भारतीय मानक **IS 11169 (Part 2) : 2023**

Indian Standard

श्रतप्त शीर्षन/श्रतप्त बहिर्वेधन प्रयोग के किये इस्पात

भाग 2 स्टेनलैस इस्पात — विशिष्टि

(पहला पुनरीक्षण)

Steels for Cold Heading/Cold Extrusion Applications

Part 2 Stainless Steels — Specification

(First Revision)

ICS 77.140.20

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October 2023 **Price Group 10**

Alloy Steels and Forgings Sectional Committee, MTD16

FOREWORD

This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Alloy Steels and Forgings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1989. While reviewing this standard, in the light of experience gained during these years, the Committee decided to revise it to bring in line with the present manufacturing and trade practices being followed in the country in this field.

This standard is published in two parts. The other part in the series is:

Part 1 Wrought carbon and alloy steels

In addition to incorporating amendment issued to previous version, the following important changes are made in this revision:

a) Grades of majorly used cold heading/cold extrusion quality are included;
b) Nomenclature of new grades is introduced as per IS 1762 (Part 1);
c) Mechanical properties in various delivery conditions are introduced;
d) Dimensional tolerances have been modified;
e) Surface quality criterion is modified;
f) Upsetting test criterion is modified by allowing acceptance limits to be agreed upon between manufacturer and purchaser;
g) Methods of mechanical tests have been updated; and
h) A comparative list indicating grades covered in various designation systems is added.

A large quantity of stainless steels are manufactured in India for cold heading/cold extrusion applications in the form of wire, wire rod and bars. Some important uses for these are cold heading quality fasteners, ball pins, shafts, gears mainly in automotive industries. Since demand and use for cold heading/cold extrusion grades available in other international standards and practically developed grades increased over the years, the committee, therefore, decided to revise by including all available cold heading/cold extrusion grades in various standards which are being used by the Indian industry.

While revising this standard assistance has been derived from ISO 4954 ‘Steels for cold heading and cold extruding’.

The composition of the Committee, responsible for the formulation of the standard is given in Annex C.

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

STEELS FOR COLD HEADING/COLD EXTRUSIONAPPLICATIONS

PART 2 STAINLESS STEELS — SPECIFICATION

(First Revision)

1 SCOPE

1.1 This standard (Part 2) covers the requirements for stainless steels intended for cold heading or cold extrusion and are delivered as wires, wire rods or bars with nominal sizes of 0.8 mm up to 50 mm for austenitic steels, up to 25 mm for ferritic steels and up to 100 mm for martensitic steels.

1.2 This standard is not applicable to the properties of cold headed/cold extruded parts.

2 REFERENCES

The standards given below contain provisions which through reference in this text, constitute provision 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 edition of these standards:

IS No.	*Title*
IS 228 (all parts)	Methods of chemical analysis of steels
IS 919 (Part 2) : 2014/ ISO 286-2 : 2010	Geometrical product specifications (GPS) — ISO code system for tolerances on linear sizes: Part 2 Tables of standard tolerance classes and limit deviation for holes and shafts (*second revision*)
IS 1608 (Part 1) : 2022/ISO 6892- 1 : 2019	Metallic materials — Tensile testing: Part 1 Method of test at room temperature (*fifth revision*)
IS 1762 (Part 1) : 1974	Code for designation of steels: Part 1 Based on letter symbols (*first 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 11371 : 2022	Method for macroetch testing inspection and rating of wrought steel products (*first revision*)
IS/ISO 14284 : 1996	Steel and iron — Sampling and preparation of samples for the determination of chemical composition

3 TERMINOLOGY

For the purposes of this document, the terms and definitions given in IS 1956 (Part 1), (Part 2) and (Part 3) shall apply.

4 SUPPLY OF MATERIAL

4.1 General requirements for the supply of material shall be as laid down in IS 8910.

4.2 Steels covered by this standard shall be supplied in one of the delivery conditions as indicated in Table 9 as agreed at the time of enquiry and order.

4.3 Information to be given by the Purchaser

The manufacturer shall obtain the following information from the purchaser at the time of enquiry and order:

a) the quantity to be delivered;
b) the product form (bar, wire rod, wire);
c) nominal dimensions, shape along with tolerance on dimensions;
d) for bars the length and for wire rod and wire the coil dimensions, that is inner diameter and mass of the coils;
e) the designation of the steel grade given in Table 10 (*see* Annex A);
f) condition of delivery as given in Table 9 (*see* Annex A); and
g) other options and supplementary or special requirements, if required.

5 CLASSIFICATION AND DESIGNATION

5.1 Classification

Stainless is classified on the basis of crystalline structure as austenitic, ferritic and martensitic.

5.2 Designation

For the steel grades covered by this document, the designations as given in the relevant tables have been allocated in accordance with IS 1762 (Part 1).

Table 15 (*see* Annex B) provides a list of steels given in Annex A and the comparable grades covered in various designation systems in other national/international/ associations standard.

6 MANUFACTURE

Unless otherwise agreed to in the order, the processes used in making the steel are left to the discretion of the manufacturer. When so desired, the purchaser shall be informed of the steel making process.

7 CHEMICAL COMPOSOTION

7.1 Ladle Analysis

The ladle analysis of different grades of steel when carried out either in accordance with relevant parts of IS 228 or any other established instrumental/ chemical method shall conform to the values given in Table 10. In case of dispute, the procedure given in various parts of IS 228 (in parts) shall be the referee method.

For cases where the methods of chemical analysis are not covered in any part of IS 228, mutually agreed methods may be adopted by the manufacturer and the customer.

7.2 Product Analysis

The permissible variation in the case of product analysis from the limits specified in Table 10 shall be according to Table 1.

8 MECHANICAL PROPERTIES

8.1 The mechanical properties of the steel in condition of supply mentioned in Table 9 shall conform to Table 11, Table 12, Table 13 and Table 14.

8.1.1 The tensile test shall be carried out in accordance with IS 1608 (Part 1). The tensile properties for cases not mentioned, may be mutually agreed between the purchaser and manufacturer.

