भारतीय मानक

Indian Standard

IS 6603 : 2024

(*Superseding IS 6527 : 1995*)

स्टेनलेस इस्पात अर्ध-तैयार उत्पाद, छड़े, तार की रॉड और चमकीले की छड़े — विशिष्टि

(दूसरा पुनरीक्षण)

Stainless Steel Semi-Finished Products, Bars, Wire Rods and Bright Bars — Specification

(Second Revision)

ICS 77.140.20

भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

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Alloy Steels and Forgings Sectional Committee, MTD 16

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wrought Steel Products Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1972 and subsequently revised in 2001. 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. This revision of IS 6603 supersedes IS 6603 : 2001 'STAINLESS STEEL BARS AND FLATS' and replaces IS 6527 : 1995 'STAINLESS STEEL WIRE ROD'. IS 6527 : 1995 shall stand withdrawn subsequently.

While revising this standard assistance has been derived from ISO 16143 (Part 2) : 2014 'Corrosion-resistant semi-finished products, bars, rods and sections' and bright products and ISO 16143 (Part 4) : 2023 'Stainless steels for general purposes — Part 4: Bright products'.

In this revision, following significant changes have been made to:

a) Scope is modified to include various forms of hot formed and cold finished products;

b) Conditions of material on delivery is aligned with existing industry practices;

c) New grades are added. Grades X07Cr18Ni9 and X10Cr17Mn6Ni4N are removed. Grades X07Cr17, X12Cr12, X15Cr16Ni2 and X108Cr17Mo are redesigned as X04Cr17, X12Cr13, X17Cr16Ni2 and X110Cr17 respectively;

d) Dimensional tolerances is mentioned for special finishes for nominal sizes up to 3 150 mm for hot finished or cold finished bars;

e) Criteria for freedom of defects is modified; and

f) For purpose of guidance, comparison of grades with other standards on the subject is given at Annex B.

The composition of the Committee responsible for the formulation of this standard is given in Annex E.

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 SEMI-FINISHED PRODUCTS, BARS, WIRE RODS AND BRIGHT BARS — SPECIFICATION

(Second Revision)

1 SCOPE

This standard specifies the technical delivery conditions for semi-finished products, hot or cold formed bars, wire rods and bright bars of various grades of corrosion resisting stainless steels for general purposes.

2 REFERENCES

The standards listed in Annex D 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 these standards.

3 TERMINOLOGY

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

3.1 Semi-finished Product — The product obtained by continuous casting or cutting of ingots and followed by rolling/forging and intended for conversion into long products by hot rolling/forging.

4 SUPPLY OF MATERIAL

4.1 General requirements for the supply of material shall be in accordance with IS 8910.

4.2 Steels covered by this standard shall be ordered and delivered on any one of the following basis:

a) Chemical composition;

b) Chemical composition and hardness in the heat-treated condition;

c) Chemical composition and mechanical properties in the heat-treated or cold-drawn condition; and

d) Chemical composition and mechanical properties in any other condition as agreed between the purchaser and the supplier.

4.3 Information to be given by the purchaser.

4.3.1 *Basis for Order*

While placing an ordering for the purchase of stainless steel bars, flats, bright bars covered by this standard, the purchaser should specify the following:

a) Type of steel;

b) Description regarding size, shape, length etc;

c) Condition of delivery;

d) Tests required;

e) Methods of manufacture:

f) Any special requirements; and

g) Test report, if required.

5 MANUFACTURE

5.1 Unless agreed otherwise in 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.

5.1.1 Steels used for manufacturing the product covered in the standard shall conform to the requirements of IS 14650.

5.2 In case of bars and flats rolled/forged from ingots, adequate top and bottom discards shall be given to eliminate pipe, harmful segregations and other injurious defects.

5.3 Bars and flats when made from continuously cast blooms/slabs shall be given adequate reduction to ensure internal soundness.

5.4 For bars for machining, surface defects up to 80 percent of machining allowance shall be permitted. For hot finished bars and flats, all visible surface defects shall be removed by grinding provided the maximum depth of grinding at any one point does not exceed 10 percent of the thickness provided the underweight tolerance is not exceeded.

6 FREEDOM FROM DEFECTS

6.1 Surface Quality

The available surface finishes are given in Table 1. The requirements concerning the maximum depth of acceptable discontinuities for bars, rods and sections in the relevant conditions are given in Table 2.

6.2 Internal Soundness

For internal soundness, where appropriate, any requirements, together with the conditions for their verification, can be agreed upon at the time of enquiry and order.

7 CHEMICAL COMPOSITION

7.1 Ladle Analysis

The ladle analysis of steel shall be as given in Table 3. The ladle analysis of steel, when carried out either by the methods specified in relevant parts of IS 228 or any other established international instrumental/chemical method. In case of any dispute, the procedure given in relevant parts of IS 228 shall be the referee method.

7.2 Product Analysis

Permissible variation in case of product analysis from the limits specified in Table 3 shall be as given in Table 4.

8 HEAT TREATMENT

8.1 Steels may be supplied in the solution annealed, hardened and tempered, or softened condition.

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

9 MECHANICAL PROPERTIES

9.1 The machanical properties for steels supplied in various conditions shall confirm to those given in Table 5 to Table 9 for semi-finished/hot formed steels and Table 15 to Table 19 for cold formed steels. The tensile test shall be carried out in accordance with IS 1608 (Part 1).

9.2 The tensile properties at elevated temperature mentioned in Table 10 to Table 14 are for the purpose of guidance only. The tensile test shall be carried out in accordance with IS 1608 (Part 2).

9.3 Hardness shall be determined in accordance with IS 1500 (Part 1), IS 1501 (Part 1) or IS 1586 (Part 1).

9.4 If required by agreement between the purchaser and the supplier Charpy impact test shall be carried out in accordance with IS 1757 (Part 1).

9.5 Mechanical properties for grades/sizes other than that mentioned in Table 5 to Table 9 or Table 15 to Table 19 shall be mutually agreed to between the purchaser and the supplier.

9.6 Any tests, other than those specified in this standard may be conducted subjected to mutual agreement between the purchaser and the supplier.

10 SAMPLING

10.1 For product analysis, the selection of samples shall be carried out in accordance with IS 3711.

10.2 Sampling for Mechanical Tests

10.2.1 Unless otherwise specified, for the purpose of mechanical tests, one sample shall be tested from each cast and heat treatment, cold-drawn or cold-rolled batch of the same thickness.

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

10.2.3 Test pieces for mechanical tests shall be taken in the longitudinal direction of the product in accordance with Fig. 1 or Fig. 2.

10.2.4 General conditions for selection and preparation of samples and test pieces shall be in accordance with IS 3711.

11 CONDITIONS OF SUPPLY

Bars and flats may be supplied either hot finished or cold finished in any one of the following conditions:

a) Hot finished/hot formed;
b) Cold finished/cold formed;
c) Soft annealed;
d) Annealed;
e) Solution annealed;
f) Hardened and tempered;
g) Polished;
h) Turned;
j) Ground; and
k) Turned and ground.

12 DIMENSIONAL TOLERANCES

Unless otherwise agreed, dimensional tolerances for the bars and flats shall be as laid down in Table 26 to Table 36 given at Annex C.

13 RETESTS

13.1 Retests for Product Analysis

If the results of the product analysis do not conform to the requirements given in Table 3 and Table 4, 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.

13.2 Retests for Mechanical Properties

Should any of the original test pieces fail to satisfy that requirement of the mechanical properties specified in the Table 5 to Table 9 or Table 15 to Table 19, 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.

14 CORROSION RESISTANCE

If required by the purchaser, the material shall be tested for corrosion resistance as per IS 10461 (Part 1) or ISO 3651 (Part 2) or any other method as agreed to between the manufacturer and the purchaser.

15 MARKING AND PACKING

15.1 Unless agreed otherwise, the material shall be identified as follows:

a) Each bar and flat over 50 mm in diameter or width across flats shall be legibly stamped/stencilled/adhesive labels attached with cast number and the type of steel;

b) Bars and flats up to and including 50 mm in diameter or width across flats shall be bundled together and a tag attached bearing the cast number and the type of steel; and

c) Each coil of wire rod shall be legibly marked or tagged with manufacturer's name/trade mark, cast number and designation of steel.

15.2 Packing

Material with suitable packing shall be provided by the manufacturer/supplier to prevent damages/ deterioration in quality during storage, handling and transport. The exact method of packing and weight of the consignment shall be mutually agreed between the purchaser and the supplier.

15.3 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.

Table 1 Types of Process Routes and Surface Finish of Long Products[a)]

(*Clause* 6.1)

Sl No.	Condition	Abbreviation[b)]	Type of Process Route	Surface Finish	Product Form			Notes
					Rods	Bars, Sections	Semi Finished	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Hot formed	1U	Hot formed, not heat treated, not descaled	Covered with scale (spot ground if necessary)	X	X	X	Suitable for products to be further hot formed. For semi-finished products, ground on all sides can be specified.
		1C	Hot formed, heat treated[c)], not descaled	Covered with scale (spot ground if necessary)	X	X	X	Suitable for products to be further processed (hot or cold). For semi-finished products, ground on all sides can be specified.
		1E	Hot formed, heat treated[c)], mechanically descaled	Largely free of scale (but some black spots might remain). Not free of surface imperfections.	X	X	X	The type of mechanical descaling[f,] for example, grinding, peeling, or shot blasting, is left to the manufacturer's discretion unless otherwise specified/agreed. Suitable for products to be further processed.
		1D	Hot formed, heat treated[c)], pickled	Free of scale (spot ground if necessary). Not free of surface imperfections.	X	X	—	Tolerance ≥ IT 14[d),e)] *See* Table C 11
		1X	Hot formed, heat treated[c)], rough machined[g] (rough turned)	Metallically clean	—	X	—	Tolerance ≥ IT 12[d),e)] *See* Table C 11
ii)	Special finishing process	1G	Centreless ground	Appearance bright, but not uniform, free of surface defects type and degree of grinding to be agreed	X	X	—	Surface roughness can be specified. Normally obtained from material in finishes 1E, 1D, 2H, or 2B. Tolerance ≤ IT 8[d),e)] *See* Table C 11

Table 1 (*Continued*)

Sl No.	Condition	Abbreviation[b)]	Type of Process Route	Surface Finish	Product Form			Notes
					Rods	Bars, Sections	Semi Finished	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		1P	Polished	Smoother and brighter than finish 1G or 2G; type and degree of polishing to be agreed	—	X	—	Surface roughness can be specified. Normally obtained from material in finishes 1E, 1D, 2B, 1G, or 2H. Tolerance ≤ IT 11[d),e)] *See* Table C 11
iii)	Cold processed	2H	Finishes 1E, 1D or 1X, cold processed[j)], coated (optional).	Smooth and matt or bright. Not necessarily polished. Not free of surface imperfections[i)].	—	X	X	In products formed by cold drawing without subsequent heat treatment, the tensile strength is substantially increased, particularly in austenitic materials, depending on the degree of cold processing. The surface hardness may be higher than the center hardness.
		2D	Finish 2H, heat treated[e)], pickled and skin-passed (optional), coated (optional).	Smooth and matt or bright. Not free of surface imperfections[i)].	—	X	X	This finish allows the restoration of the mechanical properties after cold processing similar to that of 1D. For, products with good ductility (extrusion) and specific magnetic properties.
		2B	Finishes 1E, 1D or 1X, cold processed[j)], mechanically smoothed[k)].	Smooth, uniform and bright. Free of surface imperfections.	—	—	X	Products used in their present condition or intended for better finishing. In products formed by cold drawing without subsequent heat treatment, the tensile strength is substantially increased, particularly in austenitic materials, depending on the degree of cold processing. The surface hardness may be higher than the center hardness.
		2G	Finishes 2H, 2D or 2B, entreless ground, mechanically smoothed (optional)[l)].	Smooth, uniform and bright. Free of surface defects.	—	—	X	Finish for close tolerances. Unless otherwise agreed the surface roughness shall be Ra ≤ 1.2

Table 1 (*Concluded*)

Sl No.	Condition	Abbreviation[b)]	Type of Process Route	Surface Finish	Product Form			Notes
					Rods	Bars, Sections	Semi Finished	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		2P	Finishes 2H, 2D, 2B or 2G, specular polishing[l)].	Smoother and brighter than finish 2B or 2G. Free of surface defects.	—	—	X	Products showing a well groomed surface appearance. Surface roughness shall be specified at the time of enquiry and order.

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

[b)] First digit: 1 = hot formed, 2 = cold processed.

[c)] On ferritic, austenitic, and austenitic-ferritic grades, the heat treatment can be omitted if the conditions for hot forming and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to inter granular corrosion are obtained.

[d)] For information: IT = international tolerance, as defined in IS 919 (Part 1) and in other dimensional tolerance standards.

[e)] Specific tolerance within the ranges shall be agreed upon at the time of enquiry and order.

[f)] Type of mechanical descaling (shot blasting, grinding, peeling) is left to the manufacturer's discretion unless otherwise agreed.

[g)] Type of rough machining (grinding, peeling) is left to the manufacturer's discretion unless otherwise agreed.

[h)] Type of finish is left to the manufacturer's discretion unless otherwise agreed.

[i)] Unless otherwise agreed at the time of order.

[j)] Type of cold processing (cold drawing, turning, grinding, abrading ...) is left to the manufacturer's discretion unless otherwise agreed.

[k)] Type of mechanical polishing (burnishing, abrading) is left to the manufacturer's discretion unless otherwise agreed.

[l)] Type of specular polishing (electro-polishing, felting, buffing ...) is left to the manufacturer's discretion unless otherwise agreed.

