



## CORPORATE PURCHASING SPECIFICATION

AA 120 03

Rev. No. 04

PAGE 1 OF 5

### COPPER STRIP – HARD

#### 1.0 GENERAL:

This specification governs the quality requirements of bright annealed bare Copper strip of thickness over 0.15 mm and upto 10 mm and widths upto 800 mm with radiused edges.

#### 2.0 APPLICATION:

Used for general electrical purposes such as bus bars, transformers, switchgears etc.

#### 3.0 CONDITION FO DELIVERY:

The strip shall be supplied in annealed condition, in coils or straight lengths as specified in BHEL order. The strips shall be supplied with their edges radiused as per clause 5.3.

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following national standard and also meet the requirements of this specification.

IS: 1897 – 2008 : Copper strips - for Electrical Purposes.

Gr.HD – Hard

#### 5.0 DIMENSIONS AND TOLERANCES:

**5.1 Sizes:** Copper Strips shall be supplied to the dimensions specified in BHEL order:

#### 5.2 Tolerances:

Tolerances on width, thickness, length and straightness shall be as per IS:3052, reproduced below.

##### 5.2.1 Width:

**5.2.1.1** Tolerance on width for rotary sheared strip upto 4mm thickness shall be as follows:

Width, mm			Tolerance, ±mm			
Over	upto and incl.	upto and incl. 0.25 thick	over 0.25 upto & incl. 0.55 thick	over 0.55 upto & incl. 1.0 thick	over 1.0 upto & incl. 2.0 thick	over 2. upto & incl. 4.0 thick
-	10	-	By agreement			
10	50	0.10	0.15	0.2	0.3	-
50	100	0.15	0.20	0.3	0.5	0.6

Revisions :			APPROVED :		
CI: 24.1 of MOM of MRC-NFCW+HE			INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (NFCW+HE)		
Rev. No. 04	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1 st Issue
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**CORPORATE PURCHASING  
SPECIFICATION**

100	200	0.20	0.30	0.5	0.6	0.8
200	400	0.30	0.50	0.6	0.8	1.0
400	600	0.50	0.60	0.8	1.0	1.4
600	800	0.60	0.80	1.0	1.4	1.6

5.2.1.2 Tolerance on width for guillotine sheared strip above 4 mm thick shall be as follows:

Width, mm		Tolerance, $\pm$ mm	
Over	upto & Incl.	over 4.0 upto & incl. 5.0 thick	over 5.0 upto & incl. 10.0 thick
---	500	2	3
500	800	3	4

5.2.2 Thickness:  
Tolerance on thickness shall be as follows:

Thickness, mm				Tolerance, $\pm$ mm		
Over	upto and incl.	upto and incl. 160 wide	over 160 upto & incl. 300 wide	over 300 upto & incl. 450 wide	over 450 upto & incl. 630 wide	over 630 upto & incl. 800 wide
0.16	0.20	0.015	0.020	0.025	0.03	0.04
0.20	0.63	0.020	0.025	0.03	0.04	0.05
0.63	0.90	0.025	0.030	0.04	0.05	0.06
0.90	1.20	0.030	0.04	0.05	0.06	0.07
1.20	2.00	0.040	0.05	0.06	0.07	0.09
2.00	2.80	0.050	0.05	0.07	0.09	0.11
2.80	3.50	0.060	0.07	0.09	0.11	0.14
3.50	4.50	0.070	0.09	0.11	0.14	0.17
4.50	6.00	0.090	0.11	0.14	0.17	0.20
6.00	8.00	0.110	0.14	0.17	0.20	0.25
8.00	10.0	0.140	0.17	0.20	0.25	0.30

5.2.3 Length (Rotary Sheared):

Length, mm		Tolerance, $\pm$ mm
Over	upto & incl.	
160	1000	3
1000	2000	6
2000	4000	9

5.2.4 Straightness:  
The edges of strips supplied in straight lengths shall not vary from a straight line by more than 3 mm in any 1000 mm length.



## CORPORATE PURCHASING SPECIFICATION

AA 120 03

Rev. No. 04

PAGE 3 OF 5

### 5.3 Radius on Edges:

The strip shall be supplied with edges radiused as per IS:1897, reproduced below:

Thickness, mm		Nominal radius on edge, mm	Tolerance on radius, mm
Over	up to & incld.		
--	1.00	semi-circular	± 0.06
1.0	1.60	0.60	+ 0.15 - 0.10
1.6	2.25	0.80	± 0.15
2.25	3.55	1.00	± 0.20
3.55	10.00	1.25	± 0.25

### 6.0 MANUFACTURE:

The material shall be manufactured from copper of ETP grade conform to IS:191.

The conductor shall be manufactured from ETP grade copper conforming to BHEL specification: AA 12024: Electrolytic Tough Pitch Copper Wire/Bars/Ingots/Continuously cast wire rods.

**NOTE:** It is preferable to manufacture conductor from continuously cast copper rods provided all other parameters and conditions remain same.

### 7.0 FREEDOM FROM DEFECTS:

The material shall be clean, bright, smooth and free from harmful defects.

### 8.0 CHEMICAL COMPOSITION:

The analysis of copper when analysed in accordance with IS: 440 or any other conventional/instrumental methods shall be as follows:


Element	Percent, min.	Percent, max.
Copper and Silver	99.90	--
Bismuth*	--	0.001
Lead*	--	0.005
Total of all impurities excluding silver and oxygen excl. silver and oxygen	--	0.030

\* These elements need not be determined when the material supplied conforms with mechanical and electrical properties specified in this specification. However, the supplier shall ensure that the composition of the material lies within the limits specified above.

### 9.0 TEST SAMPLES:

One sampling per size per melt per consignment of 3 tonnes or part thereof shall be taken for chemical, mechanical and electrical tests.

The sample shall be cut off cold and shall receive no further treatment before being tested.