9 PREPARATION OF SAMPLES AND TEST PIECES

9.1 Selection and Preparation of Samples for Product Analysis

Samples for product analysis shall be taken from the test pieces or samples for mechanical testing or from the same location as the mechanical test samples in accordance with IS/ISO 14284.

If the product analysis is required by the purchaser, at least one sample product shall be taken from each cast/lot.

9.2 Selection and preparation of samples and test pieces for the mechanical tests

Samples and test pieces shall be taken in accordance with the general requirements of IS 3711. The test piece shall be prepared in accordance with IS 1608 (Part 1).

a) For products with d > 25 mm: The test piece for the tensile test shall be taken to conform to the indication given in Fig. 1c).

b) For products with d > 50 mm: The test piece for the tensile test shall be taken to conform to the indication given in Fig. 1d).

c) For products with d ≤ 25 mm: The test piece for the tensile test shall be submitted to test without preliminary machining, [*see* Fig. 1a)]. If test equipment does not allow this, the test piece may be prepared by machining, as shown in Fig. 1b).

d) For forms or sizes not covered in IS 3711, selection and preparation of samples and test pieces for the mechanical test may be mutually agreed between the purchaser and manufacturer.

Table 1 Permissible Deviation in Product Analysis

(*Clause* 7.2)

Sl No.	Constituent	Permissible Content in Cast Analysis Percent		Permissible Deviation Percent
		Over	Up to and Including	
(1)	(2)	(3)	(4)	(5)
i)	Carbon	— 0.03	0.03 0.15	± 0.005 ± 0.01
ii)	Silicon	— 1.00	1.00 2.00	+ 0.05 ± 0.10
iii)	Manganese	— 1.00	1.00 2.0	+ 0.03 ± 0.04
iv)	Chromium	11.5 15 ≥ > 20	< 15 20 23	± 0.15 ± 0.20 ± 0.25
v)	Molybdenum	— 1.75 ≥	< 1.75 3.5	± 0.05 ± 0.10
vi)	Nickel	— 1 > 5 > 10 > 20	1 5 10 20 27	+ 0.03 ± 0.07 ± 0.10 ± 0.15 ± 0.20
vii)	Sulphur	— 0.015	0.015 0.030	+ 0.003 ± 0.005
viii)	Phosphorus	—	0.045	+ 0.005
ix)	Titanium	— > 1	1 2.35	± 0.05 ± 0.07
x)	Nitrogen	—	0.22	± 0.02
xi)	Aluminium	—	0.35	+ 0.10
xii)	Boron	0.001	0.010	± 0.000 5
xiii)	Copper	—	1	+ 0.04
		> 1	4	± 0.10
xiv)	Vanadium	—	0.50	± 0.03

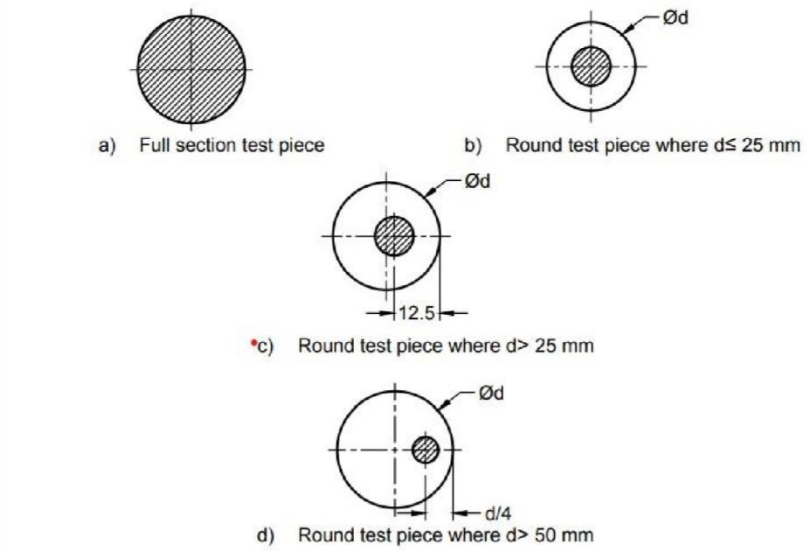

FIG.1 LOCATION OF TEST PIECE FOR THE TENSILE TEST

9.3 Sampling

9.3.1 For the purpose of this standard, products belonging to the same cast and same delivery condition shall constitute a lot. Samples shall be tested from each lot.

9.3.2 The ladle analysis shall be supplied by the producer. If a product analysis is required by the purchaser at least one sample of product shall be taken from each heat.

9.3.3 For mechanical tests, two test pieces shall be taken from each lot.

9.3.4 For other tests, the sampling method may be mutually agreed between the purchaser and the manufacturer.

10 APTITUDE TO COLD FORMING

A test for verification of the aptitude of products to cold forming may be carried out if agreed at the time of enquiry and order.

10.1 Upsetting Test

A test piece with an initial length (height) equal to 1.5 *d*, where *d* is the product diameter, is submitted to axial heading by means of a press until its length is reduced to one third of the initial value.

The above test shall be carried out at an ambient temperature and shall be limited to products with a maximum diameter of 15 mm. The tests shall be carried out at room temperature. The assessment and acceptance criteria shall also be agreed at time of enquiry and order.

11 SURFACE QUALITY

11.1 General

All products shall have a smooth surface finish appropriate to the manufacturing process applied. For hot-rolled products, minor surface imperfections, which may occur also under normal manufacturing conditions, such as prints originating from rolled-in scale, are shall not be regarded as defects.

11.1.1 *Internal Soundness*

The material should be free from harmful microscopic defects like dendrities, blowholes, porosity, segregation, flakes etc, which may impair the intended application of the material. A macro-etch test as per IS 11371 shall be performed to ensure freedom from such defects.

11.1.2 The steel shall be free from internal and surface defects likely to have an adverse effect during cold heading or subsequent heat treatment.

11.1.3 The bars, wire rods and wires may be normally subjected to any non-destructive test capable of revealing all the surface defects which would lead to rejection of the material on the basis of mutually agreed standard of acceptance.

