



## CORPORATE PURCHASING SPECIFICATION

AA 120 01

Rev. No. 04

PAGE 1 OF 5

### COPPER STRIP – ANNEALED

#### 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, connectors 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: 'O' 'Annealed'

#### 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 Length (Rotary sheared):

<u>Length, mm</u>		<u>Tolerance, ± mm</u>
Over	upto & incl.	
160	1000	3
1000	2000	6
2000	4000	9

#### Revisions :

Cl: 24.1 of MOM of MRC-NFCW+HE

#### APPROVED :

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# CORPORATE PURCHASING SPECIFICATION



## 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	0.28	0.015	0.02	0.025	0.03	0.04
0.28	0.63	0.020	0.025	0.03	0.04	0.05
0.63	0.90	0.025	0.03	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	0.06	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	10.00	0.140	0.17	0.20	0.25	0.30

## 5.2.3 Width:

5.2.3.1 Tolerance on width for rotary sheared strip upto 4 mm thickness shall be as follows

Thickness, mm		Tolerance, $\pm$ 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
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	1.5

5.2.3.2 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



## CORPORATE PURCHASING SPECIFICATION

AA 120 01

Rev. No. 04

PAGE 3 OF 5

### 5.2.4 Straightness:

The edges of strips supplied in straight lengths shall not vary from a straight line by more than 5 mm in any 1000 mm length.

### 5.3 Radius on Edges:

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

Thickness, mm		Nominal radius on edges, mm	Tolerance on radius, mm
Over	up to & incld.		
--	1.00	semi-circular	± 0.06
1.00	1.60	0.60	+ 0.15 - 0.10
1.60	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 strip shall be manufactured from copper of ETP grade conform to IS:191.

### 7.0 FREEDOM FROM DEFECTS:

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

### 8.0 CHEMICAL COMPOSITION:

The analysis of copper when analyzed 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 exclusive 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 01	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 04		
PAGE 4 OF 5		

10.0 MECHANICAL PROPERTIES:

10.1 Tensile strength (For sizes over 0.5 mm to 10mm thick) :

The test samples, when tested in accordance with IS: 1608 shall show the following properties:

Tensile Strength

: 205 N/mm<sup>2</sup> , minimum.

Elongation on 4√A or 50 mm gauge length: 35% , min

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<sup>0</sup>, without showing any sign of cracks or failures upon the convex surface of the bend.

10.3 Hardness (Vickers):

Hardness test is mandatory for thickness upto 0.5mm. When tested in accordance with IS:1501, the strips shall have a Vickers hardness not exceeding 60 HV.

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 0.01737 ohm-mm<sup>2</sup>/metre, which is equivalent to an electrical conductivity of 99.25%, 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. 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.

13.0 TEST CERTIFICATES:

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



## CORPORATE PURCHASING SPECIFICATION

AA 120 01

Rev. No. 04

PAGE 5 OF 5

The test certificate shall bear the following information:

AA 120 01, Rev 04: Copper strip – Annealed

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.

### 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 12001: Copper strip – Annealed

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

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

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



## 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 :

Cl: 24.1 of MOM of MRC-NFCW+HE

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Corp. R&D

December, 1978

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, ± 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, ± mm			
Over	upto and incl.	upto and incl. 160 wide	over 160 upto& incl. 300 wide	over 300 upto& incl. 450 wide	over450 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,± 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.



# CORPORATE PURCHASING SPECIFICATION



## 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<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 05

Rev. No. 05

PAGE 1 OF 5

### COPPER STRIP – HALF HARD

#### 1.0 GENERAL:

This specification governs the quality requirements of bright half hard 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.

#### 3.0 CONDITION OF DELIVERY:

The material shall be supplied in half hard condition, in coils or straight lengths as specified in BHEL order. The edges of the strips shall be 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: 'HB ' Half 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:

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

#### Revisions :

Cl: 24.1 of MOM of MRC-NFCW+HE

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MARCH, 1980


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

Width, mm:			Tolerance, $\pm$ 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
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 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
0.28	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 05

Rev. No. 05

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
1.00	1.60	0.60	+ 0.15 - 0.10
1.60	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 strip 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 by any other conventional/ instrumental method shall 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	--	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 electric tests.

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

## CORPORATE PURCHASING SPECIFICATION



### 10.0 MECHANICAL PROPERTIES:

#### 10.1 Tensile strength:

The test samples, for sizes over 0.50 mm to 10 mm thickness, when tested in accordance with IS:1608, shall show the following properties:

Tensile Strength : 245 N/mm<sup>2</sup>, minimum.

Elongation on 4√A or 50 mm gauge length:

Over 0.5 mm upto & incld . 2.5 mm thick : 10% , min.

Over 2.5 mm upto & incld . 10 mm thick : 15% , min.

**Note:** Material upto & incld. 0.5 mm shall be tested only for hardness.

#### 10.2 Bend Test:

##### a) Edge wise:

The strip shall not show any sign of cracks when bend once on edge through an angle of 90° around a former of radius equal to 1.5 times the width of the strip.

##### b) Transverse & Longitudinal:

The strip shall be subjected to a transverse bend test. Where this is not possible, it shall be subjected to a longitudinal bend test. The strip when subjected to the bend test in accordance with IS:1897 shall withstand the test through an angle of 180° over a former at radius equal to the thickness at the strip. The material shall show no sign of cracks or failure upon the convex surface at the bend.

#### 10.3 Hardness (Vickers):

When tested in accordance with IS:1501, the strips shall have a Vickers hardness of 75 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 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. 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 arrange.



## CORPORATE PURCHASING SPECIFICATION

AA 120 05

Rev. No. 05

PAGE 5 OF 5

### 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 05, Rev 05: Copper strip – Half hard

BHEL Order No,

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

Dimensional inspection

Results of Chemical analysis, Mechanical and electrical tests,

### 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 from damage during transit.

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

AA 12005 : Copper strip – Half hard

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

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

1. IS:191

2. IS:440

3. IS:613

4. IS: 1501

5. IS:1608

6. IS:1897

7. IS:3052

8. IS: 3635

9. ASTM E 1004



## CORPORATE PURCHASING SPECIFICATION

AA 120 07

Rev. No. 04

PAGE 1 OF 5

### COPPER STRIP – ANNEALED (CLOSE TOLERANCES)

#### 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 160 mm with radiused edges and close tolerances.

**2.0 APPLICATION:** Used for general electrical purposes such as bus bars, connectors etc.

#### 3.0 CONDITION OF DELIVERY:

Bright and Annealed.

The material shall be supplied in annealed condition, with close tolerances in coils or straight lengths as specified in BHEL order.