Table 2 Maximum Depth of Acceptable Discontinuities for Bars, Rods and Sections
(*Clause* 6.1)

Sl No.	Conditions	Product Forms	Permissible Depth of Discontinuities[a)]	Maximum Percentage of Delivered Weight in Excess of Permissible Depth of Discontinuities
(1)	(2)	(3)	(4)	(5)
i)	1U 1C-1U 1E-1C 1D-IC	Rounds and rod	0.50 mm, *Max* for 5 mm ≤ d ≤ 35 mm 0.015 d, *Max* for 35 mm < d ≤ 200 mm	2 %
ii)	1X[b)], 2H[b)], 2D[b)]	Rounds	0.2 mm, *Max* for d ≤ 20 mm 0.01 d, *Max* for 20 mm < d ≤ 75 mm 0.75 mm, *Max* for d > 75 mm	1 %
		Hexagons	0.3 mm, *Max* for d ≤ 15 mm 0.02 d, *Max* or 15 mm < d ≤ 63 mm	2 %
		Other bars	0.3 mm, *Max* for d ≤ 15 mm 0.02 d, *Max* for 15 mm < d ≤ 63 mm	4 %
iii)	1G, 2B, 2G, 2P	Rounds	Technically defect free by manufacture	0.2 %

[a)] Depth of discontinuities is understood as being the distance, measured normally to the surface, between the bottom of the discontinuities and that surface.

[b)] At the time of enquiry and order, it can be agreed that the product shall be delivered with a surface that is technically defect free by manufacture. In this case, also the maximum percent of delivered weight in excess of permissible depth of discontinuities shall be agreed.

Table 3 Chemical Composition (Ladle Analysis)

(*Clauses* 7.1, 7.2, 13.1, *and Table* 4)

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)
Austenitic steels												
i)	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	–
ii)	X02Cr19Ni10	304L	0.030	1.00	2.00	0.045	0.030	17.0 to 20.0	–	8.0 to 12.0[b]	0.10	–
iii)	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[c]
iv)	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	–
v)	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
vi)	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
vii)	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]
viii)	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	–
ix)	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
x)	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
xi)	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	–
xii)	X04Cr18Ni12	305	0.08	1.00	2.00	0.045	0.030	17.0 to 19.0	–	10.5 to 13.0	0.10	–
xiii)	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
xiv)	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
xv)	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	–
xvi)	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	–
xvii)	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	–
xviii)	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	–

Table 3 (*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)
xix)	X12Cr25Ni20	310	0.25	1.50	2.00	0.045	0.030	24.0 to 26.0	–	19.0 to 22	–	–
xx)	X04Cr25Ni20	310S	0.08	1.50	2.00	0.045	0.030	24.0 to 26.0	–	19.0 to 22	–	–
xxi)	X15Cr25Ni21Si	314	0.25	1.5 to 3.0	2.00	0.045	0.030	23.0 to 26.0	–	19.0 to 22	–	–
xxii)	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	–
xxiii)	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	–
xxiv)	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 × C to 0.80
xxv)	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	–
xxvi)	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	–
xxvii)	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	–
xxviii)	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	–
xxix)	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	–
xxx)	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	–
xxxi)	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	–
xxxii)	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
xxxiii)	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	–
xxxiv)	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
xxxv)	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
xxxvi)	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
xxxvii)	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
xxxviii)	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

Table 3 (*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)
xxxix)	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
xl)	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	–
xli)	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
xlii)	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
xliii)	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	–
xliv)	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
xlv)	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	–
xlvi)	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
xlvii)	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	–
xlviii)	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
xlix)	X02Cr28Ni8Mo5CoN[g)]		0.030	0.50	1.50	0.035	0.010	26.0 to 29.0	4.0 to 5.0	5.5 to 9.5	0.30 to 0.50	Cu: 1.00 Co: 0.50 to 2.00
Ferritic steels												
l)	X04Cr12Nb	409Nb	0.08	1.00	0.80	0.04	0.03	10.5 to 13.5	0.50	0.60	–	Nb: 10 × C - 0.75 Cu: 0.75 *Max*
li)	X04Cr12	410S	0.08[e)]	1.00	1.00	0.040	0.030[b)]	11.5 to 14.0	–	0.75	–	–
lii)	X04Cr17	430	0.08[e)]	1.00	1.00	0.040	0.030	16.0 to 18.0	–	–	–	–
liii)	X05Cr17S	430F	0.09	1.50	1.50	0.040	≥ 0.15	16.0 to 18.0	0.60	–	–	–
liv)	X03Cr17Nb	430Nb	0.05	1.00	1.00	0.040	0.015	16.0 to 18.0	–	–	–	Nb: 12 × C to 1.00

Table 3 (*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)
lv)	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
lvi)	X04Cr17Mo1	434	0.08	1.00	1.00	0.040	0.030	16.0 to 18.0	0.90 to 1.40	–	–	–
lvii)	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
Martensitic steels												
lviii)	X12Cr13/X12Cr12	410	0.08 to 0.15	1.00	1.50	0.040	0.030	11.5 to 13.5	–	0.75	–	–
lix)	X12Cr13S	416	0.08 to 0.15	1.00	1.50	0.040	≥ 0.15	12.0 to 14.0	0.60	–	–	–
lx)	X20Cr13	420	0.16 to 0.25	1.00	1.50	0.040	0.030	12.0 to 14.0	–	–	–	–
lxi)	X30Cr13	420B	0.26 to 0.35	1.00	1.50	0.040	0.030	12.0 to 14.0	–	–	–	–
lxii)	X40Cr13	420C	0.43 to 0.50	1.00	1.50	0.040	0.030	12.5 to 14.5	–	–	–	–
lxiii)	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	–	–
lxiv)	X14Cr17S	430F	0.10 to 0.17	1.00	1.50	0.040	≥ 0.15	16.0 to 18.0	0.60	—	–	–
lxv)	X110Cr17	440C	0.95 to1.20	1.00	1.00	0.040	0.030	16.0 to 18.0	0.75	0.60	–	–
lxvi)	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
lxvii)	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	–	–
lxviii)	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	–
lxix)	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	–	–

Table 3 (*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)
Precipitation-hardening steels												
lxx)	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
lxxi)	X07Cr17Ni7Al		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

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.

[a] Maximum values unless indicated otherwise.

[b] Where, for special reasons (for example 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:

1) by 0.50 percent for steels X02Cr19Ni10, X04Cr19Ni9, and X04Cr17Ni12Mo2Ti;
2) by 1.00 percent for steels X04Cr18Ni10Ti, X04Cr18Ni10Nb, X02Cr19Ni11, X04Cr17Ni12Mo2, X03Cr17Ni12Mo3, X02Cr17Ni12Mo2N and X02Cr18Ni12Mo3; and
3) by 1.50 percent for steels X02Cr17Ni12Mo2 and X02Cr17Ni12Mo3.

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

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

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

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

[g] Patented steel grade.

Table 4 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.

Table 5 Mechanical Properties at Room Temperature of Solution Annealed Austenitic Steels and Resistance to Inter Granular Corrosion in Conditions 1C, 1E, 1D, 1X, 1G and 2D

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness[i], *t* or Diameter, *d*	Proof Strength[a]		Tensile Strength	Elongation After Fracture[a]		Impact Energy (ISO-V)		Resistance to Inter-Granular Corrosion[b]	
				Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	A Percent *Min*		KV_2 J *Min*		in the Delivery Condition	in the Sensitized Condition[c]
	Grade	Numerical Symbol	mm	*Min*	*Min*		Long.[j]	Tr.[j]	Long.[j]	Tr.[j]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Austenitic steels												
i)	X15Cr18Ni8	301	[g]	–	–	500 to 700	–	–	–	–	no	no
ii)	X02Cr19Ni10	304L	≤160	180	220	480 to 680	40[e]	–	100	—	yes	yes
			160 < *t* ≤ 250				–	35	–	60		
iii)	X10Cr18Ni9S	303	≤ 160[d]	190	[h]	500 to 700	35[e]	–	–	–	no	no
iv)	X02Cr18Ni9N	304LN	160	270	310	550 to 750	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
v)	X03Cr18Ni9Cu4	304Cu	[g]	–	–	450 to 650	–	–	–	–	yes	yes
vi)	X06Cr18Ni9Cu2S	303Cu	≤ 160[d]	185	220	500 to 710	35[e]	–	–	–	no	no
vii)	X05Cr19Ni9N	304N	≤ 40	270	310	550 to 750	40	–	100	–	yes	no[f]
viii)	X04Cr19Ni9	304	≤ 160	200	240	510 to 710	40[e]	–	100	–	yes	no[f]
			160 < *t* ≤ 250				–	35	–	60		
ix)	X04Cr18Ni10Ti	321	≤ 160	200	240	510 to 710	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
x)	X04Cr18Ni10Nb	347	≤ 160	205	240	510 to 740	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		

Table 5 (*Continued*)

Sl No.	Steel Designation		Thickness[i], *t* or Diameter, *d*	Proof Strength[a]		Tensile Strength	Elongation After Fracture[a]		Impact Energy (ISO-V)		Resistance to Inter-Granular Corrosion[b]	
			mm	R_{p} 0.2 MPa	R_{p} 1.0 MPa	Rm MPa	A Percent *Min*		KV_2 J *Min*		in the Delivery Condition	in the Sensitized Condition[c]
	Grade	Numerical Symbol		*Min*	*Min*		Long.[j]	Tr.[j]	Long.[j]	Tr.[j]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xi)	X02Cr19Ni11	304LNi	≤160	180	220		40[e]	–	100	–		
			160 < *t* ≤ 250	–	–	480 to 680	–	35	–	60	yes	Yes
xii)	X04Cr18Ni12	305	≤160	190	225	480 to 680	45	–	100	–	yes	no[f]
			160 < *t* ≤ 250				–	35	–	60		
xiii)	X08Cr17Mn8Cu3N	204Cu	≤ 160[d]	270	305	560 to 760	40[e]	–	100	–	yes	no
xiv)	X03Cr15Mn8Ni5Cu3	201Cu	≤ 160	175	210	400 to 600	45	–	–	–	yes	yes
xv)	X12Cr18Mn9Ni5N	202	≤ 10[d]	350	380	700 to 900	35[e]	–	–	–	yes	no
xvi)	X11Cr19Ni8Mn6N	202S1	≤ 15[d]	340	370	750 to 950	≤ 160	–	–	–	yes	no
xvii)	X01Cr25Ni21	310L	[g]	–	–	470 to 670	–	–	–	–	yes	yes
xviii)	X12Cr25Ni20	310	≤ 160	210	250	500 to 700	35[e]					
xiv)	X04Cr25Ni20	310S	≤ 160	210	250	500 to 700	35[e]					
xv)	X15Cr25Ni21Si	314	≤ 160	230	270	550 to 750	30[e]					
xvi)	X02Cr17Ni12Mo2	316L	≤ 160	205	245	520 to 720	40	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
xvii)	X04Cr17Ni12Mo2	316	≤ 160	205	245	520 to 720	40[e]	–	100	–	yes	no[f]
			160 < *t* ≤ 250				–	30	–	60		

Table 5 (*Continued*)

Sl No.	Steel Designation		Thickness[i], *t* or Diameter, *d* mm	Proof Strength[a]		Tensile Strength	Elongation After Fracture[a]		Impact Energy (ISO-V)		Resistance to Inter-Granular Corrosion[b]	
				Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	A Percent *Min*		KV_2 J *Min*		in the Delivery Condition	in the Sensitized Condition[c]
	Grade	Numerical Symbol		*Min*	*Min*		Long.[j]	Tr.[j]	Long.[j]	Tr.[j]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xviii)	X04Cr17Ni12Mo2Ti	316Ti	≤160				40[e]	–	100	–		
			160 < *t* ≤ 250	205	245	520 to 720	–	30	–	60	yes	yes
xix)	X02Cr17Ni12Mo3		≤ 160	205	245	520 to 720	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
xx)	X03Cr17Ni12Mo3		≤ 160	205	245	520 to 720	40[e]	–	100	–	yes	no[f]
			160 < *t* ≤ 250				–	30	–	60		
xxi)	X02Cr17Ni12Mo2N	316LN	≤ 60	280	315	580 to 800	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
xxii)	X02Cr18Ni14Mo3	316LNi	≤ 160	200	235	500 to 700	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
xxiii)	X02Cr18Ni12Mo4N		[g]	–	–	540 to 740	–	–	–	–	yes	yes
xxiv)	X13Mn13Cr18N		All sizes	380	–	690	30	–	–	–	yes	yes
xxv)	X12Cr25Ni20		All sizes	205	–	515	40	–	–	–	yes	yes
xxvi)	X04Cr25Ni20		All sizes	205	–	515	40	–	–	–	yes	yes
xxvii)	X15Cr25Ni21Si		All sizes	205	–	515	40	–	–	–	yes	yes
xxviii)	X04Cr18Ni12Mo3	317	All sizes	205	–	515	40	–	–	–	yes	yes
xxix)	X02Cr17Ni13Mo4		≤ 160	280	315	580 to 800	35	–	100	—	yes	yes
			160 < *t* ≤ 250				–	30	—	60		
xxx)	X01Cr20Ni18Mo6CuN	312	≤ 160	300	340	650 to 850	35	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		

Table 5 (*Concluded*)

Sl No.	Steel Designation		Thickness[i], *t* or Diameter, *d*	Proof Strength[a]		Tensile Strength	Elongation After Fracture[a]		Impact Energy (ISO-V)		Resistance to Inter-Granular Corrosion[b]	
				R_{p} 0.2 MPa	R_{p} 1.0 MPa	Rm MPa	A Percent *Min*		KV_2 J *Min*		in the Delivery Condition	in the Sensitized Condition[c]
	Grade	Numerical Symbol	mm	*Min*	*Min*		Long.[j]	Tr.[j]	Long.[j]	Tr.[j]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xl)	X01Cr25Ni22Mo2		≤ 160	250	290	540 to 740	35[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
xli)	X01Cr24Ni22Mo4CuNW		≤ 60[d]	420	460	800 to 1 000	50[e]	–	90	–	yes	yes
xlii)	X01Cr24Ni22Mo7CuN	326	≤ 50[d]	430	470	750 to 1 050	40[e]	–	100	–	yes	yes
xliii)	X02Cr25Ni18Mn6Mo4N	345	≤ 160[d]	420	460	800 to 1 000	35[e]	–	100	–	yes	yes
xliv)	X01Ni25Cr20Mo5Cu	904L	≤ 160	220	260	530 to 730	35[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		
xlv)	X01Ni25Cr20Mo7CuN	904LN	≤ 160	300	340	650 to 850	40[e]	–	100	–	yes	yes
			160 < *t* ≤ 250				–	35	–	60		
xlvi)	X01Ni31Cr27Mo4Cu		≤ 160	220	259	500 to 750	35	–	100	–	yes	yes
			160 < *t* ≤ 250				–	30	–	60		

NOTE — 1 MPa = 1 N/mm^2.

