



CORPORATE PURCHASING SPECIFICATION

AA 281 13

Rev. No. 03

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**DOUBLE GLASS LAPPED, POLYESTERIMIDE VARNISH BONDED,
RECTANGULAR COPPER CONDUCTORS
TEMPERATURE INDEX 180**

1. GENERAL:

This specification governs the quality requirements of Polyesterimide Varnish (of temperature index at least 180) bonded Double Glass Lapped Rectangular Copper Conductors with G1, G2 and G3 grades of covering.

2. APPLICATION:

Used in the windings of electrical machines.

3. COMPLIANCE WITH NATIONAL STANDARDS:

There is no Indian Standard Covering this type of material, however assistance has been drawn from the following national standard. In addition to this standard, the material shall also comply with this specification.

IS: 13730 Pt 31-1997 / : Specification for Particular type of winding wires. ↑
IEC 317-31-1990 (Pt.2002) : Part 31-Glass Fibre wound Polyester or Polyesterimide Varnish treated Bare or enamelled. ↑

4. DIMENSIONS AND TOLERANCES:**4.1 Dimensions:****4.1.1 Sizes And Grades:**

The conductor shall be supplied to the size and grade as specified in BHEL order. The sizes shall preferably be selected from Table 1 of IEC 317-0-4 ↑

4.1.2 Radius on Corners:

Bare conductors shall have rounded corners, the radius of curvature being within the range given below. The arc shall merge smoothly in to the flat and the conductor shall be free from sharp, rough and projected edges.

Revisions :

Cl: 34.1.12 of MOM of MRC-E

APPROVED :

**INTERPLANT MATERIAL
RATIONALISATION COMMITTEE-MRC (E)**

Rev. No. 03

Amd.No.

Reaffirmed

Prepared

Issued

Dt. of 1st Issue

Dt: 02.01.2007


Dt :

Year :

BHOPAL

Corp. R&D

March, 1980

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| Nominal Thickness, mm | | Radius on Corner, mm |
|-----------------------|---------------|----------------------|
| Over | up to & incl. | |
| -- | 1.00 | Semicircular |
| 1.00 | 1.60 | 0.50 - 0.75 |
| 1.60 | 2.25 | 0.65 - 0.95 |
| 2.25 | 3.55 | 0.80 - 1.20 |
| 3.55 | and above | 1.00 - 1.50 |

4.1.3 Increase In Dimensions Due To Covering:
The increase in dimensions due to the glass covering shall conform to the values given in the Table below:

| Conductor Width mm | Minimum increase in dimension Over actual Conductor, mm | Max. Increase in dimension over max. permissible bare conductor dimensions, mm |
|--------------------|---|--|
| Over | upto | Grade of covering |
| & | : | Grade of covering : |
| Incl | : G1 : G2 : G3 | : G1 : G2 : G3 : |
| -- | 5.6 0.18 0.25 0.35 | 0.23 0.33 0.43 |
| 5.6 | 10.0 0.18 0.25 0.35 | 0.25 0.33 0.43 |
| 10.0 | 16.0 0.20 0.28 0.35 | 0.28 0.35 0.43 |

4.1.4 Increase In Dimension Due To Repaired Covering:
The increase in dimensions due to covering at the repair shall not exceed 2 times the maximum thickness of covering.

4.2 Tolerances:

4.2.1 On Nominal Dimensions:

Tolerance on nominal dimensions of bare conductors shall be as follows:

| Width or Thickness, mm | Tolerance, \pm mm |
|------------------------|---------------------|
| Over | up to & incl. |
| - | 3.15 |
| 3.15 | 6.30 |
| 6.30 | 12.50 |
| 12.50 | 16.00 |



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5. MANUFACTURE:

5.1. Conductor:

The conductor shall be manufactured from ETP grade copper conforming to AA12024

5.2 Joints:

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

6. TEST SAMPLES:

Six metres of finished conductor shall be supplied with each consignment for testing purposes.

7. CHEMICAL COMPOSITION:


The composition of copper used for conductor, when analyzed in accordance with IS:440, shall be 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 |

* 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.