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The material shall in general 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: 'O' 'Annealed'

#### 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, and length shall be as follows:

##### 5.2.1 Width / Thickness:

Tolerance on thickness, width and length shall be as follows,

Width/Thickness, mm		Tolerance, $\pm$ mm
Over	Upto & including	
-	3.0	0.03
3.0	6.3	0.05
6.3	12.0	0.07
12.0	25.0	0.10
25.0	50.0	0.12
50.0	100.0	0.25
100.0	160.0	0.50

#### Revisions :

Cl: 24.1 of MOM of MRC-NFCW+HE

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# CORPORATE PURCHASING SPECIFICATION



## 5.2.2 Length:

Tolerance on fixed length, shall be as per the table given below:

<u>Length, meter</u>		Tolerance, $\pm$ mm
Over	up to & including	
-	0.2	1.0
0.2	1	2.0
1	2	3.0
2	4	6.0
4	6	10.0

## 5.3 Radius on Edges:

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

<u>Thickness, mm</u>		Nominal radius on edges, mm	Tolerance on radius, mm
Over	upto & incld.		
--	1.0	Semi circular	$\pm 0.06$
1.0	1.6	0.60	$\pm 0.15$
			- 0.10
1.6	2.25	0.80	$\pm 0.15$
2.25	3.55	1.0	$\pm 0.20$
3.55	10.00	1.25	$\pm 0.25$

## 5.4 Straightness:

The edges of strips supplied in straight lengths shall not vary from a straight line by more than 20 mm in any 1000 mm length.

## 6.0 MANUFACTURE:

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



## CORPORATE PURCHASING SPECIFICATION

AA 120 07

Rev. No. 04

PAGE 3 OF 5

### 8.0 CHEMICAL COMPOSITION:

The analysis of copper when analyzed 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.

### 10.0 MECHANICAL PROPERTIES:

#### 10.1 Tensile strength (For sizes over 0.50 mm and upto & including 10mm thick):

The test samples, when tested in accordance with IS: 1608 shall show the following properties:

IS: 1608, shall show the following properties:

Tensile Strength: 205 N/mm<sup>2</sup>, minimum.

Elongation on 4√A or 50 mm gauge length: 35% Min

**NOTE:** Material upto and including 0.5mm shall be tested only for hardness.

#### 10.2 Hardness (Vickers):

When tested in accordance with IS:1501, the strips shall have a Vickers hardness not exceeding 60 HV, min.

#### 10.3 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.

#### 10.4 Edgewise Bending:

The material shall withstand without showing any sign of cracks or failure, when bent on edge through an angle of 180° over a former of radius equal to half the width of the strip.

## CORPORATE PURCHASING SPECIFICATION



### 11.0 ELECTRICAL RESISTIVITY (AS RECEIVED):

When measured in accordance with IS: 3635, the electrical resistivity at 20<sup>0</sup> shall not be greater than 0.01737 ohm-mm<sup>2</sup>/metre, which is equivalent to an electrical conductivity of 99.25%, 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. 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.

### 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 07, Rev 04: Copper strip – Annealed, Close Tolerances

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.



## CORPORATE PURCHASING SPECIFICATION

AA 120 07

Rev. No. 04

PAGE 5 OF 5

### 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 12007 : Copper strip – Annealed, (Close Tolerances)

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

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

1. IS:191

2. IS:440

3. IS:613

4. IS: 1501

5. IS:1897

6. IS:1608

7. IS:3635

8. ASTM E 1004

9. AA 12024



# CORPORATE PURCHASING SPECIFICATION

AA 120 08

Rev. No. 05

PAGE 1 OF 5

## COPPER RODS - ANNEALED

### 1.0 GENERAL:

This specification governs the quality requirements of round and rectangular Copper Rods, over 6 mm and upto and including 125 mm, size, in the annealed condition.

### 2.0 APPLICATION:

Used for general electrical purposes such as end rings of squirrel cage motors etc. Refer AA 12022 for rectangular copper rods with edgewise bending.

### 3.0 CONDITION FO DELIVERY:

The rods shall be supplied in annealed condition in straight lengths. Rectangular bars shall be supplied with corners radiused to Cl.5.3.

### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The rods 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 Electrical Purposes.

Condition: Annealed:

### 5.0 DIMENSIONS AND TOLERANCES:

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

### 5.2 Tolerances:

#### 5.2.1 Tolerances on diameter/across flats shall as follows:

Diameter, Width across flats or thickness		Tolerance (±)		
Over	Upto & incld.	Round (dia)	Square & Hex. Rod (Width across flat)	Rectangular bar (Width or thickness)
6	10	0.05	--	--
10	12	0.05	0.08	0.07
12	25	0.08	0.10	0.10
25	50	0.12	0.16	0.14
50	80	0.18	0.25	--
80	100	....as agreed between BHEL and supplier...		
100	160	....as agreed between BHEL and supplier.....		

Revisions :Clause:19.10.10 of MOM of MRC-NFCW+HE

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# CORPORATE PURCHASING SPECIFICATION



## 5.2.2 Tolerance on length shall be as follows:

<u>Length, mm</u>		Tolerance, $\pm$ mm
Over	Upto and Incl.	
-	150	1.2
150	1200	1.5
1200	2400	2.5
2400	--	5.0

## 5.2.3 Straightness:

The edges of rods shall not vary from a straight line by more than 3 mm in any 1000 mm length.

## 5.3 Radius on Edges - Rectangular:

<u>Thickness, mm</u>		Edge radius, mm	Tolerance, $\pm$ mm
Over	Upto&Incl.		
6	25	2.5	0.25
25	50	3.2	0.25
50	.....As agreed.....		

## 6.0 MANUFACTURE:

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

## 7.0 FREEDOM FROM DEFECTS:

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

## 8.0 CHEMICAL COMPOSITION

The analysis of copper when analysed in accordance with IS: 440, shall as follows.

Element	Percent	
	Min.	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 08

Rev. No. 05

PAGE 3 OF 5

\*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 (SAMPLING AND CRITERIA FOR CONFORMITY):

Sampling, number of tests, criteria for conformity and retest shall be as per Cl 12 of IS:613.

### 10.0 MECHANICAL PROPERTIES:

#### 10.1 Tensile:

The test samples, when tested in accordance with IS 1608 shall show the following properties:

Cross - sectional dimension, mm		Tensile strength, maximum	Elongation on 5.65 of gauge length
Over	upto & incld	N/mm <sup>2</sup>	% minimum
6	10	250	32
10	12	240	40
12	90	230	45
Over 90		..... as agreed .....	

#### 10.2 HARDNESS:

When tested in accordance with IS: 1501, the material shall have a Vickers hardness 60 HV, max.

### 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 0.01737 ohm-mm<sup>2</sup>/metre, which is equivalent to an electrical conductivity of 99.25%, 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.

