



## 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
6.0	12.0	0.07	0.03
12.0	16.0	0.10	0.05
16.0	32.0	0.13	0.07

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**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.



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### 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.

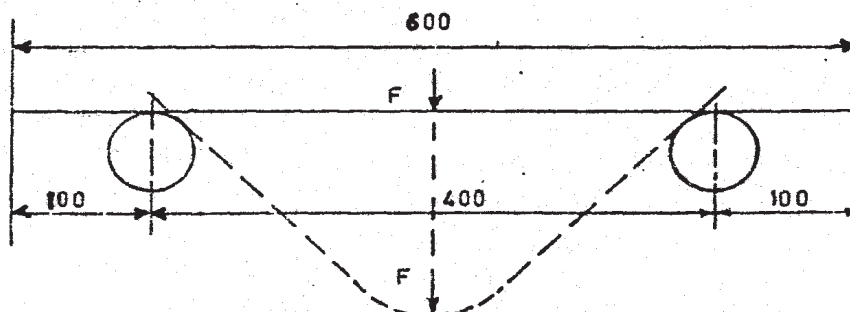
Load is applied at the centre of the flat wire till it slides through the rollers .

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.

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## 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.