air[d]
v.	X02Cr21Mn5Ni3MoN		950 to 1050	water, air
vi.	X02Cr24Ni4Mn3MoCuN24		1000 to 1150	water, air
vii.	X03Cr27Ni5Mo2N		1020 to 1100	water, air[d]
viii.	X02Cr25Ni6Mo3CuN		1040 to 1120	water
ix.	X02Cr25Ni7Mo4N		1040 to 1120	water
x.	X02Cr25Ni7Mo4CuWN		1040 to 1120	water

[a] Temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.

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

[c] Solution annealing 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 IS 10461 (Part 2) are obtained.

[d] Cooling sufficiently rapidly in order to avoid precipitation.

Ferritic Steels

Sl No.	Steel Designation	HeatTreatment Symbols*	Solution Annealing	
			Temperature[a,b] ^{0}C	Type of Cooling
(1)	(2)	(3)	(4)	(5)
i.	X04Cr13	+A	750 to 800	air
ii.	X02CrNi12		680 to 740	
iii.	X04Cr12		750 to 800	
iv.	X04Cr17		750 to 850	

v.	X05Cr17S		750 to 850	
vi.	X03Cr17Nb		750 to 850	
vii.	X04Cr17Mo1		750 to 850	
viii.	X02Cr18TiNb		750 to 850	
ix.	X15Cr26N		800 to 900	
x.	X02Cr18Mo2TiS		1 000 to 1 050	
xi.	X04Cr12Nb		750 to 850	

[a] Temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.

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

Martensitic Steels

Sl No.	**Steel Designation**	**Heat Treatment Symbols**	**Annealing**	
			Temperature[a,b] ^{0}C	**Type of Cooling**
(1)	(2)	(3)	(4)	(5)
i.	X12Cr12	+A	745 to 825	air
ii.	X12Cr13S		745 to 825	air
iii.	X20Cr13		745 to 825	furnace, air
iv.	X30Cr13		745 to 825	furnace, air
v.	X46Cr13		750 to 850	furnace, air
vi.	X17Cr16Ni2	+A[c]	680 to 800	furnace, air
vii.	X14Cr17S	+A	750 to 850	furnace, air
viii.	X110Cr17		780 to 840	furnace, air
ix.	X50Cr15MoV		750 to 850	furnace, air
x.	X03Cr13Ni4Mo		600 to 650	furnace, air
xi.	X04Cr16Ni5Mo1		600 to 650	furnace, air
xii.	X39Cr17Mo1		750 to 850	furnace, air

[a] Temperatures of annealing shall be agreed for simulated heat-treated test pieces.

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

[c] Double annealing might be advisable.

Precipitation hardening steels

Sl No.	Steel Designation	Heat Treatment Symbols	Solution Annealing	
			Temperature[a,b] ^{0}C	Type of Cooling
(1)	(2)	(3)	(4)	(5)
i.	X05Cr16Ni4CuNb	+AT[c]	1 030 to 1 050	oil, air
ii.	X07Cr17Ni7Al	+AT	1 060 to 1 080	water, air

[a] Temperatures of solution annealing shall be agreed for simulated heat-treated test pieces.

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

[c] Not suitable for direct application, prompt precipitation hardening after solution annealing is recommended to avoid cracking.

Annex C

(*Foreword*)

Table 9 — Designations of the steels given in Table 1 and of comparable grades covered in ASTM, ISO, EN, JIS and GB Standards