[a] Elongation and proof strength are not valid for rod.

[b] When tested in accordance with ISO 3651 (Part 2).

[c] *See* note to 9.

[d] For larger thicknesses the values shall be agreed upon.

[e] The maximum HB value may be raised by 100 HB or the Tensile strength may be raised by 200 MPa and the minimum elongation value can be lowered to 20 p ercent for sections and bars ≤ 35 mm thickness having a final cold deformation and for hot formed section and bars of ≤ 8 mm thickness.

[f] Sensitization treatment of 15 min at 700 °C followed by cooling in air.

[g] For rod only.

[h] Maximum HB = 262. This value can be raised by 60 units or the maximum tensile strength value can be raised by 150 MPa and the minimum elongation be lowered to 10 percent for sections and bars ≤ 35 mm thickness having undergone final cold deformation.

[i] Width across flats for hexagons.

[j] Long.- Longitudinal, tr.- Transverse.

Table 6 Mechanical Properties at Room Temperature of Solution Annealed Austenitic-Ferritic Steels and Resistance to Intergranular Corrosion in Conditions 1C, 1E, 1D, 1X, 1G and 2D

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness[g], *t* or Diameter, *d*	Hardness[a]	0.2 Percent Proof Strength	Tensile Strength	Elongation After Fracture	Impact Energy (ISO-V)	Resistance to Inter-Granular Corrosion[d]	
	Grade	Numerical Symbol		HB	$Rp0.2^{b)}$	$R_m{}^{b)}$	$A^{b),c)}$	KV_2	in the Delivery Condition	in the Sensitized Condition[e]
			mm		MPa	MPa	Percent	J		
					Min	*Min*	*Min*	*Min*		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	X02Cr22Ni2N		≤ 160 [f]	290	380	650	30	40	yes	yes
ii)	X02Cr21Mn5Ni1N	2101	≤160 [f]	290	400	650	25	60	yes	yes
iii)	X02Cr23Ni4N	2304	≤160 [f]	260	400	600	25	100	yes	yes
iv)	X02Cr22Ni5Mo3N	2205	≤160 [f]	290	450	650	25	100	yes	yes
v)	X02Cr24Ni4Mn3MoCuN	2441	≤160 [f]	290	450	650	25	60	yes	yes
vi)	X03Cr27Ni5Mo2N		≤160 [f]	260	450	620	20	85	yes	yes
vii)	X02Cr25Ni6Mo3CuN		≤160 [f]	270	500	700	25	100	yes	yes
viii)	X02Cr25Ni7Mo4N	2507	≤160 [f]	290	530	730	25	100	yes	yes
ix)	X02Cr25Ni7Mo4CuWN	2760	≤160 [f]	290	530	730	25	100	yes	yes
x)	X02Cr28Ni8Mo5CoN		≤5[f]	300	650	800	25	100	yes	yes

NOTE — 1 MPa = $1N/mm^2$.

[a] Only for guidance.

[b] For rods. Only the tensile strength values apply.

[c] At the option of the manufacturer. it is permitted to use transverse test specimens provided that the same requirement be met.

[d] When tested in accordance with ISO 3651-2.

[e] The selection of the test or tests to be agreed upon should be based on experience with the use of the selected grade of steel in the intended environment.

[f] For larger thicknesses. The values shall be agreed upon.

[g] Width across flats for hexagons.

Table 7 Mechanical Properties at Room Temperature of Annealed Ferritic Steels and Resistance to Inter-Granular Corrosion in Conditions 1C, 1E, 1D, 1X, 1G and 2D

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel designation		Thickness[e], *t* or Diameter, *d*	Hardness HB	0.2 %-Proof Strength Rp0.2	Tensile Strength Rm	Elongation After Fracture[a] A	Resistance to Inter-granular Corrosion[b]	
	Grade	Numerical Symbol	mm		MPa *Min*	MPa *Min*	Percent *Min*	in the Delivery Condition	in the Welded Condition
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	X04Cr12Nb	409Nb	100	179	170	380	20	no	no
ii)	X04Cr12		25	200	230	400	20	no	no
iii)	X04Cr17	430	75[e]	200	240	400	20	yes	no
iv)	X05Cr17S	430F	100	200	250	430	20	no	no
v)	X03Cr17Nb	430Nb	100[d]	—	230	420	20	yes	yes
vi)	X02Cr18TiNb	439	50	200	200	420	28	yes	yes
vii)	X04Cr17Mo1	434	[e]	—	—	440	—	yes	no
viii)	X02Cr18Mo2TiS		100[d]	200	280	430	15	yes	no

NOTE — 1 MPa = 1 N/mm^2.

[a] Longitudinal test pieces.

[b] When tested in accordance with ISO 3651-2.

[c] For larger thicknesses the values have to be agreed.

[d] For rod only.

[e] Width across flats for hexagons.

Table 8 Mechanical Properties at Room Temperature of Heat-Treated Martensitic Steels in Conditions 1C, 1E 1D, 1X, 1G and 2D

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness[e], *t* or Diameter, *d* mm	Heat Treatment[a]	Hardness HB	0.2 Percent Proof Strength $R_p0.2$	Tensile Strength Rm		Elongation After Fracture A		Impact Energy (ISO-V) KV_2	
	Grade	Numerical Symbol				MPa *Min*	MPa *Min*	MPa *Max*	Percent *Min* Long.[f]	Percent *Min* Tr.[f]	J *Min* Long.[f]	J *Min* Tr.[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	X12Cr13	410	–	+A	223	–	–	730	–	–	–	–
			≤ 75[b]	+QT	–	345	540	–	15	–	25	–
ii)	X12Cr13S	416	–	+A	262	–	–	880	–	–	–	–
			≤ 160[b]	+QT	–	450	650	–	12	–	–	–
iii)	X20Cr13	420	–	+A	230	–	–	900	–	–	–	–
			≤ 160[b]	+QT1	–	500	700	850	13	–	25	–
			≤ 160[b]	+QT2	–	600	800	950	12	–	20	–
iv)	X30Cr13	420B	–	+A	245	–	–	800	–	–	–	–
			≤ 75[b]	+QT	–	540	740	–	12	–	12	–
v)	X40Cr13	420C	–	+A	245	–	–	800	–	–	–	–
			≤ 160[b]	+QT	–	540	740	–	12	–	12	–
vi)	X17Cr 16Ni2	431	–	+A	295	–	–	950	–	–	–	–
			≤ 160[b]	+QT1	–	600	800	950	14[d]	–	20	–
			≤ 160[b]	+QT2	–	700	900	1 050	12[c]	–	15	–
vii)	X110Cr17	440C	≤ 100[b]	+A	285	–	–	–	–	–	–	–
viii)	X50Cr15MoV	420V	–	+A	280	–	–	900	–	–	–	–
		415	–	+A	320	–	–	1 100	–	–	–	–
			≤ 160[b]						15	–	70	–

Table 8 (*Concluded*)

Sl No.	Steel Designation		Thickness[c], *t* or Diameter, *d* mm	Heat Treatment[a]	Hardness HB	0.2 Percent Proof Strength $R_p0.2$	Tensile Strength Rm		Elongation After Fracture A		Impact Energy (ISO-V) KV_2	
	Grade	Numerical Symbol				MPa *Min*	MPa *Min*	MPa *Max*	Percent *Min* Long.[f]	Percent *Min* Tr.[f]	J *Min* Long.[f]	J *Min* Tr.[f]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
ix)	X03Cr13Ni4Mo		160 < *t* ≤ 250	+QT1	–	550	700	800	–	12	–	50
			≤ 160[b]	+QT2	–	620	780	980	15	–	70	–
			160 < *t* ≤ 250						–	12	–	50
			≤ 160[b]	+QT3	–	800	900	1 100	12	–	50	–
			160 < *t* ≤ 250						–	10	–	40
x)	X03Cr16Ni5Mo1		–	+A	320	–	–	1 100	–	–	–	–
			≤ 160[b]	+QT1	–	550	760	960	16	–	90	–
			160 < *t* ≤ 250						–	14	–	70
			≤ 160[b]	+QT2	–	700	900	1 100	16	–	80	–
			160 < *t* ≤ 250						–	14	–	60
xi)	X14Cr17S		–	+A	220			730	–	–	–	–
			≤ 60	+QT	–	500	650	850	12	–	–	–
			60 < *t* ≤ 160	+QT	–				10	–	–	–
xii)	X39Cr17Mo1	434C	–	+A	280	–	–	900	–	–	–	–
			≤ 160[b]	+QT	–	550	750	950	12	–	10	–

NOTE — 1 MPa = 1 N/mm^2

[a] +A: Soft annealed; +QT: Quenched and tempered.

[b] For Larger thickness the values shall be agreed upon.

[c] A = 10 Percent for thickness > 60 mm.

[d] A = 12 Percent for thickness > 60 mm.

[e] Width across flats for hexagons.

[f] Long.= longitudinal, Tr.= transverse.

Table 9 Mechanical Properties at Room Temperature of Heat-Treated (*See* Table 24) Precipitation Hardening Steels in Conditions 1C, 1E, 1D, 1X, 1G and 2D

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Hardness HB	Heat Treatment[a)]	0.2 Percent Proof Strength $R_{p0.2}$	Tensile Strength Rm	Elongation After Fracture A	Impact Energy (ISO-V) KV_2
	Grade	Numerical Symbol			MPa *Min*	MPa	Percent *Min*	J *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	X05Cr16Ni4CuNb	630	363	+AT	–	≤ 1 200	–	–
			–	+P1	520	800 to 950	18	75
			–	+P2	720	930 to 1100	16	40
			–	+P3	790	960 to 1160	12	–
			–	+P4	1 000	1 070 to 1 270	10	–
ii)	X07Cr17Ni7Al	–	255	+AT	–	850 *Max*[b)]	–	–

NOTE — 1 MPa = 1 N/mm^2.

[a)] +AT = solution annealed; +P = precipitation hardened.

[b)] For rod only.

Table 10 Minimum Values for the 0.2 Percent and 1 Percent Proof Strength of Austenitic Steels at Elevated Temperatures

(*Clause* 9.2)

Sl No.	Steel Designation		Heat Treat-Mentcondition[a]	Minimum 0.2 Percent Proof Strength MPa[c]										Minimum 1 Percent Proof Strength MPa[c]									
				at a Temperature (in °C) of																			
	Grade	Numerical Symbol		100	150	200	250	300	350	400	450	500	550	100	150	200	250	300	350	400	450	500	550
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
i)	X15Cr18Ni8	301	+AT	210	200	190	185	180	180	–	–	–	–	230	215	205	200	195	195	–	–	–	–
ii)	X02Cr19Ni10	304L	+AT	145	130	118	108	100	94	89	85	81	80	180	160	145	135	127	121	116	112	109	108
iii)	X02Cr18Ni9N	304LN	+AT	205	175	157	145	136	130	125	121	119	118	240	210	187	175	167	160	156	152	149	147
iv)	X04Cr19Ni9	304	+AT	155	140	127	118	110	104	98	95	92	90	190	170	155	145	135	129	125	122	120	120
v)	X04Cr18Ni10Ti	321	+AT	175	165	155	145	136	130	125	121	119	118	205	195	185	175	167	161	156	152	149	147
vi)	X06Cr18Ni10Nb	–	+AT	175	165	155	145	136	130	125	121	119	118	210	195	185	175	167	161	156	152	149	147
vii)	X02Cr19Ni11	304LNi	+AT	145	130	118	108	100	94	89	85	81	80	180	160	145	135	127	121	116	112	109	108
viii)	X04Cr18Ni12	305	+AT	155	140	127	118	110	104	98	95	92	90	190	170	155	145	135	129	125	122	120	120
ix)	X08Cr17Mn8Cu3N	204Cu	+AT	225	205	190	177	165	152	145	140	137	135	260	235	218	204	190	180	175	168	165	165
x)	X11Cr19Ni8Mn6N	202S1	+AT	225	200	185	175	165	155	–	–	–	–	255	230	210	200	190	180	–	–	–	–
xi)	X02Cr17Ni12Mo2	316L	+AT	165	150	137	127	119	113	108	103	100	98	200	180	165	153	145	139	135	130	128	127

Table 10 (*Concluded*)

Sl No.	Steel Designation		Heat Treat-Mentcondition[a]	Minimum 0.2 Percent Proof Strength MPa[c]										Minimum 1 Percent Proof Strength MPa[c]									
				at a Temperature (in °C) of										at a Temperature (in °C) of									
	Grade	Numerical Symbol		100	150	200	250	300	350	400	450	500	550	100	150	200	250	300	350	400	450	500	550
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
xii)	X05Cr17Ni12Mo2	–	+AT	175	158	145	135	127	120	115	112	110	108	210	190	175	165	155	150	145	141	139	137
xiii)	X04Cr17Ni12Mo2Ti	316Ti	+AT	185	175	165	155	145	140	135	131	129	127	215	205	192	183	175	169	164	160	158	157
xiv)	X02Cr17Ni12Mo3	–	+AT	165	150	137	127	119	113	108	103	100	98	200	180	165	153	145	139	135	130	128	127
xv)	X03Cr17Ni12Mo3	–	+AT	175	158	145	135	127	120	115	112	110	108	210	190	175	165	155	150	145	141	139	137
xvi)	X02Cr17Ni12Mo2N	316LN	+AT	215	195	175	165	155	150	145	140	138	136	245	225	205	195	185	180	175	170	168	166
xviii)	X02Cr17Ni13Mo4	–	+AT	225	200	185	175	165	155	150	–	–	–	255	230	210	200	190	180	175	–	–	–
xx)	X01Cr25Ni22Mo2	–	+AT	195	170	160	150	140	135	–	–	–	–	225	205	190	180	170	165	–	–	–	–
xxi)	X01Cr24Ni22Mo4CuNW	–	+AT	350	330	315	307	300	298	295	288	280	270	390	365	350	342	335	328	325	318	310	300
xxii)	X01Cr24Ni22Mo7CuN	326	+AT	350	320	315	310	300	295	295	285	280	275	390	370	355	345	335	330	330	320	310	305
xxiii)	X02Cr25Ni18-Mn6Mo4N	345	+AT	350	310	270	255	240	225	210	210	210	200	400	355	310	290	270	255	240	240	240	230
xxiv)	X01Ni25Cr20Mo5Cu	904L	+AT	205	190	175	160	145	135	125	115	110	105	235	220	205	190	175	165	155	145	140	135
xxv)	X01Ni25Cr20Mo7CuN	904LN	+AT	230	210	190	180	170	165	160	–	–	–	270	245	225	215	205	195	190	–	–	–
xxvi)	X01Ni31Cr27Mo4Cu	–	+AT	190	175	160	155	150	145	135	125	120	115	220	205	190	185	180	175	165	155	150	145
xvii)	X02Cr18Ni14Mo3	316LNi	+AT	165	150	137	127	119	113	108	103	100	98	200	180	165	153	145	139	135	130	128	127