AA 120 03		CORPORATE PURCHASING SPECIFICATION																						
Rev. No. 04																								
PAGE 4 OF 5																								
10.0 MECHANICAL PROPERTIES:																								
10.1 Tensile strength (For sizes over 0.5mm to 10mm thick):																								
The test samples, when tested in accordance with IS:1608 shall show the following properties: IS:1608 , shall show the following properties:																								
<table><tr><th colspan="2">Thickness mm</th><th colspan="2">Tensile Strength, N/mm<sup>2</sup> Minimum</th></tr><tr><td colspan="2"></td><th colspan="2">For widths</th></tr><tr><th>Over</th><th>upto &amp; incl.</th><th>Upto &amp; incl.3000 mm</th><th>Over 300 mm &amp; Upto &amp; Incl. 800 mm.</th></tr><tr><td>0.50</td><td>2.50</td><td>310</td><td>285</td></tr><tr><td>2.50</td><td>10.00</td><td>295</td><td>275</td></tr></table>					Thickness mm		Tensile Strength, N/mm <sup>2</sup> Minimum				For widths		Over	upto & incl.	Upto & incl.3000 mm	Over 300 mm & Upto & Incl. 800 mm.	0.50	2.50	310	285	2.50	10.00	295	275
Thickness mm		Tensile Strength, N/mm <sup>2</sup> Minimum																						
		For widths																						
Over	upto & incl.	Upto & incl.3000 mm	Over 300 mm & Upto & Incl. 800 mm.																					
0.50	2.50	310	285																					
2.50	10.00	295	275																					
10.2 Bend Test:																								
The strip shall not be subjected to transverse bend test.where this is not possible, it shall be subjected to a longitudinal bend test. The strip when tested in accordance with IS: 1897 shall withstand a close bend test, through an angle of 1800, without showing any sign of cracks or failures upon the convex surface of the bend.																								
10.3 Hardness (Vickers):																								
When tested in accordance with IS:1501, the strips shall have a Vickers hardness not exceeding 90 HV, min.																								
11.0 ELECTRICAL RESISTIVITY (AS RECEIVED):																								
When measured in accordance with IS: 3635, the electrical resistivity at 20 <sup>0</sup> C shall not be greater than 0.01777 ohm-mm <sup>2</sup> /metre, which is equivalent to an electrical conductivity of 97%, minimum of IACS standard.(Refer Appendix B of IS: 613 for temperature correction factor).																								
Alternatively, the method of measurement employing eddy current probes as per ASTM E 1004 is also acceptable.																								
12.0 INSPECTION AT SUPPLIER'S WORKS:																								
Whenever specified, tests and inspection are to be conducted in the presence of BHEL'S representative.																								
The supplier shall offer BHEL'S representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification.																								



## CORPORATE PURCHASING SPECIFICATION

AA 120 03

Rev. No. 04

PAGE 5 OF 5

The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his carrying out the prescribed tests elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and BHEL reserves the right to test the material at BHEL'S works and the final acceptance of the testing.

BHEL reserves the right to test the material at BHEL's works and the final acceptance of the material shall be based on these test results.

### 13.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied along with each consignment.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA 120 03, Rev 04: Copper strip – Hard

BHEL Order No,

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

Results of dimensional inspection, chemical analysis, mechanical and electrical tests called for in this specification.

### 14.0 PACKING AND MARKING:

The material shall be supplied in coils or drums or in straight length as ordered. The minimum eye of coil or barrel diameter of drums shall be 250 mm.

The material not supplied in drums shall be hessian wrapped and tied with string and not with wire and shall be suitably protected to with wire and shall be suitably protected to avoid damage in transit. Each coil or drum or bundle shall be legibly marked or labeled with the following information.

Each coil or drum or bundle shall be legibly marked or labeled with the following information:

AA 12003 : Copper strip – Hard

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

### 15.0 REFERRED STADARDS (Latest Publications Including Amendments):

- |                |            |            |             |
|----------------|------------|------------|-------------|
| 1. IS:191      | 2. IS:440  | 3. IS:613  | 4. IS: 1501 |
| 5. IS:1897     | 6. IS:1608 | 7. IS:3052 | 8. IS:3635  |
| 9. ASTM E 1004 |            |            |             |



## CORPORATE PURCHASING SPECIFICATION

AA 120 23

Rev. No. 08

PAGE 1 OF 5

### COPPER RODS AND SECTIONS - HARD

#### 1.0 GENERAL:

This specification governs the quality requirements of copper rods/bars and sections.

#### 2.0 APPLICATION:

Used for general electrical purposes in Transformers, switch gears, Bus - bars, HT/MT caps and control equipment.

#### 3.0 CONDITION OF DELIVERY:

The copper rods shall be supplied in hard condition in straight lengths. Rectangular rods shall be supplied with radiused edges to clause 5.3.

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The copper rods and bars shall comply with the requirements of the following national standard and also meet the requirements of this specification.

IS: 613- 2000 : Copper Rods and Bars For  
Condition : Hard Electrical purposes - specification.

#### 5.0 DIMENSIONS AND TOLERANCES:

##### 5.1 Sizes.

Copper rods and sections shall be supplied to the dimensions specified in BHEL order / drawing.

##### 5.2 Tolerances:

5.2.1 The tolerances for round, square, rectangular and hexagonal rods / bars shall be as given below :

[Table - 2 of IS: 613]

##### 5.2.2 Sections:

Shall be as per BHEL drawing accompanying the order.

#### Revisions :

CI: 24.1 of MOM of MRC-NFCW+HE

#### APPROVED :

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE-MRC (NFCW+HE)

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AA 120 23	<b>CORPORATE PURCHASING SPECIFICATION</b>		
Rev. No. 08			
PAGE 2 OF 5			

**5.2.3 Length - Rod/Sections:**

Tolerance on length shall be as follows:

Length, mm		Tolerances, $\pm$ mm
Over	Upto & incl.	
-	150	1.2
150	1200	1.5
1200	2400	2.5
2400	-	5.0

**5.2.4 Straightness:**

The straightness and/or edgewise curvature (edge bow ) shall not exceed 3 mm for every 1000 mm length.

**5.2.5 Radius on Edges - Rectangular & Squares:**

Thickness, mm		Edges Radius, mm	Tolerance in Radius $\pm$ mm
Over	Upto and incl .		
6	25	2.5	0.25
25	50	3.2	0.25
50	-	as agreed to between BHEL & manufacturer.	

**6.0 MANUFACTURE:**

The copper rods shall be manufactured from copper of ETP grade conforming to IS: 191. The conductor shall be manufactured from ETP grade copper conforming to BHEL specification AA 120 24:: Electrolytic Tough Pitch Copper Wire/Bars/Ingots/Continuously cast wire rods.

**Note:** It is preferable to manufacture conductor from continuously cast copper rods provided all other parameters and conditions remain same."

**7.0 FREEDOM FROM DEFECTS:**

The copper rods shall be clean, bright, smooth and free from fins, spills, scaling, blisters, cracks and other defects.