SL. No.	Steel designations according to[a]											
	ISO number	Steel Designation in IS	Numerical Symbol	Line	ASTM A959/ UNS[b]		EN 10088-1:2005 Number[c]		JIS[d]		GB/T20878/ ISC[e]	
						I/N/W[f]		I/N/W[f]		I/N/W[f]		I/N/W[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	a) Austenitic steels											
1)	4310-301-00-I	X15Cr18Ni8	301	AP26L	S30100	W	1.4310	N	—	—	S30110	W
2)	4307-304-03-I	X02Cr19Ni10	304L	AP27B	S30403	W	1.4307	N	SUS304L	W	S30403	W
3)	4305-303-00-I	X10Cr18Ni9S	303	AP27M	S30300	W	1.4305	W	SUS303	W	S30317	W
4)	4311-304-53-I	X02Cr18Ni9N	304LN	AP27A	S30453	W	1.4311	N	SUS304LN	W	S30453	W
5)	4567-304-30-I	X03Cr18Ni9Cu4	304Cu	AP27F	S30430	W	(1.4567)	N	SUSXM7	W	S30488	W
6)	4570-303-31-I	X06Cr18Ni9Cu2S	303Cu	AP27I	S30331	I	1.4570	N	—	—	—	—
7)	4315-304-51-I	X05Cr19Ni9N	304N	AP28F	S30451	N	1.4315	W	SUS304N1 SUS304N2	I N	S30458	W
8)	4301-304-00-I	X04Cr19Ni9	304	AP28E	S30400	W	1.4301	I	SUS304	W	S30408	W
9)	4541-321-00-I	X04Cr18Ni10Ti	321	AP28G	S32100	W	1.4541	I	SUS321	W	S32168	W
10)	4550-347-00-I	X06Cr18Ni10Nb	347	AP28H	S34700	I	1.4550	N	SUS347	W	S34778	N
11)	4306-304-03-I	X02Cr19Ni11	304LNi	AP30A	S30403	W	1.4306	N	SUS304L	W	S30403	N

SL. No.	Steel designations according to[a]											
	ISO number	Steel Designation in IS	Numerical Symbol	Line	ASTM A959/ UNS[b]		EN 10088-1:2005 Number[c]		JIS[d]		GB/T20878/ ISCe	
						I/N/W[f]		I/N/W[f]		I/N/W[f]		I/N/W[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
12)	4303-305-00-I	X06Cr18Ni12	305	AP30I	S30500	W	1.4303	N	SUS305	W	S30510	W
13)	4835-308-15-U	X07Cr21Ni11SiNCe	308	AP32N	S30815	I	1.4835	N	—	—	—	—
14)	4597-204-76-I	X08Cr17Mn8Cu3	204Cu	AP25L	—	—	1.4597	N	—	—	—	—
15)	4615-201-75-E	X03Cr15Mn8 Ni5Cu3	201Cu	AP28C	—	—	(1.4615)	I	—	—	—	—
16)	4373-202-00-I	X12Cr18Mn9Ni5N	202	AP32O	S20200	W	1.4373	N	SUS202	W	S35450	N
17)	4369-202-91-I	X11Cr19Ni8Mn6N	202S1	AP33L	—	—	1.4369	I	—	—	—	—
18)	4833-309-08-I	X18Cr23Ni13	309	AP36R	S30908	W	1.4833	N	SUH309	W	S30908	W
19)	4335-310-02-I	X01Cr25Ni21	310L	AP46A	S31002	W	1.4335	I	—	—	—	—
20)	4845-310-08-E	X01Cr25Ni20	310LN	AP46L	S31008	W	1.4845	I	SUS310S	W	S31008	N
21)	4404-316-03-I	X02Cr17Ni12Mo2	—	AM31A	S31603	W	1.4404	N	SUS316L	W	S31603	N
22)	4401-316-00-I	X05Cr17Ni12Mo2	—	AM31I	S31600	W	1.4401	N	SUS316	W	S31608	N
23)	4571-316-35-I	X06Cr17Ni12Mo2Ti	—	AM31F	S31635	W	1.4571	N	SUS316Ti	W	S31668	W
24)	4432-316-03-I	X02Cr17Ni12Mo3	—	AM32A	S31603	W	1.4432	I	SUS316L	W	S31603	W
25)	4436-316-00-I	X03Cr17Ni12Mo3	—	AM32F	S31600	W	1.4436	I	SUS316	W	S31608	W