Table 11 Minimum Values for the 0.2 Percent-Proof Strength of Austenitic-Ferritic Steels at Elevated Temperatures

(*Clause* 9.2)

Sl No.	Steel Designation		Heat Treatment Condition[a)]	Minimum 0.2 Percent Proof Strength MPa[b)] at a Temperature (in °C) of			
	Grade	Numerical Symbol		100	150	200	250
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	X02Cr21Mn5Ni1N	2101	+AT	365	325	295	275
ii)	X02Cr23Ni4N	2304	+AT	330	300	280	265
iii)	X02Cr22Ni5Mo3N	2205	+AT	360	335	315	300
iv)	X02Cr24Ni4Mn3MoCuN	2441	+AT	385	345	325	315
v)	X03Cr27Ni5Mo2N	–	+AT	360	335	310	295
vi)	X02Cr25Ni6Mo3CuN	–	+AT	450	420	400	380
vii)	X02Cr25Ni7Mo4N	2507	+AT	450	420	400	380
viii)	X02Cr25Ni7Mo4CuWN	2760	+AT	450	420	400	380

[a)] +AT = solution annealed.

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

Table 12 Minimum Values for the 0.2 Percent-Proof Strength of Ferritic Steels at Elevated Temperatures

(*Clause* 9.2)

Sl No.	Steel Designation		Heat Treatment Condition[a)]	Minimum 0.2 Percent Proof Strength MPa[b)] at a Temperature (in °C) of						
	Grade	Numerical Symbol		100	150	200	250	300	350	400
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	X04Cr12	410S	+A	220	215	210	205	200	195	190
ii)	X04Cr17	430	+A	220	215	210	205	200	195	190
iii)	X03Cr17Nb	430Nb	+A	190	180	170	160	155	–	–
iv)	X02Cr18TiNb	439	+A	190	180	170	160	155	–	–
v)	X04Cr17Mo1	434	+A	250	240	230	220	210	205	200
vi)	X02Cr18Mo2TiS	–	+A	250	240	230	220	210	205	200

[a)] +A = annealed.

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

Table 13 Minimum Values for the 0.2 Percent Proof Strength of Martensitic Steels at Elevated Temperatures

(*Clause* 9.2)

Sl No.	Steel Designation		Heat Treatment Condition[a)]	Minimum 0.2 Percent Proof Strength MPa[b)] at a Temperature (in °C) of						
	Name	Numerical Symbol		100	150	200	250	300	350	400
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	X12Cr13	410	+QT	420	410	400	385	365	355	305
ii)	X20Cr13	420	+QT1	460	445	430	415	395	365	330
			+QT2	515	495	475	460	440	405	355
iii)	X17Cr16Ni2	431	+QT1	515	495	475	460	440	405	355
			+QT2	565	525	505	490	470	430	375
iv)	X03Cr13Ni4Mo	415	+QT1	500	490	480	470	460	450	–
			+QT2	590	575	560	545	530	515	–
			+QT3	720	690	665	640	620	–	–
v)	X04Cr16Ni5Mo1	431N	+QT1	520	510	500	490	480	–	–
			+QT2	660	640	620	600	580	–	–
vi)	X39Cr17Mo1	434C	+QT	540	535	530	520	510	490	470

[a)] +QT = quenched and tempered.

[b)] 1 MPa = 1 N/mm2.

Table 14 Minimum Values for the 0.2 Percent Proof Strength of Precipitation Hardening Steels at Elevated Temperatures

(*Clause* 9.2)

Sl No.	Steel Designation		Heat Treatment Condition[a)]	Minimum 0.2 Percent Proof Strength MPa[b)] at a Temperature (in °C) of				
	Name	Numerical Symbol		100	150	200	250	300
(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	X05Cr16Ni4CuNb	630	+P1	680	660	640	620	600
			+P2	730	710	690	670	650
			+P3	880	830	800	770	750

[a)] +P = precipitation hardened.

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

Table 15 Mechanical Properties for Bright Bars at Room Temperature of Solution Annealed[a] (*See* Table 20) Austenitic Steels in Conditions 2H, 2B, 2G or 2P

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness, *t* or Diameter[b], *d* mm	Solution Annealed					
				$R_p0.2$ MPa[e] *Min*	R_m MPa[e]	A_5[C] Percent *Min*		KV_2 J *Min*	
	Grade	Numerical Symbol				(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	X02Cr19Ni10	304L	≤ 10[d]	400	600 to 930	25	–	–	–
			10 < *t* ≤ 16	380	600 to 930	25	–	–	–
			16 < *t* ≤ 40	175	500 to 830	30	–	100	–
			40 < *t* ≤ 63	175	500 to 830	30	–	100	–
			63 < *t* ≤ 160	175	500 to 700	45	–	100	–
			160 < *t* ≤ 250	175	500 to 700	–	35	-	60
ii)	X10Cr18Ni9S	303	≤ 10[d]	400	600 to 950	15	–	–	–
			10 < *t* ≤ 16	400	600 to 950	15	–	–	–
			16 < *t* ≤ 40	190	500 to 850	20	–	–	–
			40 < *t* ≤ 63	190	500 to 850	20	–	–	–
			63 < *t* ≤ 160	190	500 to 750	35	–	–	–
iii)	X06Cr18Ni9Cu2S	303Cu	≤ 10[d]	400	600 to 950	15	–	–	–
			10 < *t* ≤ 16	400	600 to 950	15	–	–	–
			16 < *t* ≤ 40	185	500 to 910	20	–	–	–
			40 < *t* ≤ 63	185	500 to 910	20	–	–	–
			63 < *t* ≤ 160	185	500 to 710	–	–	–	–

Table 15 (*Continued*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[b], *d* mm	Solution Annealed					
				$R_p0.2$ MPa[e] *Min*	R_m MPa[e]	A_5[C] Percent *Min*		KV_2 J *Min*	
	Grade	Numerical Symbol				(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
iv)	X03Cr18Ni9Cu4	304Cu	≤ 10[d]	400	600 to 850	25	–	–	–
			10 < *t* ≤ 16	340	600 to 850	25	–	–	–
			16 < *t* ≤ 40	175	450 to 800	30	–	100	–
			40 < *t* ≤ 63	175	450 to 800	30	–	100	–
			63 < *t* ≤ 160	175	450 to 650	40	–	100	–
v)	X04Cr19Ni9	304	≤ 10[d]	400	600 to 950	25	–	–	–
			10 < *t* ≤ 16	400	600 to 950	25	–	–	–
			16 < *t* ≤ 40	190	600 to 850	30	–	100	–
			40 < *t* ≤ 63	190	580 to 850	30	–	100	–
			63 < *t* ≤ 160	190	500 to 700	45	–	100	–
			160 < *t* ≤ 250	190	500 to 700	-	35	–	60
vi)	X04Cr18Ni10Ti	321	≤ 10[d]	400	600 to 950	25	–	–	–
			10 < *t* ≤ 16	380	580 to 950	25	–	–	–
			16 < *t* ≤ 40	190	500 to 850	30	–	100	–
			40 < *t* ≤ 63	190	500 to 850	30	–	100	–
			63 < *t* ≤ 160	190	500 to 700	40	–	100	–
vii)	X02Cr l9Ni11	304LNi	≤ 10[d]	400	600 to 930	25	–	–	–
			10 < *t* ≤16	380	600 to 930	25	–	–	–
			16 < *t* ≤ 40	180	460 to 830	–	–	–	–
			40 < *t* ≤ 63	180	460 to 830	30	–	100	–

Table 15 (*Continued*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[b], *d* mm	Solution Annealed					
				$R_p0.2$ MPa[e] *Min*	R_m MPa[e]	A_5[C] Percent *Min*		KV_2 J *Min*	
	Grade	Numerical Symbol				(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			$63 < t \leq 160$	180	460 to 680	–	–	–	-
			$160 < t \leq 250$	180	460 to 680	–	35	–	60
viii)	X02Cr17Ni l2Mo2	316L	≤ 10[d]	400	600 to 930	25	–	–	–
			$10 < t \leq 16$	380	580 to 930	25	–	–	–
			$16 < t \leq 40$	200	500 to 830	–	–	–	–
			$40 < t \leq 63$	200	500 to 830	–	–	–	–
			$63 < t \leq 160$	200	500 to 700	40	–	100	–
			$160 < t \leq 250$	200	500 to 700	–	30	–	60
ix)	X04Cr17Ni12Mo2	316	≤ 10[d]	400	600 to 950	25	–	–	–
			$10 < t \leq 16$	380	580 to 950	25	–	–	–
			$16 < t \leq 40$	200	500 to 850	30	–	100	–
			$40 < t \leq 63$	200	500 to 850	30	–	100	–
			$63 < t \leq 160$	200	500 to 700	–	–	–	-
			$160 < t \leq 250$	200	500 to 700	–	–	–	60
x)	X04Cr17Ni12Mo2Ti	316Ti	≤ 10[d]	400	600 to 950	25	–	–	–
			$10 < t \leq 16$	380	580 to 950	25	–	–	–
			$16 < t \leq 40$	200	500 to 850	30	–	100	–
			$40 < t \leq 63$	200	500 to 850	–	–	–	–
			$63 < t \leq 160$	200	500 to 700	40	–	100	–
			$160 < t \leq 250$	200	500 to 700	–	–	–	60

Table 15 (*Continued*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[b], *d* mm	Solution Annealed					
				$R_p0.2$ MPa[e] *Min*	R_m MPa[e]	A_5[C] Percent *Min*		KV_2 J *Min*	
	Grade	Numerical Symbol				(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
xi)	X02Cr17Ni12Mo3		≤ 10[d]	400	600 to 930	25	–	–	–
			10 < *t* ≤ 16	380	600 to 880	25	–	–	–
			16 < *t* ≤ 40	200	500 to 850	30	–	100	–
			40 < *t* ≤ 63	200	500 to 850	–	–	–	–
			63 < *t* ≤ 160	200	500 to 700	40	–	100	–
			160 < *t* ≤ 250	200	500 to 700	–	30	–	60
xii)	X03Cr17Ni12Mo3		≤ 10[d]	400	600 to 950	25	–	–	–
			10 < *t* ≤ 16	400	600 to 950	–	–	–	–
			16 < *t* ≤ 40	200	500 to 850	30	–	100	–
			40 < *t* ≤ 63	190	500 to 850	–	–	–	–
			63 < *t* ≤ 160	200	500 to 700	40	–	100	–
			160 < *t* ≤ 250	200	500 to 700	30	–	–	60
xiii)	X02Cr18Ni14Mo3	316Ni	≤ 10[d]	400	600 to 950	25	–	–	–
			10 < *t* ≤ 16	400	600 to 950	–	–	–	–
			16 < *t* ≤ 40	235	500 to 850	30	–	100	–
			40 < *t* ≤ 63	23S	500 to 850	30	–	100	–
			63 < *t* ≤ 160	235	500 to 700	40	–	100	–
			160 < *t* ≤ 50	235	500 to 700	–	30	–	60
xiv)	X0 lNi25Cr20Mo5Cu	904L	≤ 10[d]	400	600 to 930	20	–	–	–
			10 < *t* ≤ 16	400	600 to 930	20	–	–	–
			16 < *t* ≤ 40	230	530 to 880	25	–	100	–

Table 15 (*Concluded*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[b], *d* mm	Solution Annealed					
				$R_p0.2$ MPa[e] *Min*	R_m MPa[e]	A_5[C] Percent *Min*		KV_2 J *Min*	
	Grade	Numerical Symbol				(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			$40 < t \leq 63$	230	530 to 880	25	–	100	–
			$63 < t \leq 160$	230	530 to 730	35	–	100	–
			$160 < t \leq 250$	230	530 to 730	–	30	–	60
xv)	X0lNi25Cr20Mo7CuN	904LN	≤ 10[d]	550	700 to 1150	15	–	–	–
			$10 < t \leq 16$	550	700 to 1150	15	–	–	–
			$16 < t \leq 40$	300	650 to 1050	30	–	100	–
			$40 < t \leq 63$	300	650 to 900	30	–	100	–
			$63 < t \leq 160$	300	650 to 850	40	–	100	–
xvi)	X13Mn13Cr18N		All sizes	380	690	30	–	–	–
xvii)	X05Cr19Ni9N		All sizes	240	550	30	–	–	–
xviii)	X12Cr18Mn9Ni5N		All sizes	275	515	40	–	–	–
xix)	X02Cr18Ni9N	$t \leq 12.70$	310	620	30	–	–	–	–
	X04Cr18Ni10Nb X04Cr18Ni12 X12Cr25Ni20 X04Cr25Ni20 X15Cr25Ni21Si X04Cr17Ni12Mo2Ti X02Cr l7Ni l2Mo2N X04Crl8Nil2Mo3	$t > 12.70$	205	515	30	–	–	–	–

[a] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to inter granular corrosion as defined in ISO 3651-2 are obtained.