**8.0 CHEMICAL COMPOSITION:**

The analysis of copper when analyzed in accordance with IS 440 or by any other Conventional/ Instrumental method shall be as follows:

Element	Percent, min.	Percent, max.
Copper and Silver	99.90	-
*Bismuth	-	0.001
*Lead	-	0.005
*Total of all impurities excl. silver and oxygen.	-	0.030



## CORPORATE PURCHASING SPECIFICATION

AA 120 23

Rev. No. 08

PAGE 3 OF 5

- These elements need not be determined when the material supplied conforms with the mechanical and electrical properties specified in this specification. However, the supplier shall ensure that the composition of the material lies within the limits specified above.

### 9.0 TEST SAMPLES:

9.1 Tests shall be conducted as follows:

Rods and bars : Mechanical and Electrical.  
Sections : Hardness and Electrical.

9.2 One sample per size per melt per consignment of 3 tonnes or part thereof shall be taken for chemical, mechanical and electrical tests.

The sample shall be cut off cold and shall receive no further treatment before being tested .

### 10.0 MECHANICAL PROPERTIES:

#### 10.1 Tensile Strength:

The test samples, when tested in accordance with IS: 1608 shall show the following properties and hardness as per IS:1501.

#### 10.1.1 Round: TABLE FOR HD

Dia., Width, Across flats or Thickness, mm		Tensile strength, N/mm <sup>2</sup> ,min.			Elongation on 5.65√So of gauge length, % min.			Hardness for all shapes
Over	Upto & incl.	Round	Square/ Hexagonal	Rect- angular	Round	Square/ Hexagonal	Rect- angular	HV, min.
6.0	10.0	330	-	-	-	-	-	90
10.0	12.0	320	310	270	6	6	8	
12.0	25.0	290	280	260	8	8	8	
25.0	90.0	260	250	250	12	12	10	
> 90.0	As agreed between BHEL and manufacturer.							

#### 10.1.2 Rods /Bars other than rectangular:

For material over 30 mm dia, thickness or width a cross flats, the test piece shall be turned with its centre 14mm from the surface of the material for material of smaller dia or width, which may not be tested in the condition as manufacture of the test pieces shall be turned from the centre of the material.

#### 10.1.3 Rectangular Bars/Rods:

The test piece shall be taken from the centre of the rod/bar.


#### 10.2 Bend Test:

The material shall be tested for bend test in accordance with IS:1599, if specified in BHEL order.

### 11.0 ELECTRICAL RESISTIVITY (As Received):

When measured in accordance with IS: 3635, the electrical resistivity of the sample in as received condition at 20° C shall not be greater than 0.0177 ohm. mm<sup>2</sup> / metre, which is equivalent to an electrical conductivity of 97% minimum of IACS standard. (Refer Appendix B of IS: 613 for temperature correction factor.) Alternatively, the method of measurement employing eddy current probes as per ASTM E 1004 is also acceptable.



AA 120 23	<p align="center"><b>CORPORATE PURCHASING SPECIFICATION</b></p>	
Rev. No. 08		
PAGE 4 OF 5		

**12.0 CHECK LIST:**

The supplier shall fill up the enclosed checklist as per Annexure-A and submit the same alongwith each batch.

**13.0 INSPECTION AT SUPPLIER'S WORKS:**

Whenever specified, tests and inspection are to be conducted in the presence of BHEL'S representative .

The supplier shall offer BHEL's representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification. The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his carrying out the prescribed tests elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing.

BHEL reserves the right to test the material at BHEL'S works and the final acceptance of the material shall be based on these test results.

**14.0 TEST CERTIFICATES:**

Unless otherwise stated, three copies of test certificates shall be supplied along with each consignment.

In addition, the supplier shall ensure to send one copy of test certificates along with the despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:  
 AA 12023 (Rev. No. 08) : Copper Rods and sections - Hard  
 BHEL Order No.  
 Manufacturer 's / Supplier 's Name  
 Lot /Identification / Batch /Melt No.  
 Sizes and Quantity Supplied  
 Results of dimensional inspection, Chemical analysis,  
 Mechanical and electrical tests as per this specification.


**15.0 PACKING AND MARKING:**

The material shall be suitably packed to prevent damage during transit.

Each package shall be legibly marked or labeled with the following information.  
 AA 12023 : Copper Rod and sections - Hard  
 BHEL Order No  
 Manufacturer's/ supplier's Name  
 Lot/Identification/ Batch /Melt No.  
 Size and Quantity supplied.

**16.0 REFERRED STANDARDS( LATEST PUBLICATION INCLUDING AMENDMENTS):**

1) IS:191	2) IS:440	3) IS:613	4) IS:1501
5) IS:1599	6) IS:1608	7) IS: 2826	8) IS: 3635    9) ASTM E 1004

	<b>CORPORATE PURCHASING SPECIFICATION</b>	<b>AA 120 23</b> <b>Rev. No. 08</b> <b>PAGE 5 OF 5</b>
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**ANNEXURE - A (Clause 12.0)**

**CHECK LIST FOR AA 120 23: COPPER RODS AND SECTIONS - HARD**  
**(To be filled by Supplier)**

A. Name of Principal Supplier :

B. Name of Indian Agent :

1. Grade of material as per specification : Yes/No

2. Tolerance on diameter/ Width/thickness/ length and flatness as per specification and drawing : Yes/No

3. Chemical composition as per specification : Yes/No

4. Mechanical properties as per specification : Yes/No

5. Electrical Resistivity : Yes/No

6. Tests : (1) Bend

7. Details of previous experience enclosed : Yes/No.  
(For New suppliers only)

C. Deviations taken (Please specify clearly, if any) : Yes/No.

1

2

3

Date:

Place:

Signature &

Seal of Supplier

1599540/2023/HEP-SV IM20961



TSD 6206 A

# PLANT PURCHASING SPECIFICATION BHOPAL

BP22962

Rev. No. 04

PAGE 1 OF 2

**SUPERSEDES**  
BP 22962 Rev. 03

## NYLON EXTRUSIONS AND MOULDING (TYPE 6)

### 1. GENERAL :

This specification governs the quality of nylon extrusions and mouldings made from Type 6 general purpose nylon. The material shall not be affected by alkaline, weak acids, alcohols and other common solvents. Superior electrical grade materials are covered by BP 22961 (Nylon Type 11).

### 2. APPLICATION :

Used as cable bush and oil injection plug in A.C. Machines, as rod form in switchgear and for manufacturing of sealing washers for use in Transformers.

### 3. COMPLIANCE WITH NATIONAL STANDARDS :

There is no Indian Standard covering this type of material.

### 4. DIMENSIONS AND TOLERANCES V

Shall be stated on order or the drawing accompanying the order.

### 5. FINISH:

The material shall be smooth and free from surface imperfections and blow holes.