SL. No.	Steel designations according to[a]											
	ISO number	Steel Designation in IS	Numerical Symbol	Line	ASTM A959/ UNS[b]		EN 10088-1:2005 Number[c]		JIS[d]		GB/T20878/ ISC[e]	
						I/N/W[f]		I/N/W[f]		I/N/W[f]		I/N/W[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
26)	4429-316-53-I	X02Cr17Ni12Mo3	—	AM32B	S31653	W	1.4429	N	SUS316LN	W	S31653	N
27)	4435-316-91-I	X02Cr18Ni14Mo3	316LNi	AM35A	—	—	1.4435	N	SUS316L	W	S31603	W
28)	4434-317-53-I	X02Cr18Ni12Mo3N	—	AM34B	S31753	W	1.4434	N	SUS317LN	W	S31753	W
29)	4439-317-26-E	X02Cr17Ni13Mo5N	—	AM35B	S31726	N	1.4439	I	—	—	S31723	W
30)	4547-312-54-I	X01Cr20Ni18Mo7CuN	—	AM45A	S31254	W	1.4547	N	SUS312L	W	S31252	N
31)	4466- 310-50-E	X01Cr25Ni22Mo2	—	AM49A	S31050	W	1.4466	I	—	—	S31053	W
32)	4659-312-66-I	X01Cr24Ni22Mo6CuNW	—	AM52B	S31266	W	1.4659	I	—	—	—	—
33)	4652-326-54-I	X01Cr24Ni22Mo8CuN	—	AM54A	S32654	N	1.4652	I	—	—	S32652	N
34)	4565-345-65-I	X02Cr25Ni18Mn6 Mo5N	—	AM54B	S34565	W	1.4565	I	—	—	S34553	N
35)	4539-089-04-I	X01Ni25Cr20Mo5Cu	904L	AN50A	N08904	W	1.4539	N	SUS890L	W	S39042	N
36)	4529-089-26-I	X01Ni25Cr20Mo7CuN	904LN	AN52A	N08926	W	1.4529	N	—	—	—	—
37)	4563-080-28-I	X01Ni31Cr27Mo4Cu	—	AN62A	N08028	W	1.4563	I	—	—	—	—
b) Austenitic-ferritic (duplex) steels												
38)	4062-322-02-U	X02Cr22Ni2N	—	DP24A	S32202	N	1.4062	I	—	—	—	—
39)	4162-321-01-E	X02Cr21Mn5Ni1N	2101	DP27F	S32101	N	1.4162	I	—	—	—	—

SL. No.	Steel designations according to[a]											
	ISO number	Steel Designation in IS	Numerical Symbol	Line	ASTM A959/ UNS[b]		EN 10088-1:2005 Number[c]		JIS[d]		GB/T20878/ ISCe	
						I/N/W[f]		I/N/W[f]		I/N/W[f]		I/N/W[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
40)	4362-323-04-I	X02Cr23Ni4N	2304	DP27B	S32304	W	1.4362	I	—	—	S23043	W
41)	4462-318-03-I	X02Cr22Ni5Mo3N	2205	DM30A	S32205	N	1.4462	I	SUS329J3L	W	S22053	N
42)	4462-824-41-X	X02Cr24Ni4Mn3Mo2CuN	2441	DM33A	—	—	1.4462	I	—	—	—	—
43)	4460-312-00-I	X03Cr27Ni5Mo2N	—	DM34F	S31200	W	1.4460	I	—	—	S22553	W
44)	4507-325-20-I	X02Cr25Ni6Mo3CuN	—	DM34A	S32520	W	1.4507	I	—	—	S25554	—
45)	4410-327-50-E	X02Cr25Ni7Mo4N	2507	DM36A	S32750	W	1.4410	I	—	—	S25073	W
46)	4501-327-60-I	X02Cr25Ni7 Mo4CuWN	2760	DM36B	S32760	I	1.4501	N	—	—	S27603	N
47)	4658-327-07-U	X02Cr28Ni8Mo5 Co1N	—	DM42A	S32707	I	1.4658	I	—	—	—	—
c) Ferritic steels												
48)	4000-410-08-I	X06Cr13	—	FP13G	S41008	W	1.4000	N	SUS410S	N	S41008	N
49)	4016-430-00-I	X06Cr17	—	FP17I	S43000	W	1.4016	I	SUS430	W	S11710	W
50)	4004-430-20-I	X07CrS17	—	FP17L	S43020	W	(1.4004)	I	SUS430F	W	S11717	W
51)	4511-430-71-I	X03Cr17Nb	430Nb	FP17G	—	—	1.4511	N	SUS430LX	W	—	—
52)	4749-446-00-I	X15Cr26N	446	FP26R	S44600	W	1.4749	W	SUH446	W	S12550	W
53)	4509-439-40-X	X02Cr18TiNb	439	FP18B	S43940	I	1.4509	N	SUS430LX	W	S11873	I