11.1.4 In the absence of any non-destructive test, adequate number of samples shall be tested by macroetching/microscopic examination and the acceptance surface defects level shall be as given in Table 2.

11.2 Removal of Surface Defects

Removal of surface defects and imperfections may be considered if agreed to between the purchaser and the manufacturer.

11.3 Wire Rod

Wire rod shall meet surface quality requirements in accordance with quality Class 1 as given in Table 3. For certain higher applications, quality Class 2 as given in Table 3 is appropriate and may be agreed at the time of enquiry and order.

11.4 Bars

Bars shall meet surface quality requirements in accordance with Class 1 given in Table 3. Conformity to surface quality as given in quality Class 2 of Table 3 may be agreed at the time of enquiry and order. When the diameter of the product is greater than the maximum diameter specified in Table 3 for the surface quality class concerned, the maximum permissible depth of surface defects on the product shall not be greater than that specified for this maximum diameter.

11.5 Bright Products

For wire, the permissible depth of surface discontinuities shall be in proportion to the reduction of the diameter during cold drawing. Depending on the starting material for cold drawn products, the same requirements apply as specified in **11.3**.

Cold drawn bars shall be delivered with the surface quality Class 1 and peeled/turned bars shall be delivered with surface quality Class 3 in accordance with Table 4.

Table 2 Maximum Depth of Surface Discontinuities

(*Clause* 11.1.4)

Sl No.	Nominal Size in the Delivery Condition [a]	Maximum Permissible Depth of Discontinuities
	mm	mm
(1)	(2)	(3)
i)	≤ 10	0.10
ii)	> 10	1 % of nominal size

[a] For diameter less than 5 mm, the permissible depth of surface discontinuities shall be reduced in proportion of the reduction of the diameter during cold drawing

Table 3 Surface Quality Class

(*Clauses* 11.3 *and* 11.4)

Sl No.	Class	Nominal Dimension[1], *d* (mm)	Maximum Surface Depth of Surface Discontinuities[2] (mm)	Portion *Z* (Default Value) percent
(1)	(2)	(3)	(4)	(5)
i)	1	$5 \leq d \leq 20$	0.15	0.5
		$20 < d \leq 40$	0.20	
		$40 < d \leq 100$	0.005*d*	
ii)	2	$5 \leq d \leq 100$	to be agreed, pdf [3]	0.2

[1] *d* is the nominal dimension that means diameter for rounds and distance across flats for squares and hexagons.

[2] The depth of surface discontinuities is measured from the actual surface of the product in radial direction. The dimensional tolerance shall also be considered when determining the section of the finished part which is ensured to be free of defect.

[3] pdf = practically defect free. This surface quality class shall be better than Class 1. It is dependent upon the steel production process and its quality control because existing non-destructive inspection techniques cannot measure such minor discontinuities. The specific means of assuring this quality depend upon the customer's intended application and the requirements and the method of control shall be agreed upon between the parties.

Table 4 Surface Quality Classes

(*Clause* 11.5)

Sl No.	Nominal Dimension[1], *d*		Permissible Defect Depth *Max*
	Over mm	Up to and Including mm	mm
(1)	(2)	(3)	(4)
i)	—	20	0.02
ii)	20	75	0.01*d*
iii)	75	—	0.75

[1] *d* is the nominal diameter of bar and distance across flats of square and hexagons

12 RETESTS

Retests shall be as specified in IS 8910.

13 SHAPE, DIMENSIONS AND TOLERANCES

13.1 The tolerance and out-of-roundness of the bars/wire rods/wire shall be as follows:

Sl No.	*Form*	*Tolerance*	*Out of Roundness*
(1)	(2)	(3)	(4)
i)	Bars	IS 3739	IS 3739
ii)	Wire rods up to 60 mm	IS/ISO 16124	IS/ISO 16124
iii)	Wire rods over 60 mm	To be mutually agreed between the purchaser and the supplier	
iv)	Wire	As agreed to between the purchaser and the supplier	

13.2 Bright bars shall be supplied as per the dimensions specified in the orders.

13.2.1 *Tolerances on Bright Bars*

Tolerances on diameter, thickness and width of bright bars shall be as specified by the purchaser and shall be in accordance with IS 919 (Part 2), as given in Table 5.

Table 5 Tolerance Class According to Finished Conditions

(*Clauses* 13.2.1 *and* 13.2.1.1)

Sl No.	Finished Condition	Tolerance Class to IS 919 (Part 2)						
		h6	h7	h8	h9	h10	h11	h12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Drawn	—	—	—	R	R	R, S, H	R, S, H
ii)	Turned	—	—	—	R	R	R	R
iii)	Turned and reeled	—	—	—	R	R	R	R
iv)	Ground	R	R	R	R	R	R	R
where R = round, S = square, and H = hexagon.								

13.2.1.1 Unless specified otherwise, tolerances on dimensions shall be as follows:

a) For drawn round bars other than those under (e), or turned bars: h10 to Table 6;

b) For hexagonal and square drawn bars: h11 for dimensions up to and including 80 mm, h12 for dimensions over 80 mm according to Table 5 and Table 6;

c) For drawn flats: in accordance with Table 7 and Table 8;

d) For ground products: in accordance with Table 5 and Table 6; and

e) For drawn round bars in the final quenched and tempered condition: h11.

13.2.2 *Length*

Bars and sections shall be supplied in length of 2.5 m to 4.5 m with maximum of 10 percent shorts of bot less than 1.5 m. If bars of other lengths are required to be supplied the same shall be as per the mutual agreement between the purchaser and the manufacturer.

