
	CORPORATE PURCHASING SPECIFICATION	AA 120 23 Rev. No. 08 PAGE 1 OF 5						
COPPER RODS AND SECTIONS - HARD								
<p>1.0 GENERAL:</p> <p>This specification governs the quality requirements of copper rods/bars and sections.</p> <p>2.0 APPLICATION:</p> <p>Used for general electrical purposes in Transformers, switch gears, Bus - bars, HT/MT caps and control equipment.</p> <p>3.0 CONDITION OF DELIVERY:</p> <p>The copper rods shall be supplied in hard condition in straight lengths. Rectangular rods shall be supplied with radiused edges to clause 5.3.</p> <p>4.0 COMPLIANCE WITH NATIONAL STANDARDS:</p> <p>The copper rods and bars shall comply with the requirements of the following national standard and also meet the requirements of this specification.</p> <p>IS: 613- 2000 : Copper Rods and Bars For Condition : Hard Electrical purposes - specification.</p> <p>5.0 DIMENSIONS AND TOLERANCES:</p> <p>5.1 Sizes.</p> <p>Copper rods and sections shall be supplied to the dimensions specified in BHEL order / drawing.</p> <p>5.2 Tolerances:</p> <p>5.2.1 The tolerances for round, square, rectangular and hexagonal rods / bars shall be as given below : [Table - 2 of IS: 613]</p> <p>5.2.2 Sections:</p> <p>Shall be as per BHEL drawing accompanying the order.</p>								
Revisions : CI: 24.1 of MOM of MRC-NFCW+HE		APPROVED : INTERPLANT MATERIAL RATIONALISATION COMMITTEE-MRC (NFCW+HE)						
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5.2.3 Length - Rod/Sections:
Tolerance on length shall be as follows:

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

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

5.2.5 Radius on Edges - Rectangular & Squares:

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

6.0 MANUFACTURE:
The copper rods shall be manufactured from copper of ETP grade conforming to IS: 191. The conductor shall be manufactured from ETP grade copper conforming to BHEL specification AA 120 24:: Electrolytic Tough Pitch Copper Wire/Bars/Ingots/Continuously cast wire rods.
Note: It is preferable to manufacture conductor from continuously cast copper rods provided all other parameters and conditions remain same."

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

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

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



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- 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 ² ,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 20⁰ C shall not be greater than 0.0177 ohm. mm² / 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.

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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



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ANNEXURE - A (Clause 12.0)

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

- A. Name of Principal Supplier :
- B. Name of Indian Agent :
1. Grade of material as per specification : Yes/No
 2. Tolerance on diameter/ Width/thickness/ length and flatness as per specification and drawing : Yes/No
 3. Chemical composition as per specification : Yes/No
 4. Mechanical properties as per specification : Yes/No
 5. Electrical Resistivity : Yes/No
 6. Tests : (1) Bend
 7. Details of previous experience enclosed : Yes/No.
(For New suppliers only)
 - C. Deviations taken (Please specify clearly, if any) : Yes/No.
 - 1
 - 2
 - 3

Date:

Signature &

Place:

Seal of Supplier



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HEAT SHRINKABLE PVC SLEEVE FOR HIGH VOLTAGE BUSBARS AND CONNECTIONS

1. General :

Heat shrinkable PVC sleeves are used in switchgear panel products to provide insulation for high voltage round / rectangular / square busbars and connections in straight and bent connections. These sleeves are given a special treatment during the manufacturing process resulting in an in-built property of shrinking which is released at elevated temperatures. These sleeves are of fire retardant, self extinguishing grade.

2.0 Size and selections

2.1 The sleeve size is specified in terms of " Laid Flat " (L/F) dimension i.e, the sleeve width when laid flat. Available L/F sizes in mm are 240, 190, 165, 150, 140, 128, 102, 82, 74, 64, 58, 51, 43, 38, 24, 18 & 15.

2.2 Desired lengths may be ordered, however standard rolls are available in lengths of 50 metres.

2.3 The thickness of sleeve is 0.4+ 0.03 mm before heat shrinking. The achieved thickness after heat shrinking depends upon the sleeve L/F & busbar or connection size.