### 6. TEST METHODS :

Unless otherwise specified, the test shall be conducted in accordance with the relevant methods of BS: 7663-1993. In case of components, density, water absorption and hardness shall done on the components itself.

### 7. SAMPLE FOR TEST :

Six no. of samples in size 3 tk x 150 x 150 mm moulded from the same batch and in the same manner as the consignment concerned, shall be supplied for testing and approval purpose.

### 8. PHYSICAL PROPERTIES :

8.1 Density at Room Temp. :  $1.13 \pm 0.05$  g/cc.

8.2 Water Absorption at Room Temp. : 1.5% Max.

Revision :  
Reviewed & brought upto date.

Issued by :  
STANDARDS AND MATERIALS GROUP  
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Rev No : 04

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Date of first issue : May-1969



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## PLANT PURCHASING SPECIFICATION BHOPAL

BP22962

Rev. No. 04

PAGE 2 OF 2

### 9. MECHANICAL PROPERTIES :

#### 9.1 Tensile Strength : 60 N/mm<sup>2</sup>, Min. (OPTIONAL TEST)

In case of rod, the test shall be done in as received condition

#### 9.2 Hardness (ASTM D 785) : 110 ± 10, Rockwell 'L'.

### 10. ELECTRICAL PROPERTIES :

#### 10.1 Electrical Strength (BDV) at Room Temp.

Unless otherwise specified on the drawing, BDV value shall be 10 kV/mm on a 3mm thick test specimen.

### 11. CHEMICAL PROPERTIES :

#### 11.1 Identification of material :

The material shall be nylon when identified by Infra-red spectrophotometer or by any conventional method.

### 12. TEST CERTIFICATE :

Three copies of test certificates shall be supplied with each consignment.

In addition, the supplier shall ensure to enclose one copy of test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information.

BP 22962 (Rev. 04) : Nylon Extrusions and Mouldings (Type 6) :

Our Order No.

Batch/Lot No.

Test values obtained/certificate for compliance for clause 5 and 8 to 11.

### 13. PACKING AND MARKING :

The nylon extrusions and mouldings shall be suitable packed to avoid contamination and damage in transit. Packages shall be labelled with the following information.

BP 22962 : Nylon Extrusions and Mouldings (Type 6)

Our Order No.

Supplier's / Manufacture's Name & Grade.

Date of Manufacture.

Drawing and Item Nos.

Net and gross weight



## CORPORATE PURCHASING SPECIFICATION

AA 598 03

Rev. No. 03

PAGE 1 OF 4

## CHLOROPRENE RUBBER SHEETS, GASKETS AND MOULDINGS 60 IRHD

### 1.0 GENERAL :

This specification governs the quality requirements of Chloroprene Rubber Sheets, Gaskets and Mouldings having a hardness of 60 IRHD.

### 2.0 APPLICATION:

Used as gaskets and mouldings in switchgear, steam turbines, water turbines, turbo-generators, traction machines, etc.

### 3.0 COMPLIANCES WITH NATIONAL STANDARDS:

The material shall comply, in general, with the requirements of the following national standard and also meet the requirements of this specification.

BS : 2752 – 1990, Gr.: C 60 : Chloroprene Rubber Compounds

And also shall meet the additional requirement of clause 10.5 of this specification.

### 4.0 DIMENSIONS AND TOLERANCES:

#### 4.1 Sizes:

Length x Width x Thickness of the sheet shall be stated in BHEL order.

Gaskets and mouldings shall be supplied as per BHEL drawings.

Preferred thicknesses for sheets and gaskets are 1, 1.6, 3, 5, 6, 10, 12, 15 and 20mm.

#### 4.2 Tolerances:

Unless otherwise stated in the order / drawing, tolerances on length, width and thickness shall be as follows:

##### 4.2.1 On Length and Width: $\pm 1$ mm

##### 4.2.2 On Thickness:

<u>Nominal thickness, mm</u>		<u>Tolerance, <math>\pm</math> mm</u>
Over	up to & incl.	

--	6	0.25
6	12	0.50
12	--	0.80


#### Revisions :

Cl 32.7 C (iv) of MOM of MRC-CPO


#### APPROVED :


**INTERPLANT MATERIAL  
RATIONALISATION COMMITTEE-MRC (CPO)**

Rev. No. 03	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt.:15.02.2004	Dt :	Year :	BHOPAL	Corp. R&D	JULY, 1980

AA 598 03	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 03		
PAGE 2 OF 4		

5.0	<b>FINISH:</b> Material shall have a smooth finish.
6.0	<b>FREEDOM FROM DEFECTS:</b> All ingredients of the mix shall be free from grit and extraneous matter. The selection and processing of the ingredients shall be such that the vulcanizate is free from surface imperfections, blisters, porosity, voids, inclusions, flow marks, inadequate joint of moulding blank and other defects which would impair satisfactory performance.
7.0	<b>CHEMICAL COMPOSITION:</b> Sheets, gaskets and moulding shall be made at slow crystallization rate from vulcanizates based on chloroprene polymer reinforced only with carbon black, vulcanized with a metallic oxide and rubber containing at least 2 parts per hundred of a suitable antioxidant.
8.0	<b>IDENTIFICATION:</b> The material, when identified by infra-red spectra photometer or by any other convenient method shall be of chloroprene copolymer.
9.0	<b>TEST SAMPLES:</b> Three samples of sheets of the following sizes prepared from the same batch and vulcanized to the same degree as the consignment concerned shall be submitted for testing.  150 x 150 x 2 ± 0.15 mm thickness : two sheets 150 x 150 x 6.3 ± 0.15 mm thickness : one sheets
10.0	<b>PROPERTIES:</b> When tested in accordance with the Indian standards / British standards shown against each, the test samples shall show the following properties:
10.1	<b>Hardness (BS 903: Part A 26: Method N, 2 Plies, 6.3 mm + 2mm with the thicker ply on top):</b>  60 + 5, - 4 IRHD
10.2	<b>Tensile strength (IS:3400, Part I, Dumb-bell) :</b>  13 N/mm <sup>2</sup> , minimum
10.3	<b>Elongation at Break (IS:3400, Part I, Dumb-bell):</b>  250% , minimum
10.4	<b>Compression set at 70<sup>0</sup>C (IS: 3400, Part X):</b>  For 72 hours + 0, - 2, hours: 25%, maximum.