[b] Width across flats for hexagons.

[c] Elongation AS is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation has to be agreed upon at the time of enquiry and order.

[d] In the range 1 mm S d < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses < 5 min have to be agreed at the time of enquiry and order.

[e] 1 MPa = 1 N/min°.

Table 16 Mechanical Properties for Bright Bars at Room Temperature of Solution Annealed[a] (*See* Table 21) Austenitic-Ferritic Steels in Conditions 2H, 2B, 2G or 2P

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness, t or Diameter[b], d mm	Solution Annealed			
	Grade	Numerical Symbol		$R_{p0.2}$ MPa[f] *Min*	Rm MPa[f]	A_5[c] Percent *Min*	KV_2 J *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	X02Cr22Ni5Mo3N	2205	≤ 10[d]	650	850 to 1 150	12	–
			10 < t ≤ 16	650	850 to 1 100	12	–
			16 < t ≤ 40	450	650 to 1 000	15	100
			40 < t ≤ 63	450	650 to 1 000	15	100
			63 < t ≤ 160	450	650 to 880	25	100
ii)	X03Cr27Ni5Mo2N	–	≤ 10[d]	610	770 to 1 030	12	–
			10 < t ≤ 16	560	770 to 1 030	12	–
			16 < t ≤ 40	460	620 to 950	15	85
			40 < t ≤ 63	460	620 to 950	15	85
			63 < t ≤ 160	460	620 to 880	20	85
iii)	X02Cr24Ni4Mn3Mo2CuN	2441	≤ 10[d]	700	900 to 1 150	15	–
			10 < t ≤ 30	700	900 to 1 100	20	–
			30 < t ≤ 160	450	650 to 900	25	60
iv)	X02Cr22Ni2N	–	≤ 16	600	650 to 1 100	15	–
			16 < t ≤ 40	500	700 to 1 100	15	–
			40 < t	500	700 to 1 100	20	–
v)	X02Cr21Mn5Ni1N	–	≤ 10[e]	500	700 to 1 050	15	–
			10 < t ≤ 16	500	700 to 1 050	20	–
			16 < t ≤ 40	500	700 to 1 050	20	–
			40 < t ≤ 160	450	650 to 850	30	60

Table 16 (*Concluded*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[b], *d* mm	Solution Annealed			
	Grade	Numerical Symbol		$R_{p0.2}$ MPa[f] *Min*	R_m MPa[f]	A_5[c] Percent *Min*	KV_2 J *Min*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
vi)	X02Cr25Ni6Mo3CuN	–	≤ 10[d]	– e)	– e)	– e)	–
			10 < *t* ≤ 16	– e)	– e)	– e)	–
			16 < *t* ≤ 40	500	700 to 1 050	25	100
			40 < *t* ≤ 63	500	700 to 900	25	100
			63 < *t* ≤ 160	500	700 to 900	25	100
vii)	X02Cr23Ni4N	–	All sizes	400	600	25	–
viii)	X02Cr24Ni4Mn3MoCuN	–	*t* ≤ 11	540	740	25	–
			t >11	480	680	25	–
ix)	X02Cr25Ni7Mo4N	–	*t* ≤ 50.8	550	800	15	–
			t > 50.8	515	760	15	–
x)	X02Cr25Ni7Mo4CuWN	–	All sizes	550	750	25	–

[a] Initial solution treatment may be omitted if the conditions for previous hot-working and subsequent cooling have been such that the requirements for the mechanical properties of the product and the resistance to inter granular corrosion as defined in ISO 3651-2 are obtained.

[b] Width across flats for hexagons.

[c] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[d] In the range 1 mm ≤ *d* < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses < 5 mm shall be agreed at the time of enquiry and order.

[e] To be agreed upon at the time of enquiry and order.

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

Table 17 Mechanical Properties for Bright Bars at Room Temperature of Annealed[a] (*See* Table 22)
Ferritic Steels in Conditions 2H, 2B, 2G or 2P

(*Clauses* 9.1, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness, *t* or Diameter,[b] *d* mm	0.2 Percent Proof Strength Rp0.2 MPa[e] *Min*	Tensile Strength Rm MPa[e]	Elongation After Fracture A_5[c] Percent *Min*
	Grade	Numerical Symbol				
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	X04Cr17	–	≤ 10[d]	320	500 to 750	8
			10 < *t* ≤ 16	300	480 to 750	8
			16 < *t* ≤ 40	240	400 to 700	15
			40 < *t* ≤ 63	240	400 to 700	15
			63 < *t* ≤ 100	240	400 to 630	20
ii)	X05Cr17S	430F	≤ 10[d]	330	530 to 780	7
			10 < *t* ≤ 16	310	500 to 780	7
			16 < *t* ≤ 40	250	430 to 730	12
			40 < *t* ≤ 63	250	430 to 730	12
			63 < *t* ≤ 100	250	430 to 630	20
iii)	X04Cr17Mo1	434	≤ 10[d]	340	540 to 700	8
			10 < *t* ≤ 16	320	500 to 700	12
			16 < *t* ≤ 40	280	440 to 700	15
			40 < *t* ≤ 63	280	440 to 700	15
			63 < *t* ≤ 100	280	440 to 660	18
iv)	X03Cr17Nb	430Nb	≤ 10[d]	320	500 to 750	8
			10 < *t* ≤ 16	300	480 to 750	10
			16 < *t* ≤ 40	240	400 to 700	15
			40 < *t* ≤ 50	240	400 to 700	15
v)	X02Cr18TiNb	439	≤ 10[d]	320	500 to 750	8
			10 < *t* ≤ 16	300	480 to 750	10
			16 < *t* ≤ 40	240	400 to 700	15
			40 < *t* ≤ 50	240	400 to 700	15
vi)	X04Cr12Nb	–	All sizes	140	415	20

[a] Initial annealing treatment may be omitted if the conditions for previous hot working and subsequent cooling have been such that the requirements for the final mechanical properties of the product and the resistance to inter granular corrosion as defined in ISO 3651-2 are obtained.
[b] Width across flats for hexagons.
[c] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.
[d] In the range 1 mm ≤ *d* < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses < 5 mm shall be agreed at the time of enquiry and order.
[e] 1MPa = 1N/mm^2.

Table 18 Mechanical Properties for Bright Bars at Room Temperature of Heat-Treated (*See* Table 23) Martensitic Steels in Conditions 2H, 2B, 2G or 2P

(*Clauses* 9.1, 9.3, 9.4, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness, t or Diameter[a], d mm	Annealed		Quenched + Tempered						
				R_m MPa[e] *Max*	Hardness HB[b] *Max*	Heat Treatment Condition	$R_{p0.2}$ MPa[e] *Min*	R_m MPa[e]	A_5[c] Percent *Min*		KV2 J *Min*	
	Grade	Numerical Symbol							(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	X12Cr13	410	≤ 10[d]	880	280	+QT	550	700 to 1 000	9	–	–	–
			10 < t ≤ 16	880	280		500	700 to 1 000	9	–	–	–
			16 < t ≤ 40	800	250		450	650 to 930	10	–	25	–
			40 < t ≤ 63	760	230		450	650 to 880	10	–	25	–
			63 < t ≤ 160	730	220		450	650 to 850	15	–	25	–
ii)	X12Cr13S	416	≤ 10[d]	880	280	+QT	550	700 to 1 000	8	–	–	–
			10 < t ≤ 16	880	280		500	700 to 1 000	8	–	–	–
			16 < t ≤ 40	800	250		450	650 to 930	10	–	–	–
			40 < t ≤ 63	760	230		450	650 to 880	10	–	–	–
			63 < t ≤ 160	730	220		450	650 to 850	12	–	–	–
iii)	X20Cr13	420	≤ 10[d]	910	290	+QT1	600	750 to 1 000	8	–	–	–
			10 < t ≤ 16	910	290		550	750 to 1 000	8	–	–	–
			16 < t ≤ 40	850	260		500	700 to 950	10	–	25	–
			40 < t ≤ 63	800	250		500	700 to 900	12	–	25	–
			63 < t ≤ 160	760	230		500	700 to 850	13	–	25	–

Table 18 (*Continued*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[a], *d* mm	Annealed		Quenched + Tempered						
				Rm MPa[e] *Max*	Hardness HB[b] *Max*	Heat Treatment Condition	Rp0.2 MPa[e] *Min*	Rm MPa[e]	A_5[c] Percent *Min*		KV2 J *Min*	
	Grade	Numerical Symbol							(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
iv)	X30Cr13	420B	≤ 10[d]	950	305	+QT	700	900 to 1 050	7	–	–	–
			10 < *t* ≤ 16	950	305		650	900 to 1 150	7	–	–	–
			16 < *t* ≤ 40	900	280		650	850 to 1 100	9	–	12	–
			40 < *t* ≤ 63	840	260		650	850 to 1 050	9	–	12	–
			63 < *t* ≤ 160	800	245		650	850 to 1 000	10	–	15	–
v)	X40Cr13	420C	≤ 10[d]	950	305	+QT	700	900 to 1 150	7	–	–	–
			10 < *t* ≤ 16	950	305		700	900 to 1 150	7	–	–	–
			16 < *t* ≤ 40	900	280		650	850 to 1 100	8	–	12	–
			40 < *t* ≤ 63	840	260		650	850 to 1 000	8	–	12	–
			63 < *t* ≤ 160	800	245		650	850 to 1 000	10	–	12	–
vi)	X17Cr16Ni2	431	≤ 10[d]	1050	330	+QT1	750	850 to 1 100	7	–	-	–
			10 < *t* ≤ 16	1050	330		700	850 to 1 100	7	–	-	–
			16 < *t* ≤ 40	1000	310		650	800 to 1 050	9	–	25	–
			40 < *t* ≤ 63	950	295		650	800 to 1 000	12	–	25	–
			63 < *t* ≤ 160	950	295		650	800 to 950	12	–	16	–
vii)	X04Cr16Ni5-Mo1	431N	≤ 10[d]	1150	380	+QT2	750	900 to 1 150	10	–	–	–
			10 < *t* ≤ 16	1150	380		750	900 to 1 150	10	–	–	–
			16 < *t* ≤ 40	1100	320		700	900 to 1 100	12	–	80	–
			40 < *t* ≤ 63	1100	320		700	900 to 1 100	16	–	80	–
			63 < *t* ≤ 160	1100	320		700	900 to 1 100	16	–	80	–
			160 < *t* ≤ 250	1100	320		700	900 to 1 100	–	14	–	60

Table 18 (*Concluded*)

Sl No.	Steel Designation		Thickness, *t* or Diameter[a], *d* mm	Annealed		Quenched + Tempered						
				Rm MPa[e] *Max*	Hardness HB[b] *Max*	Heat Treatment Condition	Rp0.2 MPa[e] *Min*	Rm MPa[e]	A_5[c] Percent *Min*		KV2 J *Min*	
	Grade	Numerical Symbol							(Long.)	(Tr.)	(Long.)	(Tr.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
viii)	X14Cr17S	430F	≤ 10[d]	880	280	+QT	580	700 to 980	7	–	–	–
			10 < *t* ≤ 16	880	280		530	700 to 980	7	–	–	–
			16 < *t* ≤ 40	800	250		500	650 to 930	9	–	–	–
			40 < *t* ≤ 63	760	230		500	650 to 880	10	–	–	–
			63 < *t* ≤ 160	730	220		500	650 to 850	10	–	–	–
ix)	X39Cr17Mo1	434C	≤ 10[d]	1 000	340	+QT	650	800 to 1 050	8	–	–	–
			10 < *t* ≤ 16	1000	340		600	800 to 1 050	8	–	–	–
			16 < *t* ≤ 40	980	310		550	750 to 1 000	10	–	14	–
			40 < *t* ≤ 63	930	290		550	750 to 950	12	–	14	–
			63 < *t* ≤ 160	900	280		550	750 to 950	12	–	10	–
x)	X03Cr13Ni4Mo	–	All sizes	–	–	+QT	620	795	15	–	–	–

[a] Width across flats for hexagons.

[b] For information only.

[c] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[d] In the range 1 mm ≤ *d* < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses < 5 mm shall be agreed at the time of enquiry and order.