2.4 Unrestricted shrinkage of the sleeve is :

- in lengthwise direction : 10 %
- in width-wise direction : 40 %

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REV.	07	PRINTS TO :-	APPROVED –		
ALTD.	PD	SWM(PLNG)	RB		
APPD.	AD	SWM (TEST)	PREPARED	ISSUED	DATE
DATE.	17.04.2023	QCX (SCR) CONTRACT (SWE)	JSP	SMM	21-11-92



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2.5 The recommended sleeve sizes to be used are given in Table 1 below :

TABLE 1

S.No	Heat shrinkable PVC sleeve size		Cu/Al Busbar or connection (mm)
	L/F + 0.5 (mm)	Sleeve thickness (mm)	
1.	240	0.4	12 x 200, 10 x 200
2.	190	0.4	12 x 150, 10 x 150
3.	165	0.4	12 x 125, 10 x 125
4.	150	0.4	12 x 100, 20 x 100
5.	128	0.4	12 x 75*, 10 x 75 *
6.	102	0.4	25 x 50, 12 x 75, 10 x 75
7.	82	0.4	12 x 50, 10 x 50
8.	74	0.4	6 x 50
9.	51	0.4	27 dia
10.	38	0.4	5 x 20
11.	24	0.4	3 x 16, 10 dia

(* Preferred for bent connections)


2.6 Single / Double layer of sleeves :


Generally a single layer of 0.4 mm tk sleeve is sufficient for voltages upto 12 kV system. However in special constructions where busbars / connections are in close proximity or for higher system voltages (upto 24 kV), two layers of sleeves are recommended. See Table 2 for such recommendations :


TABLE - 2

S.No.	APPLICATION FOR PRODUCT TYPE		NO OF SLEEVE LAYERS FOR BUSBARS AND CONNECTIONS
	TYPE	RATED VOLTAGE (KV rms)	
1.	VM12	12	SINGLE LAYER
2.	VM12	12	SINGLE LAYER
3.	VMN12	12	SINGLE LAYER
4.	VM24	24	DOUBLE LAYER