	CORPORATE PURCHASING SPECIFICATION	AA 598 03
		Rev. No. 03
		PAGE 3 OF 4
<p><b>10.5</b></p> <p><b>10.5.1</b></p> <p><b>10.5.2</b></p> <p><b>11.0</b></p> <p><b>11.1</b></p> <p><b>11.2</b></p> <p><b>11.2.1</b></p> <p><b>11.2.2</b></p> <p><b>11.2.3</b></p> <p><b>11.3</b></p> <p><b>12.0</b></p>	<p><b>Ageing in Oil:</b></p> <p>Two test specimens each of 25 mm wide and of suitable length shall be cut from each sheet in the sample from widely separated positions. The specimens shall be aged in Servo prime 32 of IOC or its equivalent for 72 hours at 70<sup>0</sup>C.</p> <p><b>Change in Volume:</b> 10%, maximum</p> <p><b>Oil Absorption (Calculated on the Original Weight of the Specimen):</b> 15%, maximum</p> <p><b>TYPE TESTS:</b></p> <p>Whenever specified, the following type tests shall be conducted as per the test method specified against each and the norms of acceptance shall be as specified below:</p> <p><b>Volume Change (BS 903: Part A 16: Volumetric Method, Liquid B, 22 Hours At 40<sup>0</sup>C):</b> 70%, maximum.</p> <p><b>Resistance To Heat Ageing For 168 Hours At 70<sup>0</sup>C (IS: 3400, Part IV):</b></p> <p><b>Change In Hardness (BS 903: Part A 26 : Method N ):</b> + 7, IRHD maximum, when measured on 2 plies each of 2 mm thickness before and after ageing.</p> <p><b>Change in Tensile Strength (IS:3400, Part I, Dumb-bell):</b> -12%, maximum of the value obtained at clause 10.2.</p> <p><b>Change In Elongation At Break (IS:3400, Part I, Dumb-bell):</b> -20% , maximum of the value obtained at clause 10.3</p> <p><b>Adhesion To And Corrosion Of Metals (BS 903: Part A 37: Method A):</b></p> <p>There shall be no corrosion or pitting of the metals and the material shall not adhere to the metal surface or show any sign of liquid exudation. Discolouration of the metal surfaces shall not be considered to be objectionable.</p> <p><b>TEST CERTIFICATES:</b></p> <p>Unless otherwise stated, three copies of test certificates shall be supplied giving the following information: In addition, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents for quick clearance of the material.</p> <p>AA 598 03, Rev. 03: Chloroprene Rubber Sheets, Gaskets &amp; Mouldings, 60 IRHD BHEL Order No. Manufacturer/s / Supplier/s name and trade mark, if any Batch No Date of manufacture Test results of clauses 4.0, 8.0, 10.0 and 11.0.</p>	

AA 598 03	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 03		
PAGE 4 OF 4		

**13.0 KEPING PROPERTY:**

When stored under cover in a dry place under normal storage conditions, the material shall retain the properties prescribed in this specification for a period of not less than 24 months after the date of manufacture, which shall be subsequent to the date of placing the order.

**14.0 PACKING AND MARKING:**

Material shall be suitably packed to prevent damage from contamination and handling during transit.

Each package shall be legibly marked with the following information:

AA 598 03 : Chloroprene Rubber Sheets, Gaskets & Mouldings, 60 IRHD  
 BHEL Order No.  
 Manufacturer's / Supplier's Name.  
 Trade Mark, if any.  
 Batch No.  
 Drawing No. & Item No, if any  
 Size and Quantity.

**15.0 REFERRED STANDARDS (Latest Publications Including Amendments):**

1. IS: 3400	2. BS 903	3. BS 2752
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# CORPORATE PURCHASING SPECIFICATION

AA10301

Rev No.05

PAGE 1 of 4

## COLD DRAWN SPRING STEEL WIRE - ZINC COATED

### 1.0 GENERAL:

This specification governs the quality of requirements of Zinc coated cold drawn carbon steel wire.

### 2.0 APPLICATION:

Suitable for the manufacture of cold formed helical springs, spring-rings and wire forms subjected to moderate load cycles-statically stressed.

### 3.0 CONDITION OF DEIVERY;

Wire shall be supplied in the form of coils in Zinc Coated, Cold drawn condition.

### 4.0 Compliance with National Standards:

The material shall comply, in general, with requirements of the following National standards and also meet the requirements of this specification.

IS: 4454, Part 1- 2001, Gr.: SM : Steel wires for mechanical springs.

### 5.0 DIMENSIONS AND TOLERANCES:

#### 5.1 Sizes:

The material shall be supplied to the dimensions specified on BHEL order.

Wires above 0.30 mm and upto and including 20.0 mm in diameter only shall be ordered to this specification

#### 5.2 Tolerances:

5.2.1 The tolerances of the wire shall comply with Table-4 of IS: 4454, Part-1.

5.2.2 The cross-section of the round wire shall be circular to within half the tolerance of the permitted diameter tolerance, specified above.

Revisions:  
Cl. 26.6.22 of MOM of MRC-S&GPS

**APPROVED:**  
INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(S&GPS)

Rev No.05	Amd No.	Reaffirmed	Prepared	Issued	Dt. of 1 <sup>st</sup> Issue
Dt:15-01-2004	Dt:	Year:2020	HEP, Bhopal	Corp.R&D	August, 1976

AA10301

Rev No. 05

PAGE 2 of 4

# CORPORATE PURCHASING SPECIFICATION



## 6.0 MANUFACTURE:

Steel for springs shall be manufactured by the open heath, electric, basic oxygen or a combination of these processes. If any other process is employed, prior approval of BHEL shall be obtained.

Material shall be manufactured form killed steel.

The wire shall be drawn in the galvanised condition.

## 7.0 FREEDOM FROM DEFECTS:

The surface of the wire shall be smooth and free from defects such as grooves, seams, pits, die marks, tears, rust, scale, scratches and any harmful defects which may have a noticeable adverse effect on application of the wire.

## 8.0 SAMPLING:

Unless otherwise agreed to method of drawing representative sample of material and criteria for conformity shall be as per Annex. C of IS: 4454, Part 1.

## 9.0 CHEMICAL COMPOSITION:

The melt analysis of steel and the permissible variation in the composition of the finished product form the melt analysis shall be as follows:

Element	Melt analysis		Permissible variation, percent, in product analysis
	% Min.	% Max.	
Carbon	0.35	1.0	± 0.02
Silicon	0.10	0.30	± 0.03
Manganese	0.30	1.20	+ 0.05
Sulphur	---	0.03	+ 0.005
Phosphorus	---	0.03	+ 0.005
Copper	---	0.20	--

### NOTE:

- i) P + S = 0.055%, max.
- ii) Cu + Ni + Cr = 0.35%, max

## 10.0 ZINC COATING:

Zinc Coating Process (Hot dip galvanising) shall be as per IS: 2629

The final weight of zinc coating shall not be less than 60 gm/m<sup>2</sup> on any size of wire when tested as per IS: 6745



# CORPORATE PURCHASING SPECIFICATION

AA10301

Rev No.05

PAGE 3 of 4

## 11.0 WRAPPING TEST:

The wire shall be bent or wrapped round a mandrel of appropriate diameter given below without cracking of the base wire, or cracking or flaking of the coating to such an extent that any zinc can be removed by rubbing with bare fingers.