8. PROPERTIES:

Unless otherwise specified, the testing shall be conducted as per IS:13778/IEC 851 1 Series.

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8.1 PROPERTIES OF BARE CONDUCTORS:

8.1.1 Tensile Strength & Elongation

A sample of 200-250 mm long conductor after removal of insulation is fixed between the grips of a tensile testing machine & shall be steadily elongated at a rate of 50-100 mm/minute until the conductor fractures. The tensile strength and the elongation at fracture shall be as follows:

| Property | Nominal thickness, mm | |
|---|-----------------------|-------------------------------|
| | up to & incl 2.5 | Above 2.5 & up to & incl 10.0 |
| Tensile Strength, N/mm ² , max | 265 | 255 |
| Elongation, % min | 30 | 35 |

8.1.2 Hardness (Vickers):

When tested as per the test method given below, the hardness shall not exceed 60 HV.

TEST METHOD :

One piece of conductor about 300 mm length is dipped in 10% hydrochloric acid for 3-4 hours with at least 250 mm length submersed.

Conductor shall be washed with tap water and then wiped out with cloth gently. After complete removal of insulation, it shall be thoroughly washed for complete removal of acid content from the sample surface.

Vicker's hardness shall be measured at three places at least 50 mm apart.
The test load shall be 5 kg

8.1.3 Electrical Resistivity:

The electrical, resistivity of the conductor when measured directly on the sample in "as received" condition at 20°C shall not be greater than 0.01739 ohm/mm²/m (Refer Appendix B of IS:613 for temperature correction factor)



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9. GLASS COVERING:

9.1. Application Of Glass Covering:

The conductor shall be lapped firmly, evenly, closely and continuously with two layers of glass fibre yarn wound in opposite directions and firmly bonded to the conductor with polyesterimide varnish of temperature index at least 180.

9.2 Repairs To Insulation (No. Of Hand Lapped Spots):

For manufacturing reasons, if is necessary to apply a hand lapped covering of glass yarn or untreated glass tape over an interruption in the lapping, it will be permitted, but the length of any such hand lapping shall not exceed 100 mm and that this length shall be subsequently varnished. The number of hand lapped spots shall be not more than one per 100 metre length.

For easy identification of repaired part contrast coloured adhesive-tape shall be wrapped on the repaired part.

10. PROPERTIES OF GLASS COVERED VARNISH BONDED CONDUCTOR:

10.1 Flexibility (As Received):

Samples of glass covered conductor in "as received" condition shall be bent through 180° round a polished metal mandrel having a diameter 8 times, the bare width of conductor, when it is bent on edge or 8 times the bare thickness when it is bent on flat. Separate samples shall be bent, two on edge and two on the flat and when so tested the covering shall not open sufficiently to expose the bare conductor to view, when examined under diffused light by normal eye sight. There shall be no appreciable loosening of insulation or no cracks shall be seen in the insulation.

10.2 Flexibility After Heat Ageing:

Bent Samples prepared as per clause 10.1 above shall be placed in an electrically heated, forced air circulating oven, at a temperature of 200 ± 5 deg.c. for 48 ± 1 hours, than shall be removed from the oven and allowed to cool to room temperature. Sample shall pass the test as detailed in clause 10.1.

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10.3 Adherence:

A sample of approximately 250 to 300 mm length shall be straightened limiting the elongation up to a maximum of 1%. The covering shall be removed retaining the covering on the central 100 mm length of the wire. The specimen shall be elongated in an elongation tester or a tensile testing machine. The free measuring length shall be between 200 and 250 mm. The wire shall be elongated at a rate of 50 to 100 mm per minute.

The covering shall not loose adhesion after an elongation for the appropriate width/thickness ratio as given below. Loss of adhesion of the covering is shown by its being able to slide along the conductor as a whole or being detached in part.

| Width/Thickness ratio over up to & incl. | Elongation percent |
|---|--------------------|
| - 2:1 | 5 |
| 2:1 and above | 10 |

10.4 Cure Test:

Two strips of each 200 mm long shall be laid flat to flat and bound tightly with polyester fibre tape. The specimen shall then be placed in a hot air circulating oven at $180 \pm 3^\circ \text{C}$ and left for 30 ± 2 minutes. It shall then be removed and after removing the binding tape it shall be possible to separate the wires without damaging the covering.