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		<p>4. <u>Colour of sleeve</u></p> <p>Sleeve are generally black in colour, however red,yellow,blue and green coloured sleeves can also be ordered.</p> <p>At continuous elevated temperature of more than 105 degree C fading of colours other then black may be observed.</p> <p>5. <u>Method of sleeving</u> :</p> <p>Heat shrinkable PVC is supplied in its unshrinkable laid flat state (creased type). When heated to temperature of 120 deg C, the sleeve will shrink to a predetermined size or confirm to the size of busbar / connection to be covered. Following are the recommended cares / steps during the sleeving process :</p> <p>i) All burrs on the edges of the busbars / connections should be removed to avoid damage to the sleeve.</p> <p>ii) <u>Protective capping of the conductor end</u> :</p> <p>Sleeve of length 60 mm approx shall be slipped over the conductor end for about 30 mm. Subject the sleeved conductor end to the shrink temperature of 120 deg C for the sleeve tp shrink and form a protective cap over the conductor end. allowed the conductor to cool. The protective cap now formed prevents the scartching of internal surface of sleeve while insertion over the conductor by free burrs and / or sharp edge of the conductor. This cap can be removed by cutting after the shrinking procedure is over.</p> <p>iii) <u>Slipping of sleeve over the conductor</u> :</p> <p>- Lubricate bend busbar / connection by applying a thin film of silicon grease (with a melting temperature above shrink temperature). Straight conductors do not need to be lubricated.</p> <p>- Slip the specified length of the sleeve over the conductor from the "capped end" and pull it to cover the desired length of the conductor to be sleeved. The cap can now be removed by cutting. It may be noted here that bends -specially with "U" or "Z" shapped conductors may cause a certain longitudinal shrinkage of the conductor upto its terminals, apply the sleeve in folds evenly over the total length. For conductors with several bends it is recommended to determine the exact length by a trial run.</p> <p>iv) <u>Shrink Procedure</u> :</p> <p>- For heat shrinking process the use of an oven with air circulation is recommended with a minimum temperature of 120 deg C + 10 deg C.</p>		
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		<p>- Place the conductor with loosely covered sleeve in the pre-warmed oven. Suspend or support the conductor at the terminals to allow un-restricted recovery. Care shall be taken that the sleeve is not touching oven walls or floor.</p> <p>The recommended shrink temperature is 120 deg C + 10 deg C and shrink time of 20 minutes + or - 5 minutes for smooth sleeving. The bend connections may require slightly more shrink time. The shrink temperature should not exceed 130 °C Minimum conductor temperature should be 100 deg C when leaving the oven.</p>		
COPYRIGHT AND CONFIDENTIAL The information on this document is the property of Bharat Heavy Electricals Limited It must not be used directly or indirectly in any way detrimental to interest of Co.		<p>v) <u>Shrink procedure for straight conductor</u> : General procedure as outlined in para 5 iv) is applicable.</p> <p>vi) <u>Shrink procedure for bend conductor</u> : Sleeve of length 125 mm is cut and slipped over the bend conductor and is positioned at the bend to cover both arms of the bend uniformly. The conductor is then subjected to shrink procedure and the sleeve should cover the bend without undulations leaving no air cavity. Allow the conductor to cool to the room temperature. Both arms of this conductor now shall be sleeved individually by slipping sleeves of appropriate length from each capped end till the preshrunk bend portion is completely overlapped resulting, after shrinkage, in the encapsulation of the conductor with a smooth sleeving over the conductor.</p> <p>vii) <u>Shrink procedure for double sleeving</u> : The first layer of the sleeve is shrunk over the conductor as per general procedure outlined above and cooled down to the room temperature. For " Double sleeving " the same procedure is repeated after inserting the cool pre sleeved conductor again in fresh unshrunk sleeve resulting in double layered sleeved conductor.</p> <p>viii) <u>Finishing</u> : Allow the insulated conductor to cool to room temperature. Trim the ends to the required distances. No tearing of ends shall be observed after shrinking. The shrunk sleeve shall give smooth surface finish without undulations. In case of discrepancy, the job must be re-heated for a further appropriate period.</p>		
		<p>ix) <u>Handling and storage</u> : The sleeved conductor after finishing must be wrapped in polythene sheets / bags and stacked over wooden battons. Contact with sharp objects must be avoided.</p> <p>x) <u>Shipment</u> :- Sleeved busbars / connections when shipped loose shall be packed as per SG 14602 .</p>		

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		<p>6. <u>Testing and Quality checks</u> :</p> <p><u>For heat shrinkable PVC sleeve</u> :</p> <p>6.1 <u>Dimensional check</u> : The laid flat (L/F) and thickness of the sleeve shall be as per P.O. items.</p> <p>6.2 <u>Tests for properties</u> : The important properties water absorption, flammability class, Dielectric strength and material identification shall be checked and values shall be as per para 3.</p> <p><u>For sleeved conductors</u> :</p> <p>6.3 <u>Visual checks</u> : The sleeved conductor shall have a smooth surface finish without any undulation or air pockets.</p> <p>6.4 Two nos samples from each lot of straight / bend and single / double sleeved conductors shall be subjected to one minute withstand voltage test in air at room temperature, to values mentioned in para 3. There shall be no breakdown or puncture across the sleeve material.</p> <p>7. <u>Acceptance criterion for sleeves</u> :</p> <p>a) Supplier shall send certificate of tests conducted for requirements mentioned in para 6.1 and 6.2 with each lot of supply.</p> <p>b) Tests at BHEL : Dimensional checks and tests for properties mentioned in Para 6.1 and 6.2 shall be conducted on a sample length of 400 mm cut from the main roll from consignmant.</p> <p>8. <u>Supply condition</u> : The PVC sleeves shall be supplied in rolls over hard cardboard tubes and these rolls must be covered with polythene sheets and kept in cardboard containers. Source of supply, expiry date, storage conditions, sleeve dimensions and BHEL PO. Nos shall be clearly marked on the hard cardboard tube which shall be visible without unrolling the sleeve. The same markings shall also be put on outside of cardboard containers.</p> <p>Rev. History: Rev.06 : Required value of Sp. Gravity revised. Point 6 of Material Property removed. Rev. 07 : ASTM D570 has also been introduced as an alternative of BS2782-1970 (Method 502G) for water absorption test as per cl. 3 of physical properties.</p>		
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