13.2.2.1 When bars are required in specific lengths, tolerance of + 5/- 0 mm shall be applicable.

13.2.2.2 The ends of the bars shall be cut square without disturbing the dimensional tolerances.

Table 6 Tolerance Classes

(*Clause* 13.2.1.1)

Sl No.	Nominal Dimensions		Tolerance Class to IS 919 (Part 2)						
	Over	Up to and Including	h6	h7	h8	h9	h10	h11	h12
	mm	mm							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	6	10	0.009	0.015	0.022	0.036	0.058	0.090	0.150
ii)	10	18	0.011	0.018	0.027	0.043	0.070	0.110	0.180
iii)	18	30	0.013	0.021	0.033	0.052	0.084	0.130	0.210
iv)	30	50	0.016	0.025	0.039	0.062	0.100	0.160	0.250
v)	50	80	0.019	0.030	0.046	0.074	0.120	0.190	0.300
vi)	80	100	0.022	0.035	0.054	0.087	0.140	0.220	0.350

NOTE — The above deviation values are negatively disposed about the nominal dimension. For example a 20 mm nominal diameter having a tolerance Class h9 is 20 mm + 0, - 0.052 or 19.948/20.000 mm.

Table 7 Width Tolerance for Drawn Flats

(*Clause* 13.2.1.1)

Sl No.	Width		Deviation		IS 919 (Part 2) Tolerance Class to
	Over	Up to and Including	Plus	Minus	
	mm	mm	mm	mm	
(1)	(2)	(3)	(4)	(5)	(6)
i)	—	18	0	0.11	h11
ii)	18	30	0	0.13	h11
iii)	30	50	0	0.16	h11
iv)	50	80	0	0.19	h11
v)	80	100	0	0.22	h11

Table 8 Thickness Tolerance for Drawn Flats

(*Clause* 13.2.1.1)

Sl No.	Thickness		Deviation for Widths		IS 919 (Part 2) Tolerance Class to
	Over	Up to and Including	Up to and Including 65	Over 65	
	mm	mm	mm	mm	
(1)	(2)	(3)	(4)	(5)	(6)
i)	3	6	- 0.075	—	—
ii)	6	10	- 0.090	- 0.11	h11
iii)	10	18	- 0.11	—	—
iv)	18	30	- 0.13	- 0.13	h11
v)	30	50	- 0.16	- 0.16	h11
vi)	50	60	- 0.19	- 0.19	h11
vii)	60	80	- 0.30	- 0.30	h12
viii)	80	100	- 0.35	- 0.35	h12

NOTE — The above deviation values are negatively disposed.

13.2.3 *Straightness Tolerance*

13.2.3.1 Unless otherwise agreed, the permissible deviations shall not exceed 1.5 mm in any 1m length.

13.2.3.2 Any other details regarding measuring and sampling method for straightness tolerance of bright bars shall be agreed upon at the time of inquiry and order.

13.2.4 *Out of Shape*

Maximum deviation from 'out of shape' shall be not more than half the specified tolerance.

13.2.5 *Edges of Non-Round Bars*

Non-round bars, that is, square, hexagon and flat in widths up to and including 150 mm shall have sharp corners without radius. For widths over 150 mm the corner profile may be undefined within a distance of 0.5 mm of the hypothetical edge, unless sharp corners have specifically been ordered.

14 MARKING

14.1 Steel bars shall be suitably bundled and packed as per order. Each package of bars, coil of wire rods/wires shall carry a tag which shall be legibly marked with the cast number, grade, size and manufacturer's name or trade-mark. If mutually agreed, the weight of steel will be included in the tag. The colour code scheme as required by the purchaser may be adopted to mark the grade of the material.

Further requirements to special marking of the products shall be agreed at the time of enquiry and order.

14.2 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 product(s) may be marked with the Standard Mark.

15 PACKAGING

Each coil of wire rod/wire shall be bound and fastened compactly. If required by the purchaser, a special method of packaging of the product to be delivered shall be agreed at the time of enquiry and order.

ANNEX A

(*Clauses* 4.3, 5.2 *and Annex* B)

SPECIFIC REQUIREMENTS FOR COLD HEADING AND COLD EXTRUDING STAINLESS STEELS

Table 9 Combinations of Heat Treatments Conditions at Delivery, Product forms and Applicable Requirements

(*Clauses* 4.2, 4.3 *and* 8.1)

Sl No.	Heat-Treatment Condition at Delivery	Symbol	Product form[a]			Steels[a]			Applicable Requirements	
			Wire rod	Bar	Wire	Ferritic	Martensitic	Austenitic and Austenitic-Ferritic		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
i)	Solution annealed or solution annealed + peeled	+AT or AT + PE	X	X	X	—	—	X	Chemical composition as specified in Table 10	Mechanical properties as specified in Table 11, Table 12, Table 13 and Table 14
ii)	Solution annealed + cold drawn	+AT + C	–	X	X	—	—	X		
iii)	Solution annealed+ cold drawn + solution annealed	+AT + C + AT	—	X	X	—	—	X		
iv)	Solution annealed + cold drawn +solution annealed + skin passed	+AT + C + AT + LC	—	X	X	—	—	X		
v)	Soft annealed or soft annealed + peeled	+A or +A + PE	X	X	X	X	X	—		
vi)	Soft annealed +skin passed	+A +LC	—	X	X	X	X	—		
vii)	Soft annealed +cold drawn +soft annealed	+A + C + A	—	X	X	X	X	—		
viii)	Soft annealed + cold drawn + soft annealed +skin passed	+A + C + A + LC	—	X	X	X	X	—		
ix)	Others	Other delivery conditions may be agreed at the time of enquiry and order								

[a] X = applicable = Not applicable

Table 10 Chemical Composition (Applicable to Ladle Analysis) of Stainless Steel Grades

(*Clauses* 4.3, 7.1 *and* 7.2)