Diameter of wire, mm	Minimum complete turns of wrap	Mandrel diameter
3.80 and under	6	4 D*
Over 3.80 up to and incl.7.5	6	5 D
Over 7.5	$\frac{1}{4}$ (one 90° bend )	5 D

\* Diameter of wire = D

## 12.0 MECHANICAL PROPERTIES:

### 12.1 Tensile:

The tensile test shall be carried out in accordance with IS: 1608.

The tensile strength and percentage reduction of area obtained from the test pieces shall comply with those given in Table 5 of IS: 4454, Part 1.

### 12.2 Wrapping:

The wrapping test shall be applicable to wires with nominal diameter less than 3mm. Wrapping test when carried out in accordance with IS:1755 shall not show on visual examination any sign of fracture upon closely coiled for at least four turn around a mandrel of diameter equal to diameter of wire.

### 12.3 Torsion:

For wires of diameter 0.5 mm and up to and including 10.0 mm.

The sample piece of length equal to 100 times the wire diameter, but not exceeding 500mm shall be twisted in accordance with IS: 1717. The test piece shall withstand, without failure, the minimum number of turns given in Table 6 of IS: 4454, Part I. The fracture shall be perpendicular to the wire axis and surface shall not split. Any secondary helical fracture shall be ignored.

### 12.4 Cast of Wire:

As per IS: 4454

AA10301

Rev No. 05

PAGE 4 of 4

# CORPORATE PURCHASING SPECIFICATION



## 13.0 INSPECTION AT SUPPLIER'S WORKS:

Whenever specified tests and inspection are to be conducted in the presence of BHEL's representative.

The supplier shall offer BHEL's representative all reasonable facilities, without charge to satisfy the latter that the material is being furnished in accordance with this specification

The supplier shall prepare and provide necessary test specimens for testing to be carried out at his premises. If facilities are not available at his works, the supplier shall make necessary arrangements for carrying out the prescribed test elsewhere. The supplier shall notify BHEL in advance about the readiness of the material for inspection and testing.

BHEL reserves the right to test the material at BHEL's works and the final acceptance of the material shall be based on these test results.

## 14.0 TEST CERTIFICATES:

Three copies of test certificates shall be supplied, unless otherwise stated on the order.

In addition, to the above, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA10301: Rev. No. 05: COLD DRAWN SPRING STEEL WIRE - ZINC COATED

BHEL order No:

Supplier's Reference:

Name:

IdentificationNo:

Cast No./Lot No:

Results of Tests:

Results of chemical mechanical and Zinc coating tests.

## 15.0 PACKING AND MARKING:

The wires shall be supplied in coils having a maximum weight of 50kg. The wires shall be coiled in such a way that the coils remain flat when the ties are cut. The coils shall be suitably packed to prevent corrosion and damage during transit.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10301: COLD DRAWN SPRING STEEL WIRE - ZINC COATED

BHEL Order No:

Consignment/Identification No:

Size and Weight:

Supplier's Name:

## 16.0 REFERRED STANDARDS (Latest publications including amendments):

1) IS: 1608

2) IS: 1717

3) IS: 1755

4) IS: 2629

5) IS: 4454, Part1

6) IS: 6745



## CORPORATE PURCHASING SPECIFICATION

AA10112

Rev No. 07

PAGE 1 of 4

## BRIGHT STEEL BARS AND SECTIONS (STANDARD QUALITY)

## 1 GENERAL:

This specification governs the quality requirements of Bright Steel Bars and Sections of standard quality, such as I-beams and equal angles required in very small sections.

## 2 APPLICATION:

Bars are used in the manufacture of threaded and machined components for general engineering purposes. Sections are used as stator spacer plate vents in generators.

## 3 CONDITION OF DELIVERY:

## 3.1 Round Bars - Class 4, surface quality.

Up to 50 mm diameter - Cold drawn.

Above 50mm diameter - Cold drawn or Hot rolled, turned and polished

## 3.2 Rectangular/Square/Hexagonal Bars - Class 3, surface quality.

All sizes - Cold drawn.

## 3.3 Sections - Class 4, surface quality.

All sizes - Cold drawn

## 3.4 Bars and sections shall be straight, with their ends sheared, square and true and shall have a smooth surface.

## 3.5 The bars and sections shall be given a clear temporary rust preventive (TRP) coating to avoid corrosion during transit and storage.

Black TRP coating is not acceptable.

Clear TRP used shall be free from pungent smell.

The following clear TRP's are suggested:

- Servo RP 150 - M/s Indian Oil Corporation
- HE - 1612 - M/s. BHEL, Bhopal
- Rustilo DW-901 - M/s. Indrol Lubricants and Specialties Ltd.
- Rustpro Special - M/s. Tide water oil co.
- Any other clear TRP conforming to IS: 1154

## 4 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following National standards and also meet the requirements of this specification.

IS: 9550-2001 : Bright steel bars

## Revisions:

CI 27.2.d of MOM of MRC-S&GPS

## APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(S&GPS)

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Prepared  
HEP, Bhopal

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Dt. of 1<sup>st</sup> Issue  
September 1976

Dt:15-06-2005

Dt:

Year:2019

AA10112	<b>CORPORATE PURCHASING SPECIFICATION</b>	
Rev No. 07		
PAGE 2 of 4		

## 5 DIMENSIONS AND TOLERANCES:

### 5.1 Sizes:

Bars shall be supplied to the dimensions specified in BHEL order.

### 5.2 Tolerances:

#### 5.2.1 Rectangular/Square/Hexagonal/Flat Bars:

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

For drawn round bars and turned bars h10 to table 2 of IS:9550

For hexagonal and square drawn bars upto and including 80mm h11 and above 80mm h12 according to table 2 of IS:9550

For drawn flats in accordance with table 3 and 4 of IS:9550

For ground products in accordance with table 1 and 2 of IS:9550

#### 5.2.2 Sections:

As specified in BHEL order/drawing.