**CORPORATE PURCHASING  
SPECIFICATION****12.0 INSPECTION AT SUPPLIER ' WORKS:**

When ever 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. 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 arrangement for carrying out the prescribed test elsewhere.

**13.0 TEST CERTIFICATES:**

Unless other wise stated, three copies of certificates shall be supplied along with each consignment.

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

The test certificate shall bear the following information:

AA 12008 (Rev.05) Copper Rods - Annealed.

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.





## CORPORATE PURCHASING SPECIFICATION

AA 120 08

Rev. No. 05

PAGE 5 OF 5

### 14.0 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 12008 : Copper Rods - Annealed

BHEL Order No.

Manufacturer's/Supplier's Name :

Lot/Identification/Batch/Melt No.

Sizes and Quantity Supplied

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

- |                |              |            |
|----------------|--------------|------------|
| 1. IS:191      | 2. IS:440    | 3. IS:613  |
| 4. IS: 1501    | 5. IS:1608   | 6. IS:3635 |
| 7. ASTM E 1004 | 8. AA 120 22 |            |



## CORPORATE PURCHASING SPECIFICATION

AA 120 21

Rev. No. 02

PAGE 1 OF 5

### EXTRUDED COPPER SECTIONS - ANNEALED

#### 1.0 GENERAL:

This specification governs the quality requirements of Extruded copper sections in annealed condition.

#### 2.0 APPLICATION:

Used in winding of electrical machines.

#### 3.0 CONDITION OF DELIVERY:

The copper sections shall be supplied in annealed condition in straight lengths as specified in BHEL order. Joints are not permitted.

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

There is no Indian standard covering this material. However assistance has been drawn from the following National standard.

IS: 613 - 2000, Condition: Annealed: Copper Rods and Bars For Electrical purposes

#### 5.0 DIMENSIONS AND TOLERANCES:

##### 5.1 Sizes:

Extruded copper sections shall be supplied to the dimensions specified in BHEL order / drawing.

##### 5.2 Tolerances:

##### 5.2.1 Thickness and width:

The tolerances on sections shall be specified in BHEL order/drawing.

##### 5.2.2 Radius on edges:

Radius on edges and tolerances on radius shall comply with the following:

#### Revisions :

Clause: 20.2.3 of MOM of MRC-NFCW+HE

#### APPROVED :

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Thickness, mm		Radius on edges, mm	Tolerance on radius ± mm
Over	Upto and incl .		
-	1.2	0.40	0.06
1.2	1.7	0.50	0.08
1.7	2.5	0.60	0.09
2.5	4.0	0.80	0.12
4.0	10	1.00	0.15
10	25	2.5	0.25
25	80	3.2	0.25

#### 6.0 MANUFACTURE:

The copper sections 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 sections shall be clean, bright, smooth and free from fins, spills, scaling, blisters, cracks, piping, pitting, folds, waviness, camber 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 excluding silver and oxygen.	-	0.030

\* 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 Test samples shall be drawn from the same ingot as the sections they represent and shall be treated in the same manner. Test samples shall be of such size as to give test pieces of 15mm dia and 350mm long after machining. One test sample for each melt shall be supplied. Test samples shall bear necessary identification mark.



## CORPORATE PURCHASING SPECIFICATION

AA 120 21

Rev. No. 02

PAGE 3 OF 5

- 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 Bend Test Edgewise:

The copper sections shall not show any sign of cracks, when bent once on edge through an angle of  $180^0$  on smaller parallel dimensions, over a former diameter equal to the width of the section.

#### 10.2 Hardness:

When tested in accordance with IS: 1501, the material shall have a hardness of 60 HV, maximum. The copper sections shall have a uniform hardness any where along the length and cross section.

### 11.0 ELECTRICAL RESISTIVITY (As Received):

When measured in accordance with IS: 3635, the electrical resistivity of the sample in as received condition at  $20^0$  C shall not be greater than  $0.01737 \text{ ohm mm}^2 / \text{metre}$ , which is equivalent to an electrical conductivity of 99.25%, 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 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.

**CORPORATE PURCHASING  
SPECIFICATION****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 dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information:

AA 12021, Rev. No. 02: Extruded Copper Sections - Annealed  
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 copper sections shall be suitably packed to prevent damage during transit.

Each package shall be legibly marked or labeled with the following information.

AA 12021: Extruded Copper Sections - Annealed

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: 3635

6) ASTM E 1004

7) AA 12024



## CORPORATE PURCHASING SPECIFICATION

AA 120 21

Rev. No. 02

PAGE 5 OF 5

### ANNEXURE - A (Clause 12.0)

#### CHECK LIST FOR AA 120 21: EXTRUDED COPPER SECTIONS – ANNEALED

(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/ across flats/radius on edge/ 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:

Signature &

Place:

Seal of Supplier



## CORPORATE PURCHASING SPECIFICATION

AA 120 22

Rev. No. 05

PAGE 1 OF 5

### RECTANGULAR COPPER RODS - ANNEALED (WITH EDGE WISE BENDING)

#### 1.0 GENERAL:

This specification governs the quality requirements of rectangular copper rods in annealed condition with edgewise bending over 6mm and upto including 125mm thickness.

#### 2.0 APPLICATION:

Used in winding of electrical machines such as end rings of squirrel cage motors, etc., which require severe edgewise bending.  
Refer AA 12008 for rectangular and round copper rods for normal applications.

#### 3.0 CONDITION OF DELIVERY:

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

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

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

IS: 613- 2000 , Condition : Annealed : Copper Rods and Bars For Electrical purposes

#### 5.0 DIMENSIONS AND TOLERANCES:

##### 5.1 Sizes:

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

##### 5.2 Tolerances:

##### 5.2.1 Diameter/Across flats:

The tolerances on diameter / across flats shall comply to the normal tolerances as per Table 3 of IS:2826.

##### 5.2.2 Length:

Tolerance on length shall be as follows:

#### Revisions :

Cl: 19.10.20 of MOM of MRC-NFCW+HE

#### APPROVED :

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Year :

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

### 5.2.3 Straightness:

The edges of rods shall not vary from a straight line by more than 5 mm in any 1000 mm length for rods upto 50mm thick.

### 5.3 Radius on Edges:

Thickness, mm		Edge radius, mm	Tolerance on radius $\pm$ mm
Over	Upto and incl.		
6	25	2.5	0.25
25	50	3.2	0.25
50	--	As agreed between BHEL and 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 excluding silver and oxygen.	-	0.030





## CORPORATE PURCHASING SPECIFICATION

AA 120 22

Rev. No. 05

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:

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:

<u>Cross-sectional Dimension, mm</u>		<u>Tensile strength, N/mm<sup>2</sup>,max.</u>	<u>Elongation on 4√A or 50mm G.L., percent, minimum</u>
Over	Upto & incl.		
6	12	240	40
12	50	230	45
50	--	As agreed between BHEL and manufacturer.	