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

Table 19 Mechanical Properties for Bright Bars at Room Temperature of Heat-Treated (*See* Table 24) Precipitation Hardening Steels in Conditions 2H, 2B, 2G or 2P

(*Clauses* 9.1, 9.3, 9.4, 9.5 *and* 13.2)

Sl No.	Steel Designation		Thickness, *t* or Diameter [a], *d* mm	Annealed		Precipitation Hardened				
	Grade	Numerical Symbol		Rm MPa[e] *Max*	Hardness HB[b] *Max*	Heat Treatment Condition	Rp0,2 MPa[e] *Min*	Rm MPa[e]	A_5[c] Percent *Min* (Long.)	KV_2 J, *Min* (Long.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	X05Cr16Ni4CuNb	630	≤ 10[d]	1 200	360	+P1	600	900 to 1 100	10	–
			10 < *t* ≤ 16	1 200	360		600	900 to 1 100	10	–
			16 < *t* ≤ 40	1 200	360		520	800 to 1 050	12	75
			40 < *t* ≤ 63	1 200	360		520	800 to 1 000	18	75
			63 < *t* ≤ 160	1 200	360		520	800 to 950	18	75
			≤ 100	–	–	+P2	720	930 to 1 100	12	40
			≤ 100	–	–	+P3	790	960 to 1 160	10	–
			≤ 100	–	–	+P4	1 000	1 070 to 1 270	10	–

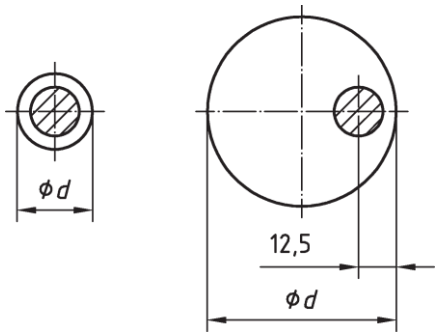
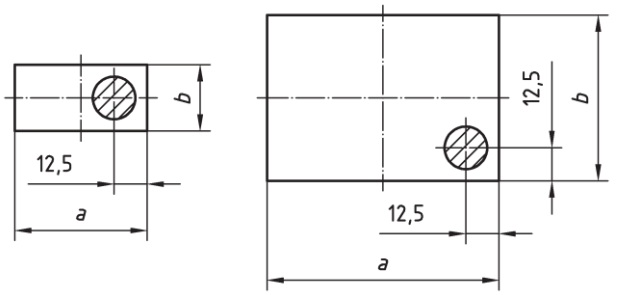
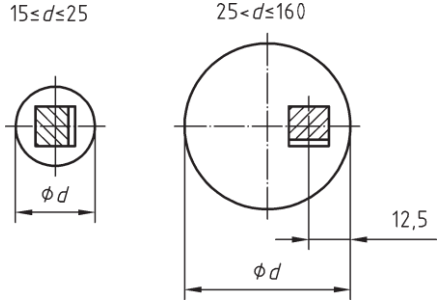
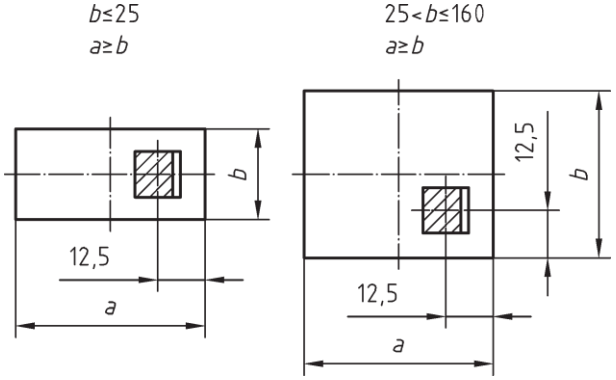
[a] Width across flats for hexagons.

[b] For information only.

[c] Elongation A_5 is valid only for dimensions of 5 mm and above. For smaller diameters, the minimum elongation shall be agreed upon at the time of enquiry and order.

[d] In the range 1 mm ≤ *d* < 5 mm valid only for rounds. The mechanical properties of non-round bars with thicknesses < 5 mm shall be agreed at the time of enquiry and order.

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

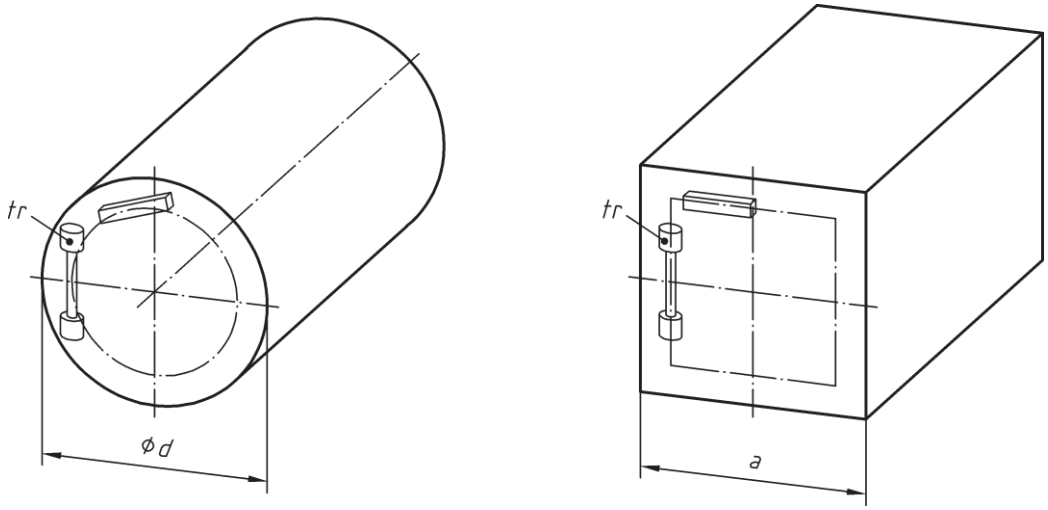
Type of test	Round cross-section products	Rectangular cross-section products
Tensile	$d \leq 25$[a] $\quad 25 < d \leq 160$ 	$b \leq 25$, $a \geq b$ $\quad 25 < b \leq 160$, $a \geq b$ 
Impact[b]	$15 \leq d \leq 25$ $\quad 25 < d \leq 160$ 	$b \leq 25$, $a \geq b$ $\quad 25 < b \leq 160$, $a \geq b$ 

All dimensions in millimetres.

FIG.1 POSITION OF TEST PIECES FOR STEEL BARS AND RODS ≤ 160 MILLIMETRES DIAMETER OR THICKNESS (LONGITUDINAL TEST PIECES)

[a] Samples of product can alternatively be tested unmachined.

[b] For products of a round cross section the axis of the notch is parallel to a diameter; for products with a rectangular cross section the axis of the notch is perpendicular to the greatest rolled surface.



Key

tr = transverse

NOTES

1 The axis of the notch on the impact test pieces should be radial in the case of round steel bars and perpendicular to the nearest rolled surface for rectangular bars.

2 The location of the impact test piece is *d*/6 or *a*/6 with maximum 50 mm from the surface.

FIG. 2 POSITION OF TEST PIECES FOR STEEL BARS > 160 MILLIMETRES DIAMETER OR THICKNESS (TRANSVERSE TEST PIECES)

ANNEX A

(*Clause* 8.2)

GUIDELINES FOR FURTHER TREATMENT (INCLUDING HEAT TREATMENT) IN FABRICATION

A-1 The guidelines given in Table 20 to Table 24 are intended for hot forming and heat treatment.

A-2 Because the corrosion resistance of stainless steels is only ensured when the surface is metallically clean. Layers of scale and annealing colours produced during hot forming heat treatment or welding should be removed as far as possible before use. Resistance to corrosion by finished parts made of steels with approximately 13 percent Cr is increased by the presence of a smooth clean surface.

Table 20 Guidelines on the Temperatures for Hot Forming and Heat Treatment[a)] of Austenitic Corrosion-Resistant Stainless Steels

(*Clause* A-1)

Sl No.	Steel Designation		Hot Forming		Heat Treatment Symbol	Solution Annealing[b)]	
	Grade	Numerical Symbol	Temperature °C	Type of Cooling		Temperature[c)] °C	Type of Cooling
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	X15Cr18Ni8	301	1 200 to 900	Air	+AT	1 000 to 1 100	Water, air[d)]
ii)	X02Cr19Ni10	304L	1 200 to 900			1 000 to 1 100	
iii)	X10Cr18Ni9S	303	1 200 to 900			1 000 to 1 100	
iv)	X02Cr18Ni9N	304LN	1 200 to 900			1 000 to 1 100	
v)	X03Cr18Ni9Cu4	304Cu	1 200 to 900			1 000 to 1 100	
vi)	X06Cr18Ni9Cu2S	303Cu	1 150 to 900			1 000 to 1 100	
vii)	X05Cr19Ni9N	304N	1 150 to 850			1 000 to 1 100	
viii)	X04Cr19Ni9	304	1 200 to 900			1 000 to 1 100	
ix)	X04Cr18Ni10Ti	321	1 200 to 900			1 020 to 1 120	
x)	X04Cr18Ni10Nb	347	1 150 to 850			1 020 to 1 120	
xi)	X02Cr19Ni11	304LNi	1 200 to 900			1 000 to 1 100	
xii)	X04Cr18Ni12	305	1 200 to 900			1 010 to 1 150	
xiii)	X08Cr17Mn8Cu3N	304Cu	1 150 to 850			1 000 to 1 100	
xiv)	X03Cr15Mn8Ni5Cu3	201Cu	1 200 to 900			1 000 to 1 100	
xv)	X12Cr18Mn9Ni5N	202	1 150 to 850			1 000 to 1 100	
xvi)	X11Cr19Ni8Mn6N	202S1	1 150 to 850			1 000 to 1 100	
xvii)	X01Cr25Ni21	310L	1 150 to 850			1 030 to 1 110	
xviii)	X02Cr17Ni12Mo2	316L	1 200 to 900			1 020 to 1 120	
xix)	X04Cr17Ni12Mo2	316	1 200 to 900			1 020 to 1 120	
xx)	X04Cr17Ni12Mo2Ti	316Ti	1 200 to 900			1 020 to 1 120	
xxi)	X02Cr17Ni12Mo3	–	1 200 to 900			1 020 to 1 120	
xxii)	X03Cr17Ni12Mo3	–	1 200 to 900			1 020 to 1 120	
xxiii)	X02Cr17Ni12Mo2N	316LN	1 200 to 900			1 020 to 1 120	

Table 20 (*Concluded*)

Sl No.	Steel Designation		Hot Forming		Heat Treatment Symbol	Solution Annealing[b]	
	Grade	Numerical Symbol	Temperature °C	Type of Cooling		Temperature[c] °C	Type of Cooling
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
xxiv)	X02Cr18Ni14Mo3	316LNi	1 200 to 900			1 020 to 1 120	
xxv)	X04Cr18Ni12Mo3	317	1 150 to 850			1 070 to 1 150	
xxx)	X02Cr17Ni13Mo4	–	1 200 to 900			1 020 to 1 120	
xxxi)	X01Cr20Ni18Mo6CuN	312	1 200 to 1 000			1 140 to 1 200	
xxxii)	X01Cr25Ni22Mo2	–	1 150 to 850			1 070 to1 150	
xxxiii)	X01Cr24Ni22Mo4CuNW	–	1 150 to 850			1 140 to 1 200	
xxxiv)	X01Cr24Ni22Mo7CuN	326	1 200 to 1 000			1 150 to 1 200	
xxxv)	X02Cr25Ni18Mn6Mo4N	345	1 200 to 950			1 120 to 1 170	
xxxvi)	X01Ni25Cr20Mo5Cu	904L	1 200 to 900			1 050 to 1 150	
xxxvii)	X01Ni25Cr20Mo7CuN	904LN	1 200 to 950			1 120 to 1 180	
xxxviii)	X01Ni31Cr27Mo4Cu	–	1150 to 850			1 050 to 1 150	

[a] The temperatures of solution annealing shall be agreed upon 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] The lower end of the range specified for solution annealing should be aimed at for heat treatment as part of further processing. Because otherwise the mechanical properties might be affected. If the temperature of hot forming does not drop below the lower temperature for solution annealing. a temperature of 980 °C is adequate as a lower limit for Mo-free steels; a temperature of 1 000 °C for steels with Mo contents up to 3 percent; a temperature of 1 020 °C for steels with Mo contents exceeding 3 percent.

[d] Rapid cooling.

Table 21 Guidelines on the Temperatures for Hot Forming and Heat Treatment[a)] of Austenitic-Ferritic Corrosion-Resistant Stainless Steels

(*Clause* A-1)

Sl No.	Steel Designation		Hot Forming		Heat Treatment Symbol	Solution Annealing[b)]	
	Grade	Numerical Symbol	Temperature °C	Type of Cooling		Temperature °C	Type of Cooling
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	X02Cr22Ni2N	–	1 100 to 950	Air	+AT	980 to 1100	Water, air[c)]
ii)	X02Cr21Mn5Ni1N	2101	1 100 to 900			1 020 to 1080	Water, air
iii)	X02Cr23Ni4N	2304	1 200 to 1 000			950 to 1050	Water, air[c)]
iv)	X02Cr22Ni5Mo3N	2205	1 200 to 950			1 020 to 1100	Water, air[c)]
v)	X02Cr24Ni4Mn3MoCuN	2441	1 150 to 900			1 000 to 1150	Water, air
vi)	X03Cr27Ni5Mo2N	–	1 200 to 950			1 020 to 1100	Water, air[c)]
vii)	X02Cr25Ni6Mo3CuN	–	1 200 to 1 000			1 040 to 1 120	Water
viii)	X02Cr25Ni7Mo4N	2507	1 200 to 1 000			1 040 to 1 120	Water
ix)	X02Cr25Ni7Mo4CuWN	2760	1 200 to 1 000			1 040 to 1 120	Water
x)	X02Cr28Ni8Mo5CoN	–	1 200 to 1 000			1 050 to 1 150	Water

a) The temperatures of solution annealing shall be agreed upon 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) Rapid cooling.

Table 22 Guidelines on the Temperatures for Hot Forming and Heat Treatment[a)] of Ferritic Corrosion-Resistant Stainless Steels

(*Clause* A-1)

Sl No.	Steel Designation		Hot forming		Heat Treatment Symbol	Annealing	
	Grade	Numerical Symbol	Temperature °C	Type of Cooling		Temperature[b)] °C	Type of Cooling
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	X04Cr12	410S	1 100 to 800	Air	+A	750 to 800	Air
ii)	X04Cr17	430				750 to 850	
iii)	X05Cr17S	430F					
iv)	X03Cr17Nb	430Nb					
v)	X02Cr18TiNb	439					
vi)	X04Cr17Mo1	434					
vii)	X02Cr18Mo2TiS	–				1 000 to 1 050	

a) The temperatures of annealing shall be agreed upon 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.