Sl No.	Designation	Numerical Symbol[f]	C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu	Others
						% mass [a] fraction							
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	**Austenitic steels**												
ii)	X10Cr18Ni8	301	0.05 to 0.15	2.00	2.00	0.045	0.015	16.0 to 19.0	6.0 to 9.5	0.80	0.10	1.00	—
iii)	X02Cr19Ni9	304L	0.030	1.00	2.00	0.045	0.030	17.5 to 19.5	8.0 to 10.0	—	0.10	1.00	—
iv)	X04Cr18Ni9Cu	304Cu	0.08	1.00	2.00	0.045	0.030	17.0 to 19.0	8.0 to 10.5	—	0.10	1.00 to 3.00	—
v)	X02Cr18Ni9Cu3		0.04	1.00	2.00	0.045	0.030	17.0 to 19.0	8.5 to 10.5 [b]	—	0.10	3.00 to 4.00	—
vi)	X02Cr18Ni8Cu		0.035	1.00	1.50 to 2.00	0.045	0.015	18.0 to 19.0	8.0 to 9.0	—	0.10	1.50 to 2.00	—
vii)	X04Cr19Ni10		0.07	1.00	2.00	0.045	0.030	17.5 to 19.5	8.0 to 10.5	—	0.10	1.00	—
viii)	X04Cr18Ni10Ti		0.08	1.00	2.00	0.045	0.030	17.0 to 19.0	9.0 to 12.0	—	—	1.00	Ti = 5xC to 0.70
ix)	X02Cr19Ni11		0.030	1.00	2.00	0.045	0.030	18.0 to 20.0	10.0 to 12.0	—	0.10	1.00	—
x)	X04Cr18Ni11		0.08	1.00	2.00	0.045	0.030	17.0 to 19.0 [c]	10.5 to 13.0	—	0.10	—	—
xi)	X02Ni18Cr16		0.04[d]	1.00	2.00	0.045	0.030	15.0 to 17.0	17.0 to 19.0	—	—	—	—
xii)	**Austenitic steels with Mo**												
xiii)	X02Cr17Ni12Mo2		0.030	1.00	2.00	0.045	0.030	16.5 to 18.5	10.0 to 13.0	2.00 to 3.00	0.10	1.00	—
xiv)	X04Cr17Ni12Mo2		0.07	1.00	2.00	0.045	0.030	16.5 to 18.5	10.0 to 13.0	2.00 to 3.00	0.10	1.00	—
xv)	X04Cr17Ni12Mo2Ti		0.08	1.00	2.00	0.045	0.030	16.5 to 18.5	10.5 to 13.5	2.00 to 2.50	—	1.00	Ti = 5xC to 0.70

Table 10 (*Concluded*)

Sl No.	Designation	Numerical Symbol[f]	C	Si	Mn	P	S	Cr	Ni	Mo	N	Cu	Others
% mass [a] fraction													
(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
xvi)	X02Cr17Ni12Mo3		0.030	1.00	2.00	0.045	0.015	16.5 to 18.5	10.5 to 13.0	2.50 to 3.00	0.10	1.00	—
xvii)	X03Cr17Ni12Mo3		0.05	1.00	2.00	0.045	0.015	16.5 to 18.5	10.5 to 13.0	2.50 to 3.00	0.10	—	—
xviii)	X02Cr17Ni12Mo3N		0.030	1.00	2.00	0.045	0.015	16.5 to 18.5	10.5 to 13.0	2.50 to 3.00	0.12 to 0.22	1.00	—
xix)	X02Cr17Ni11Cu3Mo2		0.04	1.00	2.00	0.045	0.015	16.5 to 17.5	10.0 to 11.0	2.00 to 2.50	0.10	3.00 to 3.50	—
xx)	X04Ni25Cr15Ti2Mo1VB		0.08	1.00	2.00	0.040	0.030	13.5 to 16.0	24.0 to 27.0	1.00 to 1.50	—	—	Ti: 1.90 to 2.35 Al: 0.35 V: 0.10 to 0.50 B: 0.001 to 0.010
xxi)	**Austenitic-ferritic steel**												
xxii)	X02Cr22Ni5Mo3N		0.030	1.00	2.00	0.035	0.015	21.0 to 23.0	4.5 to 6.5	2.50 to 3.50	0.10 to 0.2	—	—
xxiii)	**Ferritic steels**												
xxiv)	X04Cr17		0.08 [e]	1.00	1.00	0.040	0.030	16.0 to 18.0	—	—	—	—	—
xxv)	X04Cr17Mo1		0.08	1.00	1.00	0.040	0.030	16.0 to 18.0	—	0.75 to 1.40	—	—	—
xxvi)	**Martensitic steel**												
xxvii)	X12Cr13		0.08 to 0.15	1.00	1.50	0.040	0.030	11.5 to 13.5	0.75	—	—	—	—

Elements not quoted in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing the heat.

[a] Maximum values unless otherwise indicated.
[b] A minimum content of 8.0 percent of Ni is permitted, unless otherwise agreed at the time of enquiry and order.
[c] For this document, a range for Cr: 16.5 to 19.0 is allowed.
[d] For this document, C: 0.08 is allowed.
[e] In order to improve the cold formability, a carbon content of max. 0.04 percent is recommended and may be agreed at the time of enquiry and order
[f] For guidance only.

Table 11 Mechanical Properties for Austenitic Stainless Steels in the Specified Delivery Condition

(*Clause* 8.1)

Sl No.	Designation	Diameter		Delivery Condition							
				+AT or +AT+PE		+AT+C		+AT+C+AT		+AT+C +AT+LC	
		Above	Up to	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*
		mm	mm	Mpa	%	Mpa	%	Mpa	%	Mpa	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	X10Cr18Ni8	2	5	—	—	—	—	720	65	760	60
		5	10	660	65	890	—	680	65	730	60
		10	25	660	65	850	—	660	65	—	—
		25	50	660	65	—	—	—	—	—	—
ii)	X02Cr19Ni9	0.8	2	—	—	—	—	710	68	760	63
		2	5	—	—	—	—	680	68	730	63
		5	10	630	68	800	—	630	68	680	63
		10	25	630	68	760	—	630	68	—	—
		25	50	630	68	740	—	630	68	—	—
iii)	X04Cr18Ni9Cu	0.8	2	—	—	—	—	710	60	760	63
		2	5	—	—	—	—	700	60	630	63
		5	10	—	—	—	—	650	65	680	63
		10	25	—	—	—	—	650	65	680	63
		25	50	—	—	—	—	—	—	—	—

Table 11 (*Continued*)