10.5 Break Down Voltage Test:

A) Test Specimen:

Five samples of glass braided conductor shall be bent flatwise through 180° round a mandrel having a diameter of 6 times bare thickness of the conductor. The ends of the specimens are brought out to a distance of 75 to 100 mm and insulation stripped off at the ends for electrical connections.

B) Test Method At Room Temperature:

The specimens prepared as above shall be placed in a metallic vessel filled with metallic balls of diameter 2.0 mm maximum, and the vessel is solidly connected to earth. A sinusoidal a.c. voltage of 50 Hz is applied and increased from zero at an uniform rate of 100 volts per second until breakdown occurs.

C) Test Method At Elevated Temperature – $180 \pm 5^\circ \text{C}$:

The specimens prepared as above, along with metallic balls are placed into a heating chamber maintained at $180 \pm 5^\circ \text{C}$, and are allowed to remain there until the specimens attain the specified temperature (usually 15 minutes). They are then tested within 15 minutes after the specimens reach the specified temperature.

Total time in chamber shall not exceed 30 minutes.



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When tested as per the test methods given above, (at room temperature and at the Specified temperature of $180 \pm 5^\circ\text{C}$) four out of five samples shall not breakdown at the following values and the value of the fifth specimen shall show a minimum of 50% of the specified value.

| Temperature, $^\circ\text{C}$: Break Down Voltage, minimum | | | |
|---|-----------|----------|----------|
| : Volts (r.m.s.) | | | |
| | :G1 Grade | G2 Grade | G3 Grade |
| RT | : 320 | 450 | 630 |
| $180 \pm 5^\circ\text{C}$ | : 240 | 340 | 470 |

11. TEST CERTIFICATES:

Unless otherwise stated, three copies of test certificates shall be supplied along with each consignment.

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

The test certificate shall bear the following information :

AA 28113 : Double Glass Lapped, Polyesterimide Varnish Bonded.

(Rev.No.03) : Rectangular Copper Conductors. (T.I.180)

BHEL Order No.

Manufacturer's/Supplier's Name.

Batch/ Lot No.

Sizes and Quantity Supplied.

Test results for clause 4, 7, 8, 9 and 10.


Note:

On first consignment, the supplier shall indicate the type and make of glass yarn and varnish used for the conductors with it's life time characteristics, for BHEL's approval. The approved glass yarn and varnish as identified by IR spectroscope or any other suitable instrumental method shall only be used. On subsequent orders, supplier shall furnish a certificate that the approved glass yarn, enamel and varnish have been used. Also, the supplier shall ensure that the number of repairs undertaken lies within the specified limits. For easy identification of the repairing parts, contrast coloured adhesive tapes are to be pasted on the repaired parts.

13. PACKING AND MARKING:

Unless otherwise stated, the braided conductor shall be wound on drum No. 4520 (Dia of flange: 450 mm and approximate capacity 55 kg) to IS:2069.

The wire shall be protected against possible damage from the inner faces of the flanges of the drum by lining each flange with thick paper or card board. Each package shall be legibly marked or labeled with the following information.

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AA 28113 : Double Glass Lapped, Polyesterimide Varnish Bonded .
: Rectangular Copper Conductors. (T.I . 180)

BHEL Order No.

Manufacturer's/Supplier's Name.

Batch/Lot No.

Size and Quantity supplied.

Date of manufacture.

15. REFERRED STANDARDS (Latest publications including amendments)

- | | | | | | |
|---------------------|---|---------------|---|-----------------------|---|
| 1. IS:13730 Part 31 | ↑ | 2. IEC 317-31 | ↑ | 3. IEC : 317 - 0 - 4, | ↑ |
| 4. AA12024 | | 5. IS:440 | | 6. IS : 13778 | ↑ |
| 7. IEC : 851 | ↑ | 8. IS : 613 | | 9. IS : 2069 | |