SL. No.	Steel designations according to[a]											
	ISO number	Steel Designation in IS	Numerical Symbol	Line	ASTM A959/ UNS[b]		EN 10088-1:2005 Number[c]		JIS[d]		GB/T20878/ ISCe	
						I/N/W[f]		I/N/W[f]		I/N/W[f]		I/N/W[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
54)	4113-434-00-I	X06Cr17Mo1	—	FM18I	S43400	W	1.4113	N	SUS434	W	S11790	W
55)	4523-182-35-I	X02Cr18Mo2TiS	—	FM20C	S18235	W	1.4523	I	—	—	—	—
d) Martensitic steels												
56)	4006-410-00-I	X12Cr13	410	MP13B	S41000	W	1.4006	I	SUS410	W	S41010	W
57)	4005-416-00-I	X12Cr13S	416	MP13C	S41600	W	1.4005	N	SUS416	W	S41617	N
58)	4021-420-00-I	X20Cr13	420	MP13I	S42000	W	1.4021	I	SUS420J1	N	S42020	N
59)	4028-420-00-I	X30Cr13	420B	MP13M	S42000	W	1.4028	I	SUS420J2	W	S42030	N
60)	4034-420-00-I	X46Cr13	420C									
61)	4057-431-00-X	X17Cr16Ni2	430	MP16G	S43100	W	1.4057	I	SUS431	W	S43120	I
62)	4019-430-20-I	X14Cr17S	430F	MP17F	S43020	W	1.4019	I	-	-	S11717	W
63)	4023-440-04-I	X110Cr17	440C	MP17W	S44004	W	1.4125	I	SUS440C	N	S44096	N
64)	4313-415-00-I	X3Cr13Ni4Mo	415	MM14A	S41500	W	1.4313	N	SUSF6NM	W	S41595	W
65)	4116-420-77-E	X50Cr15MoV	420V	MM15U	—	—	1.4116	I	—	—	—	—

SL. No.	Steel designations according to[a]											
	ISO number	Steel Designation in IS	Numerical Symbol	Line	ASTM A959/ UNS[b]		EN 10088-1:2005 Number[c]		JIS[d]		GB/T20878/ ISC[e]	
						I/N/W[f]		I/N/W[f]		I/N/W[f]		I/N/W[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
66)	4122-434-09-I	X39Cr17Mo1	434C	MM18R	—	—	1.4122	I	—	—	—	—
e) Precipitation-hardening steels												
67)	4542-174-00-I	X05Cr16Ni4CuNb	630	PP20I	S17400	W	1.4542	N	SUS630	W	S51740	W
68)	4568-177-00-I	X07Cr17Ni7Al	—	PP24L	S17700	N	1.4568	N	SUS631	W	S51770	N

NOTE The grades given in this table are comparable to those given in Table 1. However to compare similar grades it is necessary to check each element before making a substitution.

[a] See the sources in the Bibliography.

[b] US steel listed in ASTM A959 and in UNS; if the steel number is given in brackets, then the steel has only a UNS number.

[c] European steel listed in EN 10088-1 : 2005 and in the “Stahl-Eisen-Liste”; if the steel number is given in brackets, then the steel is only listed in the “Stahl-Eisen-Liste”.

[d] Japanese Industrial Standard.

[e] Chinese steel of ISC number listed in GB/T20878.

I = identical steel to ISO steel grade; N = steel grade with closer match of composition, but not identical; W = wider match.