#### 10.2 Edgewise bending:

The copper rods when bent on edge through an angle of 180° over a mandrel of radius equal to half the width of the rod shall withstand without showing any signs of failure or crack.

#### 10.3 Hardness (Vickers):

When tested in accordance with IS:1501, the copper rods shall have a Vickers hardness not exceeding of 60 HV.

### 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 0.01737 ohm mm<sup>2</sup> / metre, which is equivalent to an electrical conductivity of 99.25%, 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 CHECK LIST:

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

AA 120 22	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 05		
PAGE 4 OF 5		

### 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 12022, Rev. No. 05 : Rectangular Copper Rods - Annealed (with edgewise bending)  
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 copper rods shall be suitably packed to prevent damage during transit.

Each package shall be legibly marked or labeled with the following information.

AA 12022 : Rectangular Copper Rods - Annealed (with edgewise bending)  
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:1608   |
| 6) IS: 2826 | 7) IS: 3635 | 8) ASTM E 1004 | 9) AA 12008 | 10) AA 12024 |



## CORPORATE PURCHASING SPECIFICATION

AA 120 22

Rev. No. 05

PAGE 5 OF 5

### ANNEXURE - A (Clause 12.0)

#### CHECK LIST FOR AA 120 22: RECTANGULAR COPPER RODS – ANNEALED (WITH EDGEWISE BENDING)

(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/ across flats/radius on edge/ 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:

Signature &

Place:

Seal of Supplier



## 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)

Rev. No.08

Amd.No.

Reaffirmed

Prepared

Issued

Dt. of 1st Issue

Dt:06.06.2012

Dt :

Year :

BHOPAL

Corp. R&D

Nov, 1978

### 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,	Tolerance in Radius
Over	Upto and incl .	mm	$\pm$ mm
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 HV, min.
Over	Upto & incl.	Round	Square/ Hexagonal	Rect- angular	Round	Square/ Hexagonal	Rect- angular	
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.

## CORPORATE PURCHASING SPECIFICATION



### 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 |



## CORPORATE PURCHASING SPECIFICATION

AA 120 23

Rev. No. 08

PAGE 5 OF 5

### 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:

Signature &

Place:

Seal of Supplier





## CORPORATE PURCHASING SPECIFICATION

AA 120 26

Rev. No. 07

PAGE 1 OF 5

### COPPER RODS - HALF HARD

#### 1.0 GENERAL:

This specification governs the quality requirements of copper rods in the following shapes and sizes in half hard condition.

Round	-	Over 6 mm upto 90 size
Rectangular	-	Over 6 mm upto 50 size

#### 2.0 APPLICATION:

Used for general electrical purposes.

#### 3.0 CONDITION OF DELIVERY:

The rods shall be supplied in half hard condition in straight lengths.

Rectangular bars shall be supplied with their edges radiused to clause 5.3

#### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

The rods 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 electrical purposes
Gr: HB, Half hard		

#### 5.0 DIMENSIONS AND TOLERANCES:

##### 5.1 Sizes.

Copper rods shall be supplied to the dimensions specified in BHEL Order.

##### 5.2 Tolerances:

5.2.1 The tolerances for round, square, rectangular and hexagonal rods shall be as given below :  
[Table - 2 of IS: 613]

##### 5.2.2 Sections:

Shall be as per BHEL drawing accompanying the order.

Revisions : Clause.19.10.21 of MOM of  
MRC-NFCW+HE

**APPROVED :**  
INTERPLANT MATERIAL RATIONALISATION  
COMMITTEE-MRC (NFCW+HE)

Rev. No. 07	Amd.No.	Reaffirmed	Prepared	Issued	Dt. of 1st Issue
Dt:15.11.2004	Dt :	Year :2012	BHOPAL	Corp. R&D	Sept., 1979

# CORPORATE PURCHASING SPECIFICATION

**5.2.3 Length:**

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 in any 1000 mm length.

**5.3 Radius on Edges - Rectangular:**

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 between BHEL and manufacturer	

**6.0 MANUFACTURE:**

The 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 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 26

Rev. No. 07

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 HB

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 HV
Over	Upto & incl.	Round	Square/ Hexagonal	Rect- angular	Round	Square/ Hexagonal	Rect- angular	
6.0	10.0	280	-	-	8	-	-	70 to 90
10.0	12.0	260	260	250	12	12	12	
12.0	25.0	250	250	230	18	18	18	
25.0	90.0	230	230	230	22	22	18	
> 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 14 mm 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 at 20<sup>0</sup> C shall not be greater than 0.0177ohm. 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.

# CORPORATE PURCHASING SPECIFICATION



## 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 works, the supplier shall make necessary arrangements for 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 12026 (Rev. No. 07) : Copper Rods - Half Hard

BHEL Order No.

Manufacturer 's / Supplier 's Name

Log /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 rods shall be suitably packed to prevent damage during transit.

Each package shall be legibly marked or labeled with the following information.

AA 12026: Copper Rods - Half 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: 3635

8) ASTM E 1004

9) AA 12024



## CORPORATE PURCHASING SPECIFICATION

AA 120 26

Rev. No. 07

PAGE 5 OF 5

### ANNEXURE - A (Clause 12)

#### CHECK LIST FOR AA 120 26: COPPER RODS - HALF 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:

Signature &

Place:

Seal of Supplier



## RECTANGULAR COPPER CONDUCTOR- ANNEALED, CONTROLLED OXYGEN

### 1.0 GENERAL:

This specification governs the quality requirements of rectangular copper conductors, drawn, annealed, controlled oxygen up to 12 mm thick and 32 mm width.

### 2.0 APPLICATION:

Used in stator/rotor winding after insulation.

### 3.0 CONDITION FO DELIVERY:

As drawn and annealed .

The material shall be supplied in coils or in straight length with radiused corners as specified in BHEL order. The drum dimensions of the coil shall be detailed in order.

### 4.0 COMPLIANCE WITH NATIONAL STANDARDS:

There is no National standard covering this type of material. However, assistance has been derived form the following National standard.

DIN: 46452-1977 : Rectangular bare wires for winding wires, dimensions  
Gr: E Cu 58 F20 :

### 5.0 DIMENSIONS AND TOLERANCES:

#### 5.1 Sizes:

As specified in BHEL order/drawing.