Table 23 Guidelines on the Temperatures for Hot Forming and Heat Treatment[a)] of Martensitic Corrosion-Resistant Stainless Steels

(*Clause* A-1)

Sl No.	Steel Designation		Hot Forming		Heat Treatment Symbol	Annealing		Quenching		Tempering
	Grade	Numerical Symbol	Temperature °C	Type of Cooling		Temperature[b)] °C	Type of Cooling	Temperature[b)] °C	Type of Cooling	Temperature °C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	X12Cr13	410	1 100 to 800	Air	+A	800 to 900	Slow cooling	–	–	–
						Approx. 750	Rapid cooling			
					+QT	–	–	950 to 1 000	Oil, water	700 to 750
ii)	X12Cr13S	416	1 100 to 800	Air	+A	745 to 825	Air	–	–	–
					+QT	–	–	950 to 1 000	Oil, air, water	680 to 780
iii)	X20Cr13	420	1 100 to 800	Slow cooling	+A	745 to 825	Air	–	–	–
					+QT1	–	–	950 to 1 050	Oil, air, water	650 to 750
					+QT2	–	–	950 to 1 050	Oil, air, water	600 to 700
vi)	X30Cr13	420B	1 100 to 800	Slow cooling	+A	800 to 900	Slow cooling	–	–	–
						Approx. 750	Air cooling			
					+QT	–	–	920 to 980	Oil	600 to 750
v)	X40Cr13	420C	1 100 to 800	Slow cooling	+A	750 to 800	Furnace, air	–	–	–
					+QT	–	–	950 to 1050	Oil, air	600 to 700

Table 23 (*Concluded*)

Sl No.	Steel Designation		Hot Forming		Heat Treatment Symbol	Annealing		Quenching		Tempering
	Grade	Numerical Symbol	Temperature °C	Type of Cooling		Temperature[b] °C	Type of Cooling	Temperature[b] °C	Type of Cooling	Temperature °C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
vi)	X17Cr16Ni2	431	1 100 to 800	Slow cooling	+A	680 to 800	Furnace, air	–	–	–
					+QT1	–	–	950 to 1 050	Oil, air	750 to 800+ 650 to 700[c]
					+QT2	–	–	950 to 1 050	Oil, air	600 to 650
vii)	X110Cr17	440C	1 100 to 900	Slow cooling	+A	780 to 840	Furnace, air	–	–	–
viii)	X50Cr15MoV	420V	1 100 to 800	Slow cooling	+A	750 to 850	Furnace, air	–	–	–
ix)	X03Cr13Ni4Mo	**415**	1 150 to 900	Air	+A	600 to 650	Furnace, air	–	–	–
					+QT1	–	–	950 to 1 050	Oil, air	650 to 700 + 600 to 620
					+QT2	–	–	950 to 1 050	Oil, air	550 to 600
					+QT3	–	–	950 to 1 050	Oil, air	520 to 580
x)	X04Cr16Ni5Mo1	431N	1150 to 900	Air	+A	600 to 650	Furnace, air	–	–	–
					+QT1	–	–	950 to 1 050	Oil, air	590 to 620[d]
					+QT2	–	–	950 to 1 050	Oil, air	550 to 620
xi)	X14Cr17S	Q1	1100 to 800	Air	+A	750 to 850	Furnace, air	–	–	–
					+QT	–	Air	950 to 1 070	Oil, air	550 to 650
xii)	X39Cr17Mo1	434C	1 100 to 800	Slow cooling	+A	750 to 850	Furnace, air	–	–	–
					+QT	–	–	980 to 1 060	Oil	650 to 750

[a] The temperatures of annealing, quenching and tempering shall be agreed upon 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] In cases where the nickel content is on the lower side of the range specified in Table 2, a single tempering at 620 °C to 720 °C can be sufficient.

[d] Either 2 h × 4 h or 1 h × 8 h as a minimum time.

Table 24 Guidelines on the Temperatures for Hot Forming and Heat Treatment[a)] of Precipitation-Hardening Corrosion-Resistant Stainless Steel

(*Clause* A-1)

Sl No.	Steel Designation	Hot Forming		Type of Cooling	Heat Treatment Symbol	Solution Annealing		Precipitation Hardening
	Grade	Numerical Symbol	Temperature °C			Temperature[b)] °C	Type of Cooling	Temperature °C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	X05Cr16Ni4CuNb	630	1 150 to 900	Furnace, air	+AT[c)]	1 020 to 1 060		–
					+P1	1 020 to 1 060	Rapid cooling	610 to 630/air
					+P2	1 020 to 1 060	Rapid cooling	570 to 590/air
					+P3	1 020 to 1 060		540 to 560/air
					+P4	1 020 to 1 060		470 to 490/air
ii)	X07Cr17Ni7AI		1 150 to 900	Air	+AT	1 020 to 1 080	Water, air	–

[a)] The temperatures of solution annealing shall be agreed upon 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 B

(*Foreword*)

DESIGNATIONS OF THE STEELS GIVEN IN TABLE 2 AND OF COMPARABLE GRADES COVERED IN ASTM, ISO, EN, JIS AND GB STANDARDS

Table 25 Designations of the Steels Given in Table 3 and of Comparable Grades Covered in ASTM, ISO, EN, JIS and GB Standards

Sl No.	Steel Designation 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)]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
a) Austenitic steels												
i)	4310-301-00-I	X15Cr18Ni8	301	AP26L	S30100	W	1.4310	N	–	–	S30110	W
ii)	4307-304-03-I	X02Cr19Ni10	304L	AP27B	S30403	W	1.4307	N	SUS304L	W	S30403	W
iii)	4305-303-00-I	X10Cr18Ni9S	303	AP27M	S30300	W	1.4305	W	SUS303	W	S30317	W
iv)	4311-304-53-I	X02Cr18Ni9N	304LN	AP27A	S30453	W	1.4311	N	SUS304LN	W	S30453	W
v)	4567-304-30-I	X03Crl8Ni9Cu4	304Cu	AP27F	S30430	W	(1.4567)	N	SUSXM7	W	S30488	W
vi)	4570-303-31-I	X06Cr18Ni9Cu2s	303Cu	AP27I	S30331	I	1.4570	N	–	–	–	W
vii)	|4315-304-51 -I	X05Cr19Ni9N	304N	AP28F	S30451	N	1.4315	W	SUS304N1 SUS04NZ	I N	S30458	–
viii)	4301-304-00-I	X04Cr19Ni9	304	AP28E	S30400	W	1.4301	I	SUS304	W	S30408	W
ix)	4541-321-00-I	X04Cr18Nil0Ti	321	AP28G	S32100	W	1.4541	I	SUS321	W	S32168	W
x)	|4550-347-00-I	X06Cr18Ni10Nb	–	AP28H	S34700	I	1.4550	N	SUS347	W	S34778	N
xi)	4306-304-03-I	X02Cr19Ni11	304LNi	AP30A	S30403	W	1.4306	N	SUS304L	W	S30403	N
xii)	4303-305-00-I	X06Cr18Ni12	–	AP30I	S30500	W	1.4303	N	SUS30S	W	S30510	W

Table 25 (*Continued*)

Sl No.	Steel Designation 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]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xiii)	4597-204-76-I	X08Cr17Mn8Cu3	204Cu	AP25L	–	–	1.4597	N	–	–	–	–
xiv)	4615-201-75-E	X03Cr15Mn8NisCu3	201Cu	AP28C	–	–	(1.4615)	I	–	–	–	–
xv)	4373-202-00-I	X12Cr18Mn9Ni5N	202	AP320	S20200	W	1.4373	N	SUS202	W	S35450	N
b) Steel Designation according to[a]												
xvi)	4369-202-91-I	X11Cr19Ni8Mn6N	202S1	AP33L	–	–	1.4369	I	–	–	–	–
xvii)	4335-310-02-I	X01Cr25Ni21	–	AP46A	S31002	W	1.4335	I	–	–	–	–
c) Austenitic steels with Mo												
xviii)	4404-316-03-I	X02Cr17Ni12Mo2	–	AM31A	S31603	W	1.4404	N	SUS316L	W	S31603	N
xix)	4401-316-00-I	X05Cr17Ni12Mo2	–	AM31I	S31600	W	1.4401	N	SUS316	W	S31608	N
xx)	4571-316-35-I	X06Cr17Ni12Mo2Ti	–	AM31F	S31635	W	1.4571	N	SUS316Ti	W	S31668	W
xxi)	4432-316-03-I	X02Cr17Ni12Mo3	–	AM32A	S31603	W	1.4432	I	SUS316L	W	S31603	W
xxii)	4436-316-00-I	X03Cr17Nil2Mo3	–	AM32F	S31600	W	1.4436	I	SUS316	W	S31608	W
xxiii)	429-316-53-I	X02Cr17Ni12Mo3	–	AM32B	S31653	W	1.4429	N	SUS316LN	W	S31653	N
xxiv)	435-316-91-I	X02Cr18Ni14Mo3	316LNi	AM35A	–	–	1.4435	N	SUS316L	W	S31603	W
xxv)	4434-317-53-I	X02Cr18Ni12Mo3N	–	AM34B	S31753	W	1.4434	N	SUS317LN	W	S31753	W
xxvi)	4439-317-26-E	X02Cr17Nil3Mo5N	–	AM35B	S31726	N	1.4439	I	–	–	S31723	W
xxvii)	4547-3 12-54-I	X01Cr20Ni18Mo7CuN	–	AM45A	S31254	W	1.4547	N	SUS312L	W	S31252	N

Table 25 (*Continued*)

Sl No.	Steel Designation 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)]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xxviii)	|4466-310-50-E	X01Cr25Ni22Mo2	–	AM49A	S31050	W	1.4466	I	–	–	S31053	W
xxix)	4659-3 12-66-I	X01Cr24Ni22Mo6CuNW	–	AM52B	S31266	W	1.4659	I	–	–	–	–
xxx)	|4652-326-54-I	X01Cr24Ni22Mo8CuN	_	AM54A	S32654	N	1.4652	I	–	–	S32652	N
xxxi)	4565-345-65-I	X02Cr25Ni18Mn6Mo5N	–	AM54B	S34565	W	1.4565	I	–	–	S34553	N
d) Austenitic steels with Ni/Co as main alloying elements												
xxxii)	4539-089-04-I	X01Ni25Cr20Mo5Cu	904L	AN50A	N08904	W	1,4539	N	SUS890L	W	S39042	N
xxxiii)	4529-089-26-I	X01NI25Cr20Mo7CuN	904LN	AN52A	N08926	W	1,4529	N	–	–	–	–
xxxiv)	4563-080-28-I	X01Ni31Cr27Mo4Cu	–	AN62A	N08028	W	1,4563	I	–	–	–	–
e) Austenitic-ferritic (duplex) steels												
xxxv)	4062-322-02-U	X02Cr22Ni2N	_	DP24A	S32202	N	1.4062	I	–	–	–	–
xxxvi)	4162-321-01-E	X02Cr21Mn5NilN	2101	DP27F	S32101	N	1.4062	I	–	–	–	–
xxxvii)	4362-32304-I	X02Cr23Ni4N	2304	DP27B	S32304	W	1.4062	I	–	–	S23043	W
xxxviii)	4462-31803-I	X02Cr22NiSMo3N	2205	DM30A	S32205	N	1.4462	I	SUS329J3L	W	S22053	N
xxxix)	4462-82441-X	X02Cr24Ni4Mn3Mo2CuN	2441	DM33A	–	–	1.4462	I	–	–	–	–
xl)	4460-31200-I	X03Cr27NiSMo2N	–	DM34F	S31200	W	1.4460	I	–	–	S22553	W
xli)	4507-32520-I	X02Cr25Ni6Mo3CuN	–	DM34A	S32520	W	1.4507	I	–	–	S25554	–
xlii)	4410-32750-E	X02Cr25Ni7MO4N	2507	DM36A	S32750	W	1.4410	I	–	–	S25073	W

Table 25 (*Continued*)

Sl No.	Steel Designation 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]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xliii)	4501-32760-I	X02Cr25Ni7Mo4CuWN	2760	DM36B	S32760	I	1.4501	N	–	–	S27603	N
xliv)	4658-32707-U	X02Cr28Ni8Mo5Co1N	–	DM42A	S32707	I	1.4658	I	–	–	–	–
f) Ferritic steels												
xlv)	4000-41008-I	X06Cr13	_	FP13G	S41008	W	1.4000	N	SUS410S	N	S41008	N
xlvi)	4016-43000-I	X06Cr17	_	FP17I	S43000	W	1.4016	I	SUS430	W	S11710	W
xlvii)	4004-43020-I	X07CrS17	–	FP17L	S43020	W	(1.4004)	I	SUS430F	W	S11717	W
xlviii)	4511-43071-I	X03Cr17Nb	430Nb	FP17G	–	–	1.4511	N	SUS430LX	W	–	–
xlix)	4509-439|40-X	X02Cr18TiNb	439	FP18B	S43940	I	1.4509	N	SUS430LX	W	S11873	I
l)	4113-43400-1	X06Cr17Mo1	–	FM18I	S43400	W	1.4113	N	SUS434	W	Si1790	W
li)	4523-18235-I	02Cr18Mo2TiS	_	FM20C	S18235	W	1.4523	I	–	–	–	–
g) Steel designations according to[a]												
lii)	4006-410-00-I	X12Cr13	410	MP13B	S41000	W	1.4006	I	SUS410	W	S41010	W
liii)	4005-416-00-I	X12Cr13S	416	MP13C	S41600	W	1.4005	N	SUS416	W	S41617	N
liv)	|4021-420-00-I	X20Cr13	420	MP13I	S42000	W	1.4021	I	SUS420J1	N	S42020	N
lv)	4028-420-00-I	X30Cr13	420B	MP13M	S42000	W	1.4028	I	SUS420J2	W	S42030	N
lvi)	4034-420-00-I	X40Cr13	420C									
lvii)	4057-431-00-X	X17Cr16Ni2	430	MP16G	S43100	W	1.4057	I	SUS431	W	S43120	I
lviii)	4023-440-04-I	X110Cr17	110C	MP17W	S44004	W	1.4125	I	SUS440C	N	S44096	N

Table 25 (*Concluded*)

Sl No.	Steel Designation 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)]		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
lix)	4313-415-00-I	X3Cr13Ni4Mo	415	MM14A	S41500	W	1.4313	N	SUSF6NM	W	S41595	W
lx)	4116-420-77-E	X50Cr15MoV	420V	MM1SU	–	–	1.4116	I	–	–	–	–
lxi)	|4122-434-09-I	X39Cr17Mol	434C	MM18R	–	–	1.4122	I	–	–	–	–
h) Precipitation-hardening steels												
lxii)	4542-174-00-I	X05Cr16Ni4CuNb	630	PP20I	S17400	W	1.4542	N	SUS630	W	SS1740	W
lxiii)	4568-177-00-I	X07Cr17N7AI	_	PP24L	S17700	N	1.4568	N	SUS631	W	S51770	N

NOTE — The grades given in this table are comparable to those given in Table 2. 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"; ifthe steel number is given in bracket, 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.

