



CORPORATE PURCHASING SPECIFICATION

AA 120 04

Rev. No. 06

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BARE COPPER CONDUCTOR-ANNEALED, FLEXIBLE, UNTINNED/TINNED

1.0 GENERAL:

This specification governs the quality requirements of Tinned/Untinned bare, round, stranded, flexible copper conductor manufactured from uniformly annealed high conductivity copper wire.

2.0 APPLICATION:

Used as terminal leads in transformers and traction motors.

3.0 CONDITION FO DELIVERY:

Flexible bare copper stranded conductor untinned in annealed condition.

Whenever specified, flexible tinned copper conductor in annealed condition shall be supplied.

4.0 COMPLIANCE WITH NATIONAL STANDARDS:

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

IS: 8130-1984 : Conductors for insulated electric cables and flexible cords.

5.0 DIMENSIONS AND TOLERANCES:

5.1 Size:

The sizes of the flexible conductor shall be as per Table-1. However, other sizes not covered in the table may also be ordered in case of design constraints.

5.2 Tolerances:

The diameter of wire in any conductor shall not exceed the appropriate maximum value given in Table-1.

The tolerance on the diameter of wire shall be + 0.01 mm and - 0 mm.

6.0 MANUFACTURE:

The conductor shall be manufactured from copper of ETP grade conforming to IS:191.

Revisions :

Clause: 20.10.7 of MOM of MRC-NFCW+HE

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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.

Whenever specified, the tinning shall be done by electro-tinning process while the tinning material conforms to Gr.: Sn 99.85 of IS: 26 (AA 12801).

7.0 JOINTS IN WIRES AND CONDUCTOR:

Not more than two joints shall be allowed in any one of the single wire forming complete length of the conductor and no two joints shall be within 300 mm of any other joint in the same layer. The joints shall be made by resistance butt welding layer. No joint shall be made in the conductor after it has been stranded.

Table-1: Standard sizes and resistance of flexible copper conductors (CI 5.1, 5.2 & 11.2)

Nominal cross-sectional area, mm ²	Max.dia. of wire in conductor, mm	Max. resistance of conductor at 20°C. ohms/ km	
		Untinned	Tinned
0.50	0.21	39.0	40.1
0.75	0.21	26.0	26.7
1.0	0.21	19.5	20.0
1.5	0.26	13.3	13.7
2.5	0.26	7.98	8.21
4	0.31	4.95	5.09
6	0.31	3.30	3.39
10	0.41	1.91	1.95
16	0.41	1.21	1.24
25	0.41	0.780	0.795
35	0.41	0.554	0.565
50	0.41	0.386	0.393
70	0.51	0.272	0.277
95	0.51	0.206	0.210
120	0.51	0.161	0.164
150	0.51	0.129	0.132
185	0.51	0.106	0.108
240	0.51	0.0801	0.0817
300	0.51	0.0641	0.0654
400	0.51	0.0486	0.0495
500	0.61	0.0384	0.0391
630	0.61	0.0287	0.0292

Note: For sizes not covered above, the resistance shall be calculated as per the formula given in Annexure - 1 to this specification which is in line with Appendix B-1 of IS:8130.



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8.0 FREEDOM FROM DEFECTS:

The material shall be clean, free from harmful defects and reasonably uniform in size and shape. Its surface shall be free from sharp edges.

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.

Element	Minimum Percent	Maximum percent
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.

10.0 TEST SAMPLES:

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

The sample shall be cutoff cold and shall not receive further treatment before being tested.

11.0 PROPERTIES:


When tested in accordance with the relevant clauses of IS:10810 mentioned against each, the test sample shall show the following properties:

11.1 Persulphate test for tinned copper only (IS:10810, Part 4):

Wire diameter, mm		Permissible mass of copper dissolved, g/m ² , max.
Above	upto & incld.	
--	0.41	5
0.41	--	3

11.2 Electrical Resistance (IS: 10810, Part 5) -As received:

The resistance of the conductor at 20⁰ C shall be as per Table-1. The temperature correction factor shall be as per IS: 8130.

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12.0 INSPECTION AT SUPPLIER ' WORKS:

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

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

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

13.0 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 120 04, Rev.06: Bare Copper Conductor - Annealed, flexible, untinned/tinned
BHEL Order No.
Manufacturer 's/Supplier's Name:
Trade mark, if any.
Lot/Identification/Batch/Melt No.
Size and length of conductor
Quantity Supplied.
Test results of dimensional inspection, chemical analysis, mechanical and electrical .

14.0 PACKING AND MARKING:

The conductor shall be either wound on reels or drums or supplied in coils, suitably packed to prevent damages during transit.
Each consignment shall be labeled with the following information.

AA 12004: Bare Copper Conductor - Annealed, flexible, untinned/tinned
BHEL Order No.
Manufacturer's/Supplier's Name :
Lot/Identification/Batch/Melt No
Trade mark, if any.
Size and length of conductor
Quantity Supplied

15.0 REFERRED STADARDS (Latest Publications Including Amendments):

1. IS: 26	2. IS:191	3. IS:440	4. IS:8130
5. IS: 10810, Pt 4 & 5	6. ASTM E 1004.		



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AANEXURE - 1 (See Note under Table-1)

Formulae for calculation of Resistance

The resistance values specified have been calculated from the formula

$$R = \frac{4 P}{n d^2} \times k_1 k_2 k_3$$

Where, R = Resistance at 20°C in ohms/km
P = Standard resistivity of the metal at 20°C in absolute ohm. mm²/km,
i.e. 17.241 for annealed copper and 28.264 for aluminium

n = Number of wires in the conductor

d = Nominal diameter of the wires in the conductor in mm

k₁ = A factor depending on the diameter of the wires in the conductor, on the kind of metal and on whether or not copper wires are tin coated. The values of this factor is given in table below:

<u>Maximum dia. of wires in conductor, mm</u>		<u>k₁ for stranded conductor</u>	
<u>Over</u>	<u>up to & incld.</u>	<u>Tinned copper</u>	<u>Un tinned copper</u>
0.05	0.10	1.12	1.07
0.10	0.31	1.07	1.04
0.31	0.91	1.04	1.02
0.91	3.60	1.03	1.02
3.60	4.50	1.03	1.02
4.50	--	--	--

k₂ = A factor depending on the way in which the conductor is stranded.

The value of the factor is

- 1.00 for solid conductors
- 1.02 for stranded conductors for fixed cables, if the nominal wire diameter exceeds 0.6 mm.
- 1.03 for stranded conductors for flexible cables, and flexible cords if the nominal wire diameter exceeds 0.6 mm.
- 1.04 for stranded or bunched conductors, if the nominal wire diameter exceeds 0.6 mm.

k₃ = A factor depending on the way in which the cores are twisted together.

The value of the factor is

- 1.00 for single core cables and single core flexible cords and for multicore cables and flexible cords, the cores of which are not twisted together (that is flat cables)
- 1.02 for multicore cables (other than flexible cables) the cores of which are twisted together
- 1.05 for multicore flexible cables and cords, the cores of which are twisted together.

These values of k₃ does not apply to cables and flexible cords in which the lay ratio is usually small.