Sl No.	Designation	Diameter		Delivery Condition							
				+AT or +AT+PE		+AT+C		+AT+C+AT		+AT+C +AT+LC	
		Above	Up to	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*
		mm	mm	Mpa	%	Mpa	%	Mpa	%	Mpa	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
iv)	X02Cr18Ni9Cu3	0.8	2	—	—	—	—	630	68	680	63
		2	5	—	—	—	—	600	68	650	63
		5	10	590	68	740	—	590	68	640	63
		10	25	590	68	700	—	590	68	—	—
		25	50	590	68	—	—	—	—	—	—
v)	X02Cr18Ni8Cu	2	5	—	—	—	—	630	68	680	63
		5	10	610	68	790	—	610	68	660	63
		10	25	610	68	750	—	610	68	—	—
		25	50	610	68	—	—	—	—	—	—
vi)	X04Cr19Ni10	0,8	2	—	—	—	—	710	60	760	60
		2	5	—	—	—	—	700	60	750	60
		5	10	650	65	820	—	650	65	700	60
		10	25	650	65	780	—	650	65	680	63
		25	50	650	65	—	—	—	—	—	—
vii)	X04Cr18Ni10Ti	2	5	—	—	—	—	720	65	770	60
		5	10	680	65	850	—	680	65	730	60
		10	25	680	65	810	—	680	65	—	—
		25	50	680	65	—	—	—	—	—	—

Table 11 (*Continued*)

Sl No.	Designation	Diameter		Delivery Condition							
				+AT or +AT+PE		+AT+C		+AT+C+AT		+AT+C +AT+LC	
		Above	Up to	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*
		mm	mm	Mpa	%	Mpa	%	Mpa	%	Mpa	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
viii)	X02Cr19Ni11	2	5	—	—	—	—	680	68	730	63
		5	10	630	68	780	—	630	68	680	63
		10	25	630	68	740	—	630	68	—	—
		25	50	630	68	—	—	—	—	—	—
ix)	X04Cr18Ni11	0.8	2	—	—	—	—	680	65	740	60
		2	5	—	—	—	—	670	65	720	60
		5	10	650	65	800	—	650	65	700	60
		10	25	650	65	770	—	650	65	680	63
		25	50	650	65	—	—	—	—	—	—
x)	X02Ni18Cr16	0.8	2	—	—	—	—	640	68	690	63
		2	5	—	—	—	—	600	68	640	63
		5	10	—	—	—	—	—	—	640	63
		10	25	—	—	—	—	—	—	640	63
		25	50	—	—	—	—	—	—	—	—
xi)	X02Cr17Ni12Mo2	0.8	2	—	—	—	—	710	68	760	63
		2	5	—	—	—	—	670	68	720	63
		5	10	650	68	780	—	650	68	700	63
		10	25	650	68	750	—	650	68	700	63
		25	50	650	68	—	—	—	—	—	—

Table 11 (*Continued*)

Sl No.	Designation	Diameter		Delivery Condition							
				+AT or +AT+PE		+AT+C		+AT+C+AT		+AT+C +AT+LC	
		Above	Up to	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*
		mm	mm	Mpa	%	Mpa	%	Mpa	%	Mpa	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
xii)	X04Cr17Ni12Mo2	0.8	2	—	—	—	—	710	68	760	63
		2	5	—	—	—	—	690	65	740	60
		5	10	660	65	830	—	670	65	720	60
		10	25	660	65	790	—	660	65	720	60
		25	50	660	65	—	—	—	—	—	—
xiii)	X04Cr17Ni12Mo2Ti	2	5	—	—	—	—	720	65	770	60
		5	10	680	65	850	—	680	65	730	60
		10	25	680	65	810	—	680	65	—	—
		25	50	680	65	—	—	—	—	—	—
xiv)	X02Cr17Ni12Mo3	2	5	—	—	—	—	670	68	720	63
		5	10	650	68	780	—	650	68	700	63
		10	25	650	68	750	—	650	68	—	—
		25	50	650	68	—	—	—	—	—	—
xv)	X03Cr17Ni13Mo3	2	5	—	—	—	—	690	65	740	60
		5	10	660	65	830	—	670	65	720	60
		10	25	660	65	790	—	660	65	—	—
		25	50	660	65	—	—	—	—	—	—

Table 11 (*Concluded*)

Sl No.	Designation	Diameter		Delivery Condition							
				+AT or +AT+PE		+AT+C		+AT+C+AT		+AT+C +AT+LC	
		Above	Up to	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*
		mm	mm	Mpa	%	Mpa	%	Mpa	%	Mpa	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
xvi)	X04Cr17Ni12Mo2	2	5	—	—	—	—	690	65	740	60
		5	10	660	65	830	—	670	65	720	60
		10	25	660	65	790	—	660	65	—	—
		25	50	660	65	—	—	—	—	—	—
xvii)	X02Cr17Ni12Mo3N	2	5	—	—	—	—	820	60	870	55
		5	10	780	60	940	—	800	60	850	55
		10	25	780	60	910	—	780	60	—	—
		25	50	780	60	—	—	—	—	—	—
xviii)	X02Cr17Ni11Cu3Mo2	2	5	—	—	—	—	630	68	680	63
		5	10	610	68	760	—	610	68	660	63
		10	25	610	68	720	—	610	68	—	—
		25	50	610	68	—	—	—	—	—	—
xix)	X04Ni25Cr15Ti2Mo1VB	0.8	2	—	—	—	—	780	65	830	60
		2	5	—	—	—	—	730	65	780	60
		5	10	—	—	—	—	—	—	780	60
		10	25	—	—	—	—	—	—	780	60
		25	50	—	—	—	—	—	—	—	—

Table 12 Mechanical Properties for Austenitic-Ferritic Stainless Steels in the Specified Delivery Condition

(*Clause* 8.1)

Sl No.	Designation	Diameter		Delivery Condition							
				+AT or +AT+PE		+AT+C		+AT+C+AT		+AT+C+AT+LC	
		Above	Up to	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*	Rm *Max*	Z *Min*
		mm	mm	MPa	%	MPa	%	MPa	%	MPa	%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	X02Cr22Ni5Mo3N	2	5	880	55	—	—	950	55	1 010	50
		5	10	880	55	1 020	—	900	55	970	50
		10	25	880	55	1 000	—	880	55	—	—