### 5.3 Length:

Bar and sections shall be supplied in lengths of 2.5 to 4.5 meters with maximum 10% of shorts of not less than 1.5 meters.

### 5.4 Straightness:

Unless otherwise agreed to, the permissible deviation shall not exceed 1.5mm in any one meter length. Bars and sections shall be free from twists and bends.

## 6 MATERIAL:

The rolled bars used for purpose of producing the bright bars shall be such, so as to ensure freedom from segregation, piping and other harmful defects.

## 7 MANUFACTURE:

Steel shall be manufactured by the open-hearth, electric, basic oxygen or a combination of these processes.

## 8 FREEDOM FROM DEFECTS:

All finished steel bars and section shall be sound and free from internal and surface defects. They shall be bright and clean.

## 9 SURFACE CONDITION:

### 9.1 Round Bars and Sections:

Shall be entirely free from cracks and other surface defects.

### 9.2 Rectangular/Square/Hexagonal Bar-Type '3' Finish:

Shall comply with IS: 9550, Class 3 of table 5.

## 10 CHEMICAL COMPOSITION:

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be as follows:



## CORPORATE PURCHASING SPECIFICATION

AA10112

Rev No. 07

PAGE 3 of 4

Element	Melt analysis percent, max	Permissible variation percent
Carbon	0.25	$\pm 0.02$
Sulphur	0.040	+ 0.005
Phosphorus	0.040	+ 0.005

**11 TEST SAMPLES:**

One sample for chemical and tensile test shall be selected from finished steel for every 20,000 kg or part thereof, with a minimum one per heat.

**12 MECHANICAL PROPERTIES:**

When tested in accordance with IS:1608, the test pieces shall show the following properties:

**12.1 Rectangular/Square/Hexagonal/Section - Cold Drawn:**

Tensile Strength : 440 N/mm<sup>2</sup>, min

Elongation on  $5.65\sqrt{S_0}$  gauge length : 8 – 20%

**12.2 Round Bars:****12.2.1 Bars upto 50mm Diameter – Cold Drawn**

Tensile Strength : 440 N/mm<sup>2</sup>, min

Elongation on  $5.65\sqrt{S_0}$  gauge length : 8 – 20%

**12.2.2 Bars above 50mm Diameter:**

Cold drawn or hot rolled, turned and polished.

Property	Hot rolled, turned and polished	Cold drawn
Tensile strength, min.	: 410 N/mm <sup>2</sup>	440 N/mm <sup>2</sup>
Elongation on $5.65\sqrt{S_0}$ gauge length	: 23%, min	8-20%

**13 TEST CERTIFICATES:**

Three copies of test certificates shall be supplied, unless otherwise stated on the order.

In addition, to the above, the supplier shall ensure to enclose one copy of the test certificate along with their despatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA10112; Rev. No. 07 :

BHEL order No,

Supplier's Reference:

Name

Identification No.

Melt No.

Results of Tests:

Dimensional inspection.

Results of Chemical analysis and mechanical tests.

1599540/2023/HEP-SWM20961

AA10112

Rev No. 07

PAGE 4 of 4

**CORPORATE PURCHASING SPECIFICATION****14 PACKING AND MARKING**

The material shall be suitably packed in bundles – polythene wrapped to prevent sagging, corrosion and damage during transit. A suitable clear temporary rust preventive shall be applied all the bars as per clause 3.5 above and finally dispatched in wooden boxes.

Each bar over 50mm shall be stamped at one end with 'AA10112'. Bars 50mm and below shall be bundle together and tied with wire at 3 to 4 places along the length of the bar.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10112: BRIGHT STEEL BARS AND SECTIONS (STANDARD QUALITY)

BHEL Order No.

Consignment/Identification No.

Melt No.

Size and Weight.

Supplier's Name.

**15 REFERRED STANDARDS** (Latest Publications Including Amendments):

1) IS: 1154

2) IS: 1608

3) IS: 9550





# CORPORATE PURCHASING SPECIFICATION

AA10113

Rev No. 07

PAGE 1 of 5

## HOT ROLLED CARBON STEEL SHEET (330 N/mm<sup>2</sup> Tensile)

### 1.0 GENERAL:

This specification governs the quality requirements of Hot Rolled Carbon Steel Sheet of thickness of 2.5 mm to 4.0 mm (both inclusive).

### 2.0 APPLICATION:

Suitable for cold forming / drawing / fabrication by welding.

### 3.0 CONDITION OF DELIVERY:

Sheets shall be supplied in hot rolled, decaled and oiled condition. Imported sheets shall be supplied in straight lengths. The edges shall be flattened and sheared. Mill edges are not acceptable. Sheets shall be free from waviness and shall have a uniformly dull (matt) finish.

Oil used for rust prevention should be free from pungent smell. The following oils are suggested:

- SERVO RP 125 of M/s. IOC.
- RUSTOP 387/388 of M/s. HPC
- Bharat TCPF of M/s. Bharat Petroleum
- Any other TRP conforming to IS : 1154

### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall comply with the requirements of the following National standards and also meet the requirements of this specification.

IS: 5986 – 2011, Gr.: 205: Hot rolled steel flat products for structural forming and flanging purposes - Specification.

### 5.0 DIMENSIONS AND TOLERANCES:

#### 5.1 Sizes:

Hot rolled carbon steel sheets shall be supplied to the dimensions in BHEL order.

#### 5.2 Tolerances:

The tolerances on sheets shall comply with the following:

##### 5.2.1 Thickness (IS: 1852):

Thickness, mm	Tolerance, mm
2.50	± 0.20
3.15	± 0.22
4.0	± 0.25

Revisions:

As per Cl.No.38.1 of MOM of MRC– S&amp;GPS

**APPROVED:**INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(S&GPS)

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Dt:

Year:

HEP, Bhopal

Corp.R&amp;D

July, 1976

AA10113

Rev No. 07

PAGE 2 of 5

# CORPORATE PURCHASING SPECIFICATION



## 5.2.2 Width (IS: 1852):

Width, mm	Tolerance, mm
Upto & incld. 1250 mm	+ 6 mm - 0 mm
Over 1250 mm & upto and incld. 1550 mm	+ 0.5 percent - 0.0 percent
Over 1550 mm	+ 0.6 percent - 0.0 percent

## 5.2.3 Length (Continuous mill) IS: 1852:

Length, mm	Tolerance, mm
Upto & incld. 2500 mm	+ 25 mm - 00 mm
Over 2500 mm	+ 1 percent subject to a maximum of 70 mm - 0 percent

## 5.2.4 Flatness (for cut lengths):

Thickness, mm	Width, mm	Flatness tolerance, mm
From 2.5 to 4.0	Upto & incld. 1200	15
	Over 1200 & upto incld. 1500	20
	Over 1500	25

## 5.2.5 Edge camber IS: 5986:

The edge camber (i.e. lateral departure of the edge of the material from a straight line forming a chord) of sheets in cut lengths and coil shall not exceed the following values:

### 5.2.5.1 For Cut Lengths:

Length in meters		Tolerance, mm
Over	Upto & incld.	
--	1.25	5
1.25	1.80	6
1.80	2.50	8
2.50	3.15	10
3.15	3.55	12
3.55	4.00	16
4.00	5.00	19

### 5.2.5.2 For Coils:

25 mm in any 5000 mm length.