#### 5.2 Tolerances:

##### 5.2.1 On width:

Permissible deviation from nominal width shall be as follows:

Width, mm		Permissible deviation, mm	
Over	Upto & incld.	( + )	( - )
---	3.0	0.03	0.01
3.0	6.0	0.05	0.05 (Total deviation 0.07)
6.0	12.0	0.07	0.03
12.0	16.0	0.10	0.05
16.0	32.0	0.13	0.07

**Revisions:** Letter from HW, email:dtd.09.02.02  
TSD/Bhopal, TSD/SM/411Dt:20.03.99 from BP,  
TSD/SM/411 Dt:13.05.98

**APPROVED :**  
**INTERPLANT MATERIAL RATIONALISATION**  
**COMMITTEE-MRC (NFCW+HE)**

Rev. No. 02

Amd.No.03

Reaffirmed

Prepared

Issued

Dt. of 1st Issue

D :15-03-04

Dt :15-03-02

Year :

BHOPAL

Corp. R&D

01-12-96

**5.2.2 On Thickness:**

Permissible deviation from nominal thickness shall be as follow:

<u>Thickness, mm</u>		<u>Permissible deviation, mm</u>	
Over	Upto & incld.	( + )	( - )
---	2.0	0.03	0.03 (Total deviation 0.04)
2.0	6.0	0.05	0.02
6.0	12.0	0.07	0.03

**5.3 Edge Radius of Bare Conductor:**

<u>Nominal thickness, mm</u>		<u>Edge Radius, mm</u>	<u>Permissible deviation, ± mm</u>
Over	Upto & incld.		
---	1.0	Thickness/2	----
1.0	1.6	0.50	0.13
1.6	2.24	0.65	0.16
2.24	3.55	0.80	0.20
3.35	6.0	1.00	0.25
6.0	12.0	1.25	0.30

**6.0 FREEDOM FROM DEFECTS:**

The material shall be clean, bright, straight , smooth and free from fins, slivers, spills, scale, blisters, cracks and other harmful defects.

**7.0 JOINTS:**

No joints shall be made in the conductor after it has been drawn. Any joint made during the drawing process shall be resistance welded only. Not more than 2 lengths per coil shall be allowed but only one length, if possible, is preferred. In case of supplies with two wire lengths, the ends of the wires shall not be soldered. The joints shall be made by many layers of coloured adhesive tape, whereby the wire ends have to overlap at least 100 mm. A paper strip shall be placed prominently before the end at a suitable distance in order to indicate the end of a wire length.

**8.0 TEST SAMPLES:**

One sample per size per batch per consignment shall be selected for testing and approval purposes.



## CORPORATE PURCHASING SPECIFICATION

AA 120 30

Rev. No. 02

PAGE 3 OF 5

### 9.0 CHEMICAL COMPOSITION:

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

Copper and Silver	: 99.00 minimum
Oxygen	: 0.005 to 0.040 %

### 10.0 PROPERTIES:

When tested in accordance with the relevant clauses of DIN 40500-Part 4, the test sample shall show the following values:

#### 10.1 Tensile Strength:

<u>Thickness, mm</u>		Tensile Strength, N/mm <sup>2</sup>	Elongation on 200 mm gauge length, min
Over	upto & incld.		
0.9	1.5	200-270	33
1.5	3.0	200-270	35
3.0	----	200-260	37

#### 10.2 Hardness:

55 HV, maximum.

#### 10.3 Stiffness Test ( Upto 6 mm Thick And 10 mm Width):

The straightened flat wire 600 mm long is placed with the width horizontal on two rollers of 15 mm diameter and an axial distance of 400 mm so that there is a projection of 100 mm each on both sides.

Load is applied at the centre of the flat wire till it slides through the rollers .

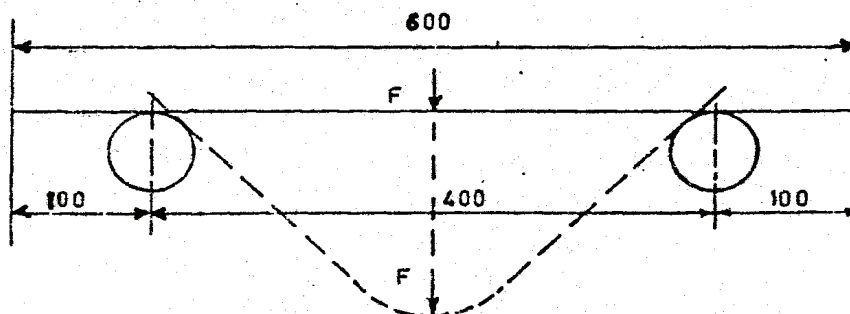
The stiffness value  $X_w$  is calculated by the formula

$$X_w = \frac{F \cdot 100}{w} \text{ N/mm}^2, \quad \text{where}$$

$$W = \text{Moment of resistance} = \frac{\text{Thickness}^2 \times \text{Width mm}^3}{6}$$

F= Load in Newton.





Three tests shall be carried out. The mean value shall not exceed  $X_w$  value as given below:

Thickness, mm		Stiffness, $X_w$ , N / mm <sup>2</sup>
Over	Upto & incld	
--	1	80
1	2	110
2	3	125
3	4	130
4	5	135
5	6	140

#### 10.4 ELECTRICAL RESISTIVITY :

The electrical resistivity at 20<sup>0</sup> C of the conductor of one metre in length and of uniform cross sectional area of 1 mm<sup>2</sup>, in annealed condition of the sample, shall be not greater than 0.01724 ohm mm<sup>2</sup>/metre, which corresponds to 100% of electrical conductivity of IEC standard. ( Refer Appendix B of IS: 613 for temperature correction factor. )

#### 11.0 INSPECTION AT SUPPLIER ' WORKS:

When ever 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.

AA 120 30	CORPORATE PURCHASING SPECIFICATION	
Rev. No. 02		
PAGE 5 OF 5		

## 12.0 TEST CERTIFICATES:

Unless other wise stated, three copies of certificates shall be supplied along with each consignment giving the following information.

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

AA 12030 (Rev.02) Rectangular Copper Conductors - Annealed Controlled Oxygen.  
BHEL Order No.

Manufacturer 's/Supplier's Name:

Trade mark, if any.

Batch/lot no.

Quantity Supplied.

Test results of clauses 5, 9 and 10.

## 13.0 PACKING AND MARKING:

The material shall be supplied as stated on the order and suitably packed to prevent damages during transit. Conductor shall be wound on a drum of sufficient strength so that there shall not be any breakage/damage to drum and copper during transportation and handling. The maximum weight of copper shall be 100 to 110 kg on each drum. The weight copper and drum size shall be as per IS: 2069. However, the flange thickness shall be  $38 \pm 4$  mm in place of  $28 \pm 4$  mm.

Each consignment shall be legibly marked or labeled with the following information.

AA 12030 : Rectangular Copper Conductors - Annealed, Controlled Oxygen.

BHEL Order No.

Manufacturer's/Supplier's Name :

Batch/lot No.

Trade mark, if any.