Table 13 Mechanical Properties for Ferritic Stainless Steels in the Specified Delivery Condition

(*Clause* 8.1)

Sl No.	Designation	Diameter		Delivery Condition							
				+A or +A+PE		+A+LC		+A+C+A		+A+C+A+LC	
		Above mm	Up to mm	R_m *Max* MPa	Z *Min* %	R_m *Max* MPa	Z *Min* %	R_m *Max* MPa	Z *Min* %	R_m *Max* MPa	Z *Min* %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	X04Cr17	0.8	2	—	—	—	—	—	—	700	61
		2	5	—	—	—	—	560	63	620	61
		5	10	560	63	660	60	560	63	600	61
		10	25	560	63	640	60	560	63	600	61
ii)	X04Cr17Mo1	0.8	2	—	—	—	—	—	—	740	61
		2	5	—	—	—	—	600	60	660	58
		5	10	600	60	710	57	600	60	640	58
		10	25	600	60	690	57	600	60	640	58

Table 14 Mechanical Properties for Martensitic Stainless Steels in the Specified Delivery Condition

(*Clause* 8.1)

Sl No.	Designation	Diameter		Delivery Condition							
				+A or +A+PE		+A+LC		+A+C+A		+A+C+A+LC	
		Above mm	Up to mm	Rm *Max* MPa	Z *Min* %	Rm *Max* MPa	Z *Min* %	Rm *Max* MPa	Z *Min* %	Rm *Max* MPa	Z *Min* %
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	X12Cr13	0.8	2	—	—	—	—	—	—	740	58
		2	5	—	—	—	—	600	60	660	58
		5	10	600	60	720	57	600	60	640	58
		10	25	600	60	700	57	600	60	640	58
		25	100	600	60	—	—	—	—	—	—

ANNEX B

(*Clause* 5.2)

Table 15 Designation of Steels Given in Annex A and the Comparable Grades Covered in Various Designation Systems

(*Clause* 5.2)

Sl No.	Steel Names in Accordance with										
	IS Designation	ISO Number	ASTM/ SAE/UNS[a]		EN 10263[b]			JIS[c]		GB/ISC[d]	
				i/n/w[e]			i/n/w[e]		i/n/w[e]		i/n/w[e]
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)
i)	**Austenitic stainless steels for cold heading and cold extruding**										
ii)	X10Cr18Ni8	4310-301-00-I	S30100	W	X10CrNi18-8	1.4310	N	—	—	S30110	W
iii)	X02Cr19Ni9	4307-304-03-I	S30403	W	X2CrNi18-9	1.4307	N	SUS304L	W	S30403	W
iv)	X04Cr18Ni9Cu	4567-304-98-X	—	—	X6CrNiCu18-9-2	1.4567	N	SUS304J3	I	S30480	I
v)	X02Cr18Ni9Cu3	4567-304-30-I	—	—	X3CrNiCu18-9-4	1.4567	I	SUSXM7	W	S30488	W
vi)	X02Cr18Ni8Cu	4560-304-75-E	—	—	X3CrNiCu19-9-2	1.4560	I	—	—	—	—
vii)	X04Cr19Ni10	4301-304-00-I	S30400	W	X5CrNi18-10	1.4301	I	SUS304	W	S30408	W
viii)	X04Cr18Ni10Ti	4541-321-00-I	S32100	W	X6CrNiTi18-10	1.4541	I	SUS321	W	S32168	W
ix)	X02Cr19Ni11	4306-304-03-I	S30403	W	X2CrNi19-11	1.4306	N	SUS304L	W	S30403	N
x)	X04Cr18Ni11	4303-305-00-I	S30500	W	X6CrNi18-12	1.4303	N	SUS305	W	S30510	W
xi)	X02Ni18Cr16	4839-384-00-I	—	—	X3NiCr18-16	1.4839	I	SUS384	I	—	—
xii)	X02Cr17Ni12Mo2	4404-316-03-I	S31603	W	X2CrNiMo17-12-2	1.4404	N	SUS316L	W	S31603	N
xiii)	X04Cr17Ni12Mo2	4401-316-00-I	S31600	W	X5CrNiMo17-12-2	1.4401	N	SUS316	W	S31608	N
xiv)	X04Cr17Ni12Mo2Ti	4571-316-35-I	S31635	W	X6CrNiMo- Ti17-12-2	1.4571	N	SUS316Ti	W	S31668	W
xv)	X02Cr17Ni12Mo3	4432-316-03-I	S31603	W	X2CrNiMo17-12-3	1.4432	I	SUS316L	W	S31603	W
xvi)	X03Cr17Ni12Mo3	4436-316-00-I	S31600	W	X3CrNiMo17-12-3	1.4436	I	SUS316	W	S31608	W

Table 15 (*Concluded*)

Sl No.	Steel Names in Accordance with										
	IS Designation	ISO Number	ASTM/ SAE/UNS[a]		EN 10263[b]			JIS[c]		GB/ISC[d]	
				i/n/w[e]			i/n/w[e]		i/n/w[e]		i/n/w[e]
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)
xvii)	X02Cr17Ni12Mo3N	4429-316-53-I	S31653	W	X2CrNi-MoN17-12-3	1.4429	N	SUS316LN	W	S31653	N
xviii)	X02Cr17Ni11Cu3Mo2	4578-316-76-E	—	—	X3CrNiCu-Mo17-11-3-2	1.4578	I	—	—	—	—
xix)	X04Ni25Cr15Ti2 Mo1VB	4980-662-86-X	S66286	N	X6NiCrTi-MoVB25-15-2	1.4980	N	SUH660	I	S51525	W
xx)	**Austenitic — Ferritic stainless steels for cold heading and cold extruding**										
xxi)	X02Cr22Ni5Mo3N	4462-318-03-I	S32205	N	X2CrNiMoN22-5-3	1.4462	I	SUS329J3L	W	S22053	N
xxii)	**Ferritic stainless steels for cold heading and cold extruding**										
xxiii)	X04Cr17	4016-430-00-I	S43000	W	X6Cr17	1.4016	I	SUS430	W	S11710	W
xxiv)	X04Cr17Mo1	4113-434-00-I	S43400	W	X6CrMo17-1	1.4113	N	SUS434	W	S11790	W
xxv)	**Martensitic stainless steels for cold heading and cold extruding**										
xxvi)	X12Cr13	4006-410-00-I	S41000	W	X12Cr13	1.4006	I	SUS410	W	S41010	W

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

[b]European steel listed in EN 10263 and in the "Stahl-Eisen-Liste". If the steel number is given in brackets, then the steel is only listed in the "Stahl-Eisen-Liste".