# CORPORATE PURCHASING SPECIFICATION

AA10113

Rev No.07

PAGE 3 of 5

## 6.0 MANUFACTURE:

Process of manufacture is left to the discretion of the manufacturer except Bessemer process.

Material shall be manufactured from semi killed or killed steel.

## 7.0 FREEDON FROM DEFECTS:

The sheets shall be free from harmful defects, twists, buckle, rust, scale and waviness and shall be reasonably smooth, flat and square.

## 8.0 CHEMICAL COMPOSITION:

The melt analysis of steel and the permissible variation in the composition of the material from the melt analysis shall be as follows:

Element	Melt analysis, percent, max.	Permissible variation, percent, max.
Carbon	0.15	0.03
Manganese	0.80	0.05
Sulphur	0.040	0.005
Phosphorus	0.040	0.005

## 9.0 TEST SAMPLES:

### 9.1 Tensile Test:

One sample shall be taken per thickness per consignment from each melt.

As far as possible test pieces shall be cut transverse to the direction of rolling and shall be of full thickness of the sheet rolled.

### 9.2 Bend Test:

One sample shall be taken per thickness per consignment from each melt.

Bend test pieces shall be cut so that the axis of the bend is parallel to the direction of rolling viz. transverse.

**Note:** When more than one thickness is rolled from the same melt, one additional test piece for each thickness shall be taken.

## 10.0 MECHANICAL PROPERTIES:

### 10.1 Bend:

When tested in accordance with IS: 1599, the test pieces shall be capable of being bent cold through 180° close. The outer convex surface of the test piece shall be free from cracks.

### 10.2 Tensile:

When tested as per IS: 1608, the test pieces shall show the following properties:

AA10113

Rev No. 07

PAGE 4 of 5

# CORPORATE PURCHASING SPECIFICATION



Tensile strength	: 330 – 440 N/mm <sup>2</sup>
Yield strength	: 205 N/mm <sup>2</sup> , min.
Elongation:	
For sheets up to & Incl. 3 mm, thick	: 20 %, minimum on 80 mm gauge length
For sheets above 3 mm, thick	: 28 %, minimum in 5.65 $\sqrt{S_0}$ gauge length

## 11.0 HARDNESS (VICKERS):

When tested in accordance with IS: 1501, the material shall show a Vickers hardness in the range of 100 – 140 HV.

**Note:** Hardness test shall be conducted only when tensile test cannot be performed.

## 12.0 TEST CERTIFICATES:

Unless otherwise specified, three copies of test certificates shall be supplied.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA10113, Rev 07: HOT ROLLED CARBON STEEL SHEET (330 N/mm<sup>2</sup> Tensile)

BHEL Order No,

Supplier's name,

Identification No

Melt No,

Process of manufacture

Details of pickling, descaling and oiling

Results of dimensional inspection

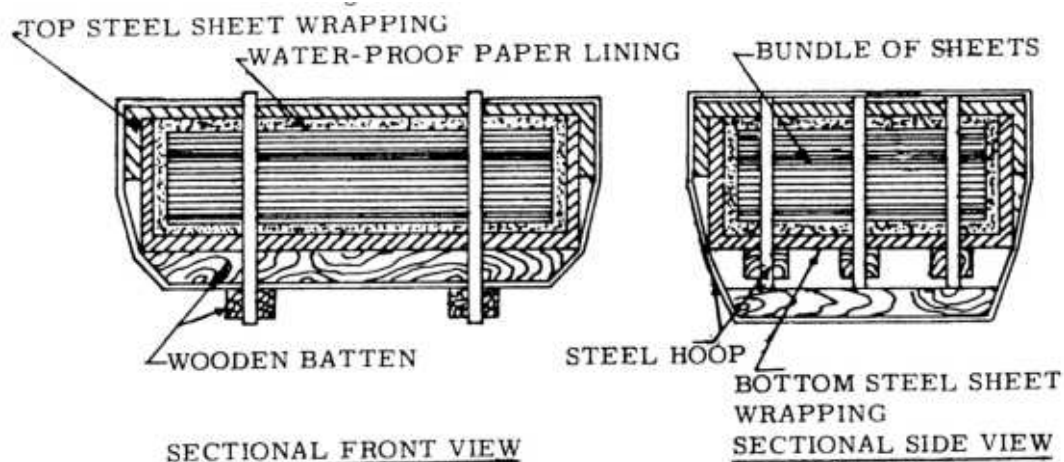
Results of Chemical analysis and Mechanical tests,

**Note:** Material procured, supplied and certified as AA10113 / IS: 5986, Gr.:205 and comply with the requirements of this specification is acceptable.

## 13.0 PACKING AND MARKING:

Steel sheets shall be supplied in bundles and shall be suitably packed in bundles to prevent corrosion and damage during transit.

The recommended packing for imported material shall be as shown below.





# CORPORATE PURCHASING SPECIFICATION

AA10113

Rev No.07

PAGE 3 of 5

## Note:

- a) Water proof paper lining shall be preferably Volatile Corrosion Inhibitor (V.C.I.) Coated Paper with an additional polythene (100 micron) enveloped.
- b) Approximate weight of each bundle shall be 2 to 3 tonnes. Bundle weighing 2 metric tonnes is however preferred.

A metal label shall be securely attached to each bundle and shall bear the following information:

AA10113:HOT ROLLED CARBON STEEL SHEET (330 N/mm<sup>2</sup> Tensile)

BHEL Order No,

Supplier's Name & Identification No,

Size & Thickness of sheets

Weight

## 14.0 REFERRED STANDARDS (Latest publications including amendments):

- |             |             |             |             |             |
|-------------|-------------|-------------|-------------|-------------|
| 1) IS: 1154 | 2) IS: 1501 | 3) IS: 1852 | 4) IS: 1599 | 5) IS: 1608 |
|-------------|-------------|-------------|-------------|-------------|