Length, weight and quantity Supplied

## 14.0 REFERRED STANDARDS (Latest Publications Including Amendments):

1. IS:613

2. IS:440

3. DIN 40500 - Part 4.

4. DIN 46452

5. ASTM E 1004.

**PAGE 1 of 04**

**SUPERSEDES**  
**BP 12071 Rev 07**

- Square Bar : 11 to 50 mm

STANDARDS AND MATERIALS GROUP  
TECHNICAL SERVICES DEPARTMENT

Date of first Issue : Feb. 1986



TSD 6207A

# PLANT PURCHASING SPECIFICATION BHOPAL

BP 12071

REV NO. 08

PAGE 2 of 4

## 5.2 Tolerances

### 5.2.1 Rectangular Bar :

Tolerances of rectangular bars shall be as given below :

Width (mm)		Perm. Varn.  Plus/ Minus	Permissible variation of thickness (mm)  Plus / Minus					
Dimension Range			From 2 to 3	Over 3 to 6	Over6 to 10	Over10 to 18	Over18 to 30	Over30 to 40
Over	Upto							
10	18	0.15	0.07	0.10	0.12	0.15	-	-
18	30	0.22	0.07	0.10	0.12	0.15	0.22	-
30	50	0.30	0.10	0.13	0.15	0.18	0.22	0.30
50	80	0.37	0.13	0.16	0.18	0.22	0.30	0.37
80	120	0.45	-	0.18	0.22	0.27	0.35	0.45

### 5.2.2 Square Bar :

Tolerance on square bar shall be as given below:

Size ( mm )		Permissible Variation (mm)	
From	To	Minus	Plus
11	18	0.18	0.00
19	30	0.21	0.00
31	50	0.25	0.00

### 5.2.3 Straightness:

The edges of rods shall not vary from a straight line by more than 3 mm in any 1000 mm length.

## 5.3 Length:

In straight lengths with straight edges as called for in the drawing / order.

## 6. MANUFACTURE :

### 6.1 Conductor material

The conductor shall be manufacture from ETP Gr. copper conforming to AAI2024 "Electrolytic Tough pitch copper wire / Bar / Ingots / Continuously Cast Wire Rods".



TSD 6207A

# PLANT PURCHASING SPECIFICATION BHOPAL

BP 12071

REV NO. 08

PAGE 3 of 4

**Note :-** It is preferable to manufacture conductor from continuous cast copper rods provided all other acceptance parameters & conditions remain same.

7. FREEDOM FROM DEFECTS :

The material shall be clean, smooth, straight, free from cracks, slivers, scales and other harmful defects.

8. TEST SAMPLES :

One test sample shall be selected per size, per heat treatment batch, per consignment for testing. The sample shall be cut off cold & shall receive no further treatment before testing.

9. MECHANICAL PROPERTIES :

The material when tested in accordance with IS:1608 shall show the following properties.

9.1 Tensile (For sizes Up-to 50mm) :

Tensile Strength	200 -250 N/mm <sup>2</sup>
Elongation on 5.65 $\sqrt{S_0}$ G.L.	38 Percent Minimum

9.2 Hardness ( Brinell )\*

When tested in accordance with IS:1500 the material shall have a Brinell Hardness of 45-70 HB.

\* **Note :-** Hardness Tests shall be done only when Tensile Test cannot be carried out.

10. ELECTRICAL RESISTIVITY:

When measured in accordance with IS3635, the Electrical Resistivity at 20°C shall not be greater than 0.01754 Ohms mm<sup>2</sup>/mtr which, corresponds to 98.28 % Min, of Electrical Conductivity of IACS Standard.

Alternatively the method of measurement employing Eddy Current probes as per ASTM E 1004 shall also be acceptable.

Refer Appendix - B of IS:613-for temperature correction factor.



TSD 6207A

## PLANT PURCHASING SPECIFICATION BHOPAL

BP 12071

REV NO. 08

PAGE 4 of 4

### 11. TEST CERTIFICATE

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

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

The test certificate shall bear the following information.

BHEL Reference:

BP 12071 Rev. 08

Order No,

Supplier's Reference

Supplier's Name

Size and Number

Batch No,

Test Results:

Test results obtained for Electrical & Mechanical Properties & Dimensional tolerances, shall be recorded.

### 12. PACKING AND MARKING;

The material shall be properly wrapped with Kraft Packing Paper bound with cord or soft wire and packed in crates to prevent corrosion and damage during transit.

Each crate shall be legibly marked with the following information :

BP12071: Copper Bar Annealed Straight Edge (Controlled Oxygen)

BHEL Order No,

Supplier's Name

Size and Weight.



TSD6206A

## PLANT PURCHASING SPECIFICATION BHOPAL

BP 12083

REV NO. 08

PAGE 1 of 04

### RECTANGULAR COPPER CONDUCTORS - ANNEALED-CONTROLLED OXYGEN (400PPM MAX.)

**SUPERSEDES  
BP12083 Rev 07**

**1. GENERAL :**

This specification governs the requirements of bare rectangular, high conductivity copper conductors, in annealed condition with controlled Oxygen (400PPM Max.) up to a thickness or width of 16mm, with rounded corners.

**2. APPLICATION :**

For use in Traction / Electrical machines .

**3. CONDITION OF DELIVERY :**

The material shall be supplied in annealed condition, with rounded Corners.

**4. COMPLIANCE WITH NATIONAL STANDARDS :**

There is no National standard covering this type of material.

**5. DIMENSIONS AND TOLERANCES :**

**5.1 Sizes**

The conductors shall be supplied to the sizes stated on our order.

**5.2 Tolerances -**

Tolerances on thickness or width shall be as given in Table1 below :

**5.2.1 Thickness / width : Table - 1**

**Thickness/ Width : Table -1**

Specified Width or Thickness		Tolerance (±) mm
Over mm	Up to & incl. mm	
--	03.15	0.030
03.15	06.30	0.050
0630	12.50	0.070
1250	16.00	0.100

**Revision :**

**Reviewed & No Tech. Change**

**Issued by :**

**STANDARDS AND MATERIALS GROUP  
TECHNICAL SERVICES DEPTMENT**

**Rev. 08**

**Date : 07.11.2019**

**Date of first Issue : July 1983**



TSD 6207A

## PLANT PURCHASING SPECIFICATION BHOPAL

BP 12083

REV NO. 08

PAGE 2 of 4

### 5.2.2 Radius on Corners :

The conductor shall have round corners, the radius of curvature being within the range given below in Table 2.

The arc shall merge smoothly into the flat and the conductors shall be free from sharp, rough ' and projecting edges.