[c]Japanese Industrial Standard.

[d]Chinese National Standard.

[e]I = identical steel to IS & ISO steel grade, n = steel grade with closer match of composition, but not identical, w = wider match.

ANNEX C

(*Foreword*)

COMMITTEE COMPOSITION

Alloy Steels and Forgings Sectional Committee, MTD 16

Organization	*Representative(s)*
Mishra Dhatu Nigam Limited, Hyderabad	SHRI T. MUTHUKUMAR **(*Chairperson*)**
All Indian Stainless Steel Industries Association, Mumbai	SHRI HITENDERA BHALARIA SHRI JAY KUMAR BANSAL (*Alternate*)
Atomic Mineral Division, Nagpur/New Delhi	DR SMEER DURANI SHRI ALOK PANDEY (*Alternate*)
BEML Ltd, Kolar	SHRI B. H. MADHUSUDHAN SHRI RAVEENDRA (*Alternate*)
Bharat Forge Limited, Pune	SHRI SAGAR BAPAT
Bharat Heavy Electrical Limited, New Delhi	SHRI VENKATESWARLU ALA SHRI MANU SHANKAR HARISH (*Alternate*)
CSIR National Metallurgical Laboratory, Jamshedpur	DR S. GHOSH CHOWDHURY DR B. RAVI KUMAR *(Alternate)*
Defence Metallurgical Research Laboratory, Hyderabad	SHRI B. VEERABABU SHRI BIDYAPATI MISHRA (*Alternate*)
Directorate General Quality Assurance, New Delhi	SHRI L. P. VARTE SHRI M. K. SHRIVASTAV (*Alternate*)
Hindustan Aeronautical Limited, Bangalore	DR R. R. BHAT SHRI ANIL KUMAR M. (*Alternate*)
Indian Stainless Steel Development Association, Gurugram	SHRI ROHIT KUMAR SHRI A. K. SHARMA (*Alternate*)
Indira Gandhi Centre for Atomic Research, Kalpakkam	SHRI UTPAL BOHRA
Jindal Stainless Limited, New Delhi	SHRI BISWABASU ROY CHOWDHURY SHRI NISHA GOEL (*Alternate*)
Mahindra Sanyo Special Steel Private Limited, Khopoli	SHRI SACHIN BHAMBURE
Ministry of Commerce and Industry, DPIIT, New Delhi	SHRI S. K. JAIN
Ministry of Steel, New Delhi	SHRI PARMJEET SINGH SHRI BHAGIRATHI PRADHAN (*Alternate*)
Mishra Dhatu Nigam Limited, Hyderabad	SHRI CHANDAN HALDER DR SAURABH DIXIT (*Alternate*)
Mukand Ltd, Thane, Kalwe	SHRI M. M. RAO SHRI SUNIL NAIR (*Alternate*)
National Test House, Kolkata	SHRI A. DAS SHRI YOGESH SINGH (*Alternate*)
Nuclear Fuel Complex, Hyderabad	SHRI H. R. RAVINDRA SHRI Y. BALAJI RAO (*Alternate*)
RITES Limited, Gurugram	SHRI SANDEEP GUPTA SHRI V. K. DWIVEDI (*Alternate*)

Organization	*Representative(s)*
Schaeffler India Limited, Pune	SHRI ANUSHUMAN GANERIWALA SHRI BISWANATH NANDI (*Alternate*)
Society of Indian Automobile Manufacturers (SIAM), New Delhi	SHRI KARTIKE KARWAL MS KANISHKA CHANA (*Alternate*)
Star wire (India) Limited, Ballabgarh	DR SHIVRAJ SINGH KASANA DR AVNISH KUMAR (*Alternate*)
Steel Authority of India Limited (SAIL), Research & Development Centre for Iron & Steel, Ranchi	SHRI S. K. JHA SHRI P. KUMAR (*Alternate*)
SAIL, Visvesvaraya Iron and Steel Plant, Bhadravathi	SHRI RAVI KIRAN UPADYA SHRI KUMAR M. S (*Alternate*)
Steel Authority of India Limited, IISCO Steel Plant, Barddhaman	SHRI SAIKAT DE SHRI RAJIB KHANDA (*Alternate*)
Steel Authority of India Limited (SAIL) — Salem Steel Plant, Salem	SHRI P. GOVINDRAJAN SHRI VIRENDER VEER (*Alternate*)
Sundram Fasteners Limited, Chennai	SHRI ATUL KUMAR AGARWAL DR P. SHANMUGAM (*Alternate*)
Sunflag Iron & Steel Company Limited, New Delhi	SHRI K. K. BARIAR
Tata Motors Ltd, Pune	SHRI PRADEEP KULKARNI SHRI HEMANT MORE (*Alternate*)
Tata Steel Limited, Jamshedpur	DR T. BHASKAR
Viraj Profiles Limited, Boisar	SHRI K. R. K. MURTHY
BIS Directorate General	SHRI SANJIV MAINI, SCIENTIST 'F'/SENIOR DIRECTOR AND HEAD (METALLURGICAL ENGINEERING) [REPRESENTING DIRECTOR GENERAL (*Ex-officio*)]

Member Secretary
SHRI ARUN PUCCHAKAYALA
SCIENTIST 'D'/JOINT DIRECTOR
(METALLURGICAL ENGINEERING), BIS

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Review of Indian Standards

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