



## 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						
10	50	0.10	0.15	0.2	0.3	-	
50	100	0.15	0.20	0.3	0.5	0.6	

#### Revisions :

Cl: 24.1 of MOM of MRC-NFCW+HE

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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.

	<b>CORPORATE PURCHASING SPECIFICATION</b>	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	<b>CORPORATE PURCHASING SPECIFICATION</b>	
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:

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 180°, 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° 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.

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AA 120 23		CORPORATE PURCHASING SPECIFICATION		
Rev. No. 08				
PAGE 2 OF 5				

5.2.3 Length - Rod/Sections:

Tolerance on length shall be as follows:

Length, mm		Tolerances, ± 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 ± 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<sup>0</sup> 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	<b>CORPORATE PURCHASING SPECIFICATION</b>	
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

	<h2 style="margin: 0;">CORPORATE PURCHASING SPECIFICATION</h2>	<div style="border-bottom: 1px solid black; padding-bottom: 2px;">AA 120 23</div> <div style="border-bottom: 1px solid black; padding-bottom: 2px;">Rev. No. 08</div> <div style="padding-bottom: 2px;">PAGE 5 OF 5</div>
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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



# 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&GPS

#### APPROVED:

INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE – MRC(S&GPS)

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Dt:22-02-2014	Dt:	Year:	HEP, Bhopal	Corp.R&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.

	<h1 style="text-align: center;">CORPORATE PURCHASING SPECIFICATION</h1>	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 √So 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

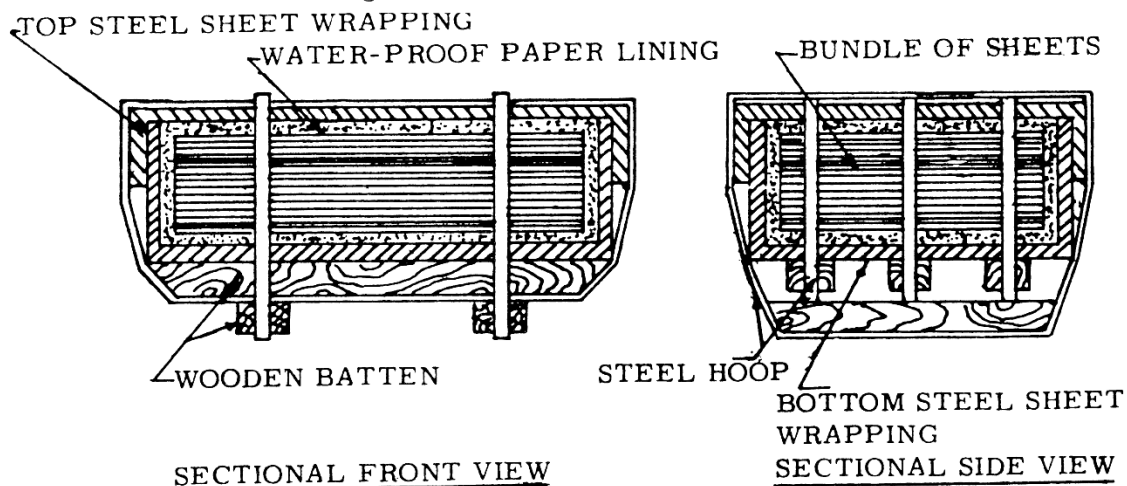
Results of Chemical analysis and Mechanical tests,

**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.



	<p align="center"><b>CORPORATE PURCHASING SPECIFICATION</b></p>	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 |
|-------------|-------------|-------------|-------------|-------------|