Table - 2

Nominal Thickness		Corner Radius mm
Over mm	Up to & in cld. mm	
-	1.00	Semicircular
1.00	1.60	0.50-0.65
1.60	2.24	0.65-0.80
2.24	3.55	0.80-1.00
3.55	-	1.00-1.25

### 6. FREEDOM FROM DEFECTS :

The material shall be clean, smooth and free from harmful defects such as slivers, Cracks and other defects.

### 7. MANUFACTURE :

#### 7.1 Conductor Material

The conductor shall be manufactured from ETP grade copper conforming to CPS AA I2024 "Electrolytic Tough pitch copper wire bars / Ingots/Continuously Cast Wire Rods"

**Note :-** It is preferable to manufacture conductor from continuous cast copper rods provided all other acceptance parameters & conditions remain same.

### 8 TEST SAMPLES

One sample per size per batch per consignment of 500 kg or part there - off shall be taken for test.





TSD 6207A

## PLANT PURCHASING SPECIFICATION BHOPAL

BP 12083

REV NO. 08

PAGE 3 of 4

### 9. MECHANICAL PROPERTIES :

#### 9.1 Tensile Strength & Elongation :

A sample of conductor 250 mm gauge length when tested by the methods prescribed in IS: 1608 shall have the tensile strength and elongation at fracture as follows

Tensile strength : 205-245 N/ mm<sup>2</sup>

Elongation : 36 Percent Minimum (up to 5 mm<sup>2</sup>)

: 38 Percent Minimum (5 mm<sup>2</sup> - 30 mm<sup>2</sup>)

: 40 Percent Minimum (above 30 mm<sup>2</sup>)

#### 9.2 Edgewise Bend Test (For all thickness)

The material shall withstand, without showing any sign of fracture, when bent edgewise through 180° over a former of diameter equal to half the width of the material.

#### 9.3 Low Stress Elongation :

The conductor shall have a minimum LSE value of 1 percent, when determined in accordance with ASTM Method B 279.

#### 9.4 Hardness – Vickers (with 5kg load) :

When tested in accordance with IS:1501:Part, material shall have Vicker Hardness of 53 to 58 HV

### 10 ELECTRICAL RESISTIVITY:

When measured in accordance with IS:3635 directly on a sample in the "As Received" condition, the Electrical Resistivity at 20°C shall be not greater than 0.01724 ohm mm<sup>2</sup> /meter, which is equivalent to 100% Conductivity of IACS Standard. Alternatively, the method of measurement employing Eddy Current Probe as per ASTM E1004 shall also be acceptable.

Refer IS 613, Appendix B for temperature correction factor.

### 11. JOINTS :

No joint shall be made in the copper conductor after it is drawn. Any joint made during drawing shall be only resistance welded.



TSD 6207A

## PLANT PURCHASING SPECIFICATION BHOPAL

BP12083

REV NO. 08

PAGE 4 of 4

### 12. TEST CERTIFICATE ;

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

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 :

BP 12083

Rev. 08

BHEL Order No.

Supplier's Reference/Name.

Size

Identification /Batch/Melt No.

Test results obtained for Electrical and Mechanical properties, Chemical Composition and dimensional Tolerances as per the specification.

### 13. PACKING AND MARKING

The material shall be supplied on drums, wound tightly and evenly spread, free from dropped turns and shall be layer wound. The conductors shall be secured firmly to the drums and they shall further be protected from physical damage by closely spaced wooden strips held securely in position. Each drum shall be legibly marked with the following information.

BP 12083- Rectangular Copper Conductors,

Annealed –Controlled Oxygen (400 PPM max.)

BHEL Order NO.

Supplier's Name

Size and Net weight of conductor.



PRODUCT STANDARD  
TME DIVISION, BHOPAL

TM 10411

PAGE 01 OF 05

TME/2011

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**SPECIFICATION OF COPPER RODS AND BARS FOR ELECTRICAL PURPOSES**

**1.0 Scope :**

1.1 The material covered by this specification required to be used in manufacture of 3 Ø phase traction motor type 6FRA 6068 / 6FXA 7059. The material shall comply with this specification instruction in chemical composition, mechanical properties and all other listed requirements.

**2.0 Covering Standard :**

2.1 The material shall conform to IS: 613' 2000 annealed (o) in terms of material composition.

2.2 General requirement relating to the supply of material shall conform to IS: 1387 '93.

**3.0 Technical Requirement :**

**3.1 Chemical composition :**

The following chemical composition of ETP grade copper as per IS: 191 (part V) – '80 to be followed.

<u>Element</u>	<u>Percent</u>
Copper + Silver (Min)	99.90
Bismuth (Max.)	0.001
Lead (Max. )	0.005

Total of all impurities excluding  
Silver & oxygen (Max.) 0.03  
Oxygen shall be limited to 0.06 percent.

Revision: 02

Date: 24-10-18

Distribution

Qty.

Approved :

  
24/10/18  
S.P.Singh

CIM

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Prepared:

Checked:

Date:

TXM

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24/10/2018  
Prasad Telang


  
24/10/18  
Vikas Rawtiya

24-10-18


TME


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		<div></div> <div>PRODUCT STANDARD TME DIVISION, BHOPAL</div>		TM 10411																			
		TME/2011		PAGE 02 OF 05																			
		3.2 Mechanical Properties :																					
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of BHARAT HEAVY ELECTRICALS LTD. It must not be used directly or indirectly in any way detrimental to the interest of the company	<table><tr><td>Condition</td><td>Main cross Section Dimension</td><td>Tensile Strength</td><td>Percentage Elongation</td><td>Hardness HV (RF)</td><td>Shape</td></tr><tr><td>Annealed (O)</td><td>6 – 10 mm</td><td>210 - 250 N/mm<sup>2</sup></td><td>40 (min)</td><td>60 (65) max</td><td>Other then rectangular</td></tr><tr><td></td><td>--Do --</td><td>210 - 250 N/mm<sup>2</sup></td><td>40 (min)</td><td>60 (65) max</td><td>Rectangular</td></tr></table>					Condition	Main cross Section Dimension	Tensile Strength	Percentage Elongation	Hardness HV (RF)	Shape	Annealed (O)	6 – 10 mm	210 - 250 N/mm <sup>2</sup>	40 (min)	60 (65) max	Other then rectangular		--Do --	210 - 250 N/mm <sup>2</sup>	40 (min)	60 (65) max	Rectangular
	Condition	Main cross Section Dimension	Tensile Strength	Percentage Elongation	Hardness HV (RF)	Shape																	
	Annealed (O)	6 – 10 mm	210 - 250 N/mm <sup>2</sup>	40 (min)	60 (65) max	Other then rectangular																	
		--Do --	210 - 250 N/mm <sup>2</sup>	40 (min)	60 (65) max	Rectangular																	
3.3 Electrical Resistivity :																							
	<u>Condition</u>	<u>Resistivity Ohm mm<sup>2</sup> /m at 20<sup>o</sup> C. max.</u>	<u>Conductivity (IACS) Percentage, min</u>																				
	Annealed (o)	0.01737	99.25																				
	3.3.1 Resistance measurement on tests sample after annealing:																						
	Resistance measurement shall be made on specimens of the rod after cleaning and processing down to a diameter of approximately 6 to 10 mm and annealing at temperature 500°C for 30 minutes. Other equivalent annealing method may be used.																						
	4.0 Freedom from defects:																						
	The rod shall be bright and clean. It shall be free from blisters, Silvers, scale, fins, spills cracks and other defects.																						
	5.0 Tests and Tests method :																						
	5.1 The following tests to be carried out in presence of inspection authority and values to be recorded.																						
	5.2 The sampling of the tests on each component shall be followed as per Table – 1.																						