[f)] I = Identical steel to ISO steel grade; N = steel grade with closer match of composition. but not identical; W = wider match.

ANNEX C

(*Clause* 12)

DIMENSIONAL TOLERANCES

Table 26 Permissible Variation in Size for Hot-Rolled Round and Square Bars

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Nominal Size		Tolerance	
	Over	Up to and Including	Permissible Variation	Out of Round or Out of Square Section
(1)	(2)	(3)	(4)	(5)
i)	8	11	± 0.15	0.23
ii)	11	16	± 0.18	0.25
iii)	16	22	± 0.20	0.30
iv)	22	25	± 0.24	0.35
v)	25	28	± 0.25	0.40
vi)	28	31	± 0.28	0.45
vii)	31	34	± 0.30	0.50
viii)	34	38	± 0.36	0.60
ix)	38	50	± 0.40	0.60
x)	50	64	+ 0.8 - 0	0.80
xi)	64	89	+ 1.2 - 0	0.80
xii)	89	114	+ 1.8 - 0	1.20
xiii)	114	139	+ 2.0 - 0	1.50
xvi)	139	165	+ 3.2 - 0	1.80
xvii)	165	200	+ 4.0	2.00
xviii)	> 200		- 0 + 2 % - 0	

NOTES

1 Out of round is the difference between the maximum and minimum diameters of the bars, measured at the same cross section. Out-of-square section is the difference in the two dimensions at the same cross-section of a square bar, each dimension being the distance between opposite faces.

2 Size tolerances for rounds in the size range of 6 mm to 8 mm. Including and for rounds in the size range of 6 mm to approximately 16 mm. which are produced on rod mills in coils, are not shown here in the table.

3 Variations in size of coiled product made on rod mills are greater than size tolerances for product made on bar mills.

4 Squares in this size are not produced as hot-rolled product.

Table 27 Permissible Variation in Size for Hot-Rolled Hexagon Bars

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Nominal Size		Tolerances	
	Over	Up to and Including	Permissible Variation	Maximum Differences in Three Measurements for Hexagons
(1)	(2)	(3)	(4)	(5)
i)	6	12	± 0.18	0.28
ii)	12	25	± 0.25	0.4
iii)	25	38	± 0.5	0.6
iv)	38	50	± 0.8	0.8
v)	50	64	± 1.2	1.2
vi)	64	89	± 1.6	1.6

Table 28 Permissible Variation in Size for Hot-Rolled Square Edge and Round Edge Flats

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Specified Width		Thickness Tolerance						Tolerance
	Over	Up to and Including	Over 3 Up to and Including 12 mm	Over 12 Up to and Including 25 mm	Over 25 Up to and Including 50 mm	Over 50 Up to and Including 100 mm	Over 100 Up to and Including 150 mm	Over 150 Up to and Including 200 mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	–	25	± 0.20	± 0.25	–	–	–	–	± 0.38
ii)	25	50	± 0.30	± 0.28	± 0.80	–	–	–	± 0.80
iii)	50	100	± 0.38	± 0.50	± 0.80	+ 1.60	+ 2.40	–	± 1.60
						- 0.80	- 3.20		
iv)	100	150	± 0.38	± 0.50	± 0.80	+ 1.60	+ 2.40	–	± 2.40
						- 0.80	- 3.20	- 1.60	
v)	150	200	± 0.40	± 0.60	± 0.80	+ 1.60	+ 2.40	+ 3.20	–
						- 0.80	- 3.20	- 4.00	
vi)	200	250	± 0.50	± 0.80	± 0.80	+ 1.60	+ 2.40	+ 3.20	–
						- 0.80	- 3.20	- 4.00	

Table 29 Permissible Variation in Size of Cold-Finished Round Bars

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Specified Size		Permissible Variation
	Over	Up to and Including	
(1)	(2)	(3)	(4)
i)	–	12	± 0.04
ii)	12	25	± 0.05
iii)	25	38	± 0.06
iv)	38	100	± 0.08

NOTE — Unless otherwise specified, size tolerances are over and under as shown in this table. When required however, they may be specified all over and nothing under or all under and nothing over or any combination of over and under. provided the total spread in size tolerance for a specified size is not less than the total spread shown in this table

Table 30 Permissible Variation in Size of Cold-Finished Hexagonal and Square Bars

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Specified Over	Size Up to and Including	Permissible Variation
(1)	(2)	(3)	(4)
i)	12	25	+ 0 - 0.10
ii)	25	50	+ 0 - 0.15
iii)	50	75	+ 0 - 0.20
iv)	75	—	+ 0 - 0.25

NOTES

1 When it is necessary to heat-treat or heat-treat and pickle after cold-finishing, the size tolerances are double of those shown in this table.

2 When it is necessary to heat-treat and pickle after cold-finishing, the size tolerances are double of those shown in this table.

Table 31 Permissible Variation in Width and Thickness of Cold-Finished Flat Bars

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Width		Permissible Variation in Width	
	Over	Up to and Including	For the Thickness 6 mm and Under	For Thicknesses Over 6 mm
(1)	(2)	(3)	(4)	(5)
i)	10	25	± 0.10	± 0.05
ii)	25	50	± 0.15	± 0.08
iii)	50	75	± 0.20	± 0.10
iv)	75	112	± 0.25	± 0.13
	Thickness		**Permissible Variation in Thickness**	
	Over	Up to and Including		
i)	3	25	± 0.05	
ii)	25	50	± 0.08	
iii)	50	75	± 0.10	
iv)	75	112	± 0.13	
NOTE — When it is necessary to heat-treat and pickle after cold-finishing the size tolerances are double of those shown in this table.				

Table 32 Permissible Variation in Lengths of Hot-Finished or Cold-Finished Bars in Fixed Lengths

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Specified Size of Rounds, Squares, Hexagonal and Width of Flats		Permissible Variation in Length	
	Over	Up to and Including	Up to and Including 3 600	Over 3 600 Up to and Including 7 500
(1)	(2)	(3)	(4)	(5)
i)	–	50	+ 12 - 0	+ 20 – 0
ii)	50	100	+ 20 - 0	+ 25 - 0
iii)	100	150	+ 25 - 0	+ 30 - 0
iv)	150	225	+ 30 - 0	+ 38 - 0
v)	225	300	+ 38 - 0	+ 50 - 0

Table 33 Permissible Variation in Length of Hot-Finished or Cold-Finished Bars Machine Cut to Fixed Lengths After Machine Straightening

(*Clause* 12)

All dimensions in millimeters.

Sl No.	Specified Size of Rounds Squares, Hexagons and Width of Flats		Permissible Variation in Length	
	Over	Up to and Including	Up to and Including 3600	Over 3 600 Up to and Including 7 500
(1)	(2)	(3)	(4)	(5)
i)	–	75	+ 3 - 0	+ 4 - 0
ii)	75	150	+ 4 - 0	+ 6 - 0
iii)	150	225	+ 6 - 0	+ 8 - 0
iv)	225	300	+ 8 - 0	+ 12 - 0

Table 34 Permissible Variation in Straightness of Machine Straightened Hot-Finished or Cold-Finished Bars

(*Clause* 12)

Sl No.	Hot-Finished	Cold-Finished
(1)	(2)	(3)
i)	3 mm in any metre length	1.5 mm in any metre length

Table 35 Tolerances for Stainless Steel Wire Rods shall be as Given Below:

(*Clause* 12)

Sl No.	Diameter mm	Size Tolerance mm *Max*	Out of Round mm *Max*
(1)	(2)	(3)	(4)
i)	5.5 to 9.5	± 0.40	0.50
ii)	Over 9.5 up to 16	± 0.50	0.60
iii)	Over 16 up to 20	± 0.60	0.75
iv)	Over 20	± 0.70	0.90

Table 36 Values of Standard Tolerance Grades for Nominal Sizes Up to 3 150 mm for Hot Finished or Cold Finished Bars

(*Clause* 12)

Sl No.	Nominal Size mm		Standard Tolerance Values																		
	Above	Up to and Including	IT01	IT0	IT1	IT02	IT03	IT04	IT05	IT06	IT07	IT08	IT09	IT10	IT11	IT12	IT13	IT14	IT15	IT16	IT17	IT18
			µm													mm						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
i)	–	3	0.3	0.5	0.8	1.2	2	3	4	6	10	14	25	40	60	0.1	0.14	0.25	0.4	0.6	1	1.4
ii)	3	6	0.4	0.6	1	1.5	2.5	4	5	8	12	18	30	48	75	0.12	0.18	0.3	0.48	0.75	1.2	1.8
iii)	6	10	0.4	0.6	1	1.5	2.5	4	6	9	15	22	36	58	90	0.15	0.22	0.36	0.58	0.9	1.5	2.2
iv)	10	18	0.5	0.8	1.2	2	3	5	8	11	18	27	43	70	110	0.18	0.27	0.43	0.7	1.1	1.8	2.7
v)	18	30	0.6	1	1.5	2.5	4	6	9	13	21	33	52	84	130	0.21	0.33	0.52	0.84	1.3	2.1	3.3
vi)	30	50	0.6	1	1.5	2.5	4	7	11	16	25	39	62	100	160	0.25	0.39	0.62	1	1.6	2.5	3.9
vii)	50	80	0.8	1.2	2	3	5	8	13	19	30	46	74	120	190	0.3	0.46	0.74	1.2	1.9	3	4.6
viii)	80	120	1	1.5	2.5	4	6	10	15	22	35	54	87	140	220	0.35	0.54	0.87	1.4	2.2	3.5	5.4
ix)	120	180	1.2	2	3.5	5	8	12	18	25	40	63	100	160	250	0.4	0.63	1	1.6	2.5	4	6.3
x)	180	250	2	3	4.5	7	10	14	20	29	46	72	115	185	290	0.46	0.72	1.15	1.85	2.9	4.6	7.2
xi)	250	315	2.5	4	6	8	12	16	23	32	52	81	130	210	320	0.52	0.81	1.3	2.1	3.2	5.2	8.1
xii)	315	400	3	5	7	9	13	18	25	36	57	89	140	230	360	0.57	0.89	1.4	2.3	3.6	5.7	8.9
xiii)	400	500	4	6	8	10	15	20	27	40	63	97	155	250	400	0.63	0.97	1.55	2.5	4	6.3	9.7
xiv)	500	630	–	–	9	11	16	22	32	44	70	110	175	280	440	0.7	1.1	1.75	2.8	4.4	7	11

Table 36 (*Concluded*)

Sl No.	Nominal Size mm		Standard Tolerance Values																		
	Above	Up to and Including	IT01	IT0	IT1	IT02	IT03	IT04	IT05	IT06	IT07	IT08	IT09	IT10	IT11	IT12	IT13	IT14	IT15	IT16	IT17	IT18
			µm													mm						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
xv)	630	800	–	–	10	13	18	25	26	50	80	125	200	320	500	0.8	1.25	2	3.2	5	8	12.5
xvi)	800	1 000	–	–	11	15	21	28	40	56	90	140	230	360	560	0.9	1.4	2.3	3.6	5.6	9	14
xvii)	1 000	1 250	–	–	13	18	24	33	47	66	105	165	260	420	660	1.05	1.65	2.6	4.2	6.6	10.5	16.5
xviii)	1 250	1 600	–	–	15	21	29	39	55	78	125	195	310	500	780	1.25	1.95	3.1	5	7.8	12.5	19.5
xix)	1 600	2 000	–	–	18	25	35	46	65	92	150	230	370	600	920	1.5	2.3	3.7	6	9.2	15	23
xx)	2 000	2 500	–	–	22	30	41	55	78	110	175	280	440	700	1 100	1.75	2.8	4.4	7	11	17.5	28
xxi)	2 500	3 150	–	–	26	36	50	68	96	135	210	330	540	860	1 350	2.1	3.3	5.4	8.6	13.5	21	33

ANNEX D

(Clause 2)

LIST OF REFERRED STANDARDS

IS No./Other Standards	*Title*
IS 228 (all parts)	Method of chemical analysis of steels
IS 919 (Part 1) : 2014/ ISO 286-1 : 2010	Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes: Part 1 Basis of tolerance, deviation and fits (*third revision*)
IS 1500 (Part 1) : 2019/ISO 6506-1 : 2014	Metallic materials — Brinell hardness test: Part 1 Test method (*fifth revision*)
IS 1501 (Part 1) : 2020/ISO 6507-1 : 2018	Metallic materials — Vickers hardness test: Part 1 Test method (*fifth revision*)
IS 1586 (Part 1) : 2018/ISO 6508-1 : 2016	Metallic materials — Rockwell hardness test: Part 1 Test method (*fifth revision*)
IS 1599 : 2019/ ISO 7438 : 2016	Metallic materials — Bend test (*fourth revision*)
IS 1608	Metallic materials — Tensile testing:
(Part 1) : 2022/ ISO 6892-1 : 2019	Method of test at room temperature (*fifth revision*)
(Part 2) : 2020/ ISO 6892-2 : 2018	Method of test at elevated temperature (*fourth revision*)
IS 1757 (Part 1) : 2020/ ISO 148-1 : 2016	Metallic materials — Charpy pendulum impact test: Part 1 Test method (*fourth revision*)
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 10461 (Part 1) : 1994	Resistance to inter-granular corrosion of austenitic stainless steels — Method for determination: Part 1 Corrosion test in nitric acid medium by measurement of loss in mass (huey test) (*first revision*)
IS/ISO 10474 : 2013	Steel and steel products — Inspection documents (*first revision*)
IS/ISO 14284 : 1996	Steel and iron-sampling and preparation of samples for the determination of chemical composition
IS 14650 : 2023	Unalloyed and alloyed steel ingot and semi-finished products for re-rolling purposes — Specification (*first revision*)
ISO 3651 (Part 2) : 1998	Determination of resistance to inter granular corrosion of stainless steels — Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels — Corrosion test in media containing sulfuric acid

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ANNEX E

(*Foreword*)

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