<div>TM 10411</div>	<div><div></div><div>PRODUCT STANDARD TME DIVISION, BHOPAL</div></div>
	<div>PAGE 03 OF 05</div>

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	Sl. No.	Tests to be carried	No. of Sample for Tests in prototype.	No. of Sample for Test in Routine test.
	1	Dimensions & Tolerances	100% of offered quantity.	10% of offered quantity of each component.
	2	Chemical component	2 Nos or 4 % whichever is more in a batch	4% of offered quantity or 2 Nos which ever is more in a batch
	3	Tensile Test	2 Nos or 4 % whichever is more in a batch	4% of offered quantity or 2 Nos which ever is more in a batch
	4	Elongation	2 Nos or 4 % whichever is more in a batch	4% of offered quantity or 2 Nos which ever is more in a batch
	5	Hardness	2 Nos or 4 % whichever is more in a batch	4% of offered quantity or 2 Nos which ever is more in a batch
	6	Electrical Resistivity	2 Nos or 4 % whichever is more in a batch	4% of offered quantity or 2 Nos which ever is more in a batch
	<div>6.0 Retest :</div> <div>6.1 If the test result of the chemical analysis fails to satisfy the requirement for any of the constituents, two more test for that constituents shall be done on the same sample in order to confirm that the analysis has been done properly. If both the test results satisfy the relevant requirement, the lot shall be considered.</div> <div>6.2 If the test results on any sample for Tensile Test and electrical resistivity Test, fails to satisfy the requirements for any of the mechanical properties and electrical resistivity, two more tests shall be done on the sample selected from the same lot. If both the test results satisfy the relevant requirements the lot shall be considered as conforming to the specification otherwise not.</div>			

		 <b>PRODUCT STANDARD TME DIVISION, BHOPAL</b>	<b>TM 10411</b>  <b>PAGE 04 OF 05</b>
		TME/2011	
<b>COPYRIGHT AND CONFIDENTIAL</b> The information on this document is the property of <b>BHARAT HEAVY ELECTRICALS LTD.</b> It must not be used directly or indirectly in any way detrimental to the interest of the company		<p><b>7.0 Inspection_:</b></p> <p>7.1 The successful Tender shall submit prototype to BHEL before undertaking bulk production/supply.</p> <p>7.2 The supplier shall offer prototype for inspection and tests at his works with prior intimation to inspecting authority. They shall provide all the necessary facilities for inspection and testing at their cost. After the Test if it is considered by the authorized inspecting representative to carry out further additional Test or Trial of the prototype samples at BHEL, supplier shall have to arrange the same by quickest means.</p> <p>7.3 Any short comings / defects in the design and workmanship of the equipment shall be pointed out after the test to enable the supplier to incorporate the necessary improvements before bulk supply is commenced without effecting the guaranteed program and delivery.</p> <p>7.4 Any testing and approval by the purchaser, of the design drawing and prototype shall in no way absolve the supplier of his responsibility under the Terms of contract for the item supplied.</p> <p>7.5 The supplier shall not offer any material of service production to the inspecting officer authorized under the contract until the prototype has been finally approved.</p> <p>7.6 Routine inspection of the items shall be carried out only after the approval of the prototype samples by the authorized inspecting authority.          The manufacturer shall provide all the necessary facilities for inspection and testing for all tests in accordance with the specification at their own cost.</p> <p><b>8.0 Information for Tenderer :</b></p> <p>8.1 The Tenderer shall study carefully the drawing and specification before they submit their offers.</p> <p>8.2 The Tenderer shall note that BHEL do not undertake to supply drawing for jig and fixture, tooling, templates and / or process sheets on any other such detail. BHEL may however comment / suggest alteration / modification to the suppliers drawing and method, if required, during the manufacture, Testing / inspection of material and / or use of the material in BHEL production.</p> <p>8.3 While submitting the offer the tenderer shall furnish the following information failing which the offer may not be considered.</p> <ol style="list-style-type: none"> <li>List of M &amp; P, Test facilities and manufacturing process sheet.</li> <li>Detail of material offered.</li> <li>Quality control system and quality assurance plan adopted by tenderer.</li> <li>Past performance for similar type of items.</li> </ol>	

			<b>PRODUCT STANDARD TME DIVISION, BHOPAL</b>	<b>TM 10411</b>
		TME/2011		<b>PAGE 05 OF 05</b>
<div><div><div>COPYRIGHT AND CONFIDENTIAL</div><div>The information on this document is the property of <b>BHARAT HEAVY ELECTRICALS LTD.</b> It must not be used directly or indirectly in any way detrimental to the interest of the company</div></div><div><div>e) Tenderer may furnish additional details / information as relevant to establish their capacity to undertake the manufacturing of items covered by this specification.</div><div>f) Tenderer shall furnish all the relevant detail as asked for in ‘BID DOCUMENT’ without fail.</div><div><div>9.0</div><div><b>Marking :</b></div></div><div><div>9.1</div><div>Finished material shall be legibly marked with following information.</div><div><div>1) Grade of Material.</div><div>2) Number of identification mark by which it can be traced from, which metal it was made.</div><div>3) Manufacturers initial, or trade mark, purchase order Ref. and date, batch order etc.</div></div></div><div><div>10.0</div><div>While submitting the offer, the tenderer shall furnish a list of deviations, if any, from this specification / concerned drawing. Even if tenderer has no particular deviation in their offer a ‘NIL’ statement shall be submitted.</div></div><div><div>11.0</div><div><b>Packing :</b></div></div><div><div>11.1</div><div>The finish material shall be packed in wooden boxes after tightly wrapped in polythene paper so that no damage can arise during transportation. Each wooden box shall have 30 Nos of finish material.</div></div><div><div>12.0</div><div><b>Reference to CLW standards :</b></div></div><div><div>12.1</div><div>This specification is as per CLWs specification 4.TMS.096.062 alt. 04.</div></div></div></div>				