SPECIFICATION FOR

POLYIMIDE COVERED COPPER CONDUCTOR

FOR CLASS 'C' TRACTION MOTOR

(TYPE HS: 15250A)

CHKD	SPECIFICATION FOR POLYIMIDE COVERED COPPER CONDUCTOR FOR CLASS 'C' TRACTION MOTOR (TYPE HS: 15250A)	DY.CEE/TMD	CHITTARANJAN LOCOMOTIVE WORKS WEST BENGAL, INDIA
DRN			NO. 4TMS.095.002 REV.0 DATE : 23.06.2011

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ALTERATION SHEET

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SPECIFICATION FOR
POLYIMIDE COVERED COPPER CONDUCTOR
FOR CLASS 'C' TRACTION MOTOR (TYPE HS: 15250A)

DY.CEE/TMD

CHITTARANJAN LOCOMOTIVE WORKS
WEST BENGAL., INDIA
NO. 4TMS.095.002,REV.0
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SPECIFICATION FOR POLYIMIDE COVERED COPPER CONDUCTOR FOR CLASS 'C' TRACTION MOTOR,TYPE- HS:15250A.

1.0 SCOPE:

This specification covers Polyimide Covered high conductivity copper conductors of rectangular section for manufacture of armature power coils and equaliser coils for class 'C' Traction Motors, Type-HS:15250A.

2.0 STANDARD SPECIFICATION:

This specification is prepared taking assistance from various national and international standards for copper conductors and covered copper conductors for Electrical machines, and is generally based on IS : 9148-79.

2.1 TEST PLAN: As per **9.0** of sheet No.10 of 10

3.0 SIZE OF CONDUCTORS;

3.1 Polyimide Covered Copper Conductor, dimension of bare copper size: 6.90 ± 0.07 mm x 3,30 ± 0.05 mm and corner radius 0.8 ± 0 1 mm dimension over 2/3 positive lap (67% to 70%) insulation (covered size): 7.26 x 3.63 mm maximum.

3.2 Polyimide Covered Copper Conductor, dimension over of bare copper size: 5.5±0.04 mm x 4±0.03 mm and corner radius 0,6±0.1 mm dimension over 1/2 positive lap (**51% to 55%**) insulation (covered size): 5.705 x 1.595 mm maximum

4.0 TEST ON BARE CONDUCTOR :

4.1 Materi(Copper):

The bare copper conductor shall be manufactured from Oxygen controlled copper to **ASTM : B1 7/B187M-06 (UNS No. C10200)** with **Copper purity 99.95** % (min) and **Oxygen content 10 PPM (max).Chemical Analysis** & O_2 content test **for one sample/lot** shall be determined by spectrometric method & Leco Analyser respectively from NABL approved laboratory The cost of such tests shall be borne by the supplier The conductor shall have a smooth surface and radiused corners and shall be free from sharp, rough and projecting edges. The copper conductor shall be in continuous length.

4.2 Edge-Wise Bending:

The conductor shall withstand without showing any sign of cracks or failures, when bent on edge through an angle of 180 degrees over a mandrel of diameter equal to half the width of the conductor. However, the minimum diameter of mandrel shall be 4 mm.

4.3 Resistance to Alternate Bends.

Conductor shall withstand the following alternate bends through 180° without fracture or crack

Thickness of Conductor 'mm'	Radius of Bend (mm)	Minimum No of alternate bends to withstand without fracture/ crack
1.4	5	9
3.3	15	15

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The test specimen shall be finally hold in its flat surface as shown in FIG. I A in a suitable fixture and shall be bend through 90^0 to the longitudinal axis as shown in FIG-1 B, over a pin of specified radius. The specimen shall then be bent through 180^0 over another pin of same specified radius and brought to position 3 as shown in FIG.1C, passing the test specimen through its position I and thus subjecting it to one alternate bend.

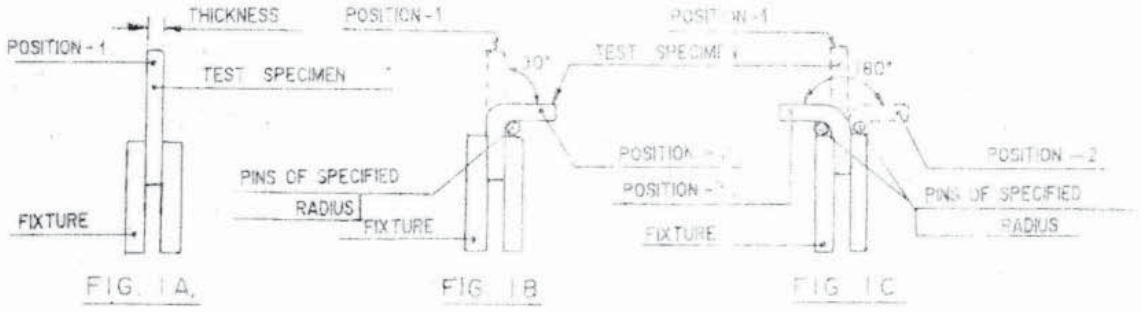

FIG. 1A FIG. 1B FIG. 1C

The procedure shall be repeated until the specimen is subjected to the minimum specified number of alternate bends. The specimen shall then be removed and examined for any cracks/fractures etc.

4.4 Springiness Test :

The spring back angle shall not exceed 5^0 when tested as per clause 4.2 of IS: 13778 (Pt-3):1993, "Specification for. Rectangular Wires- Method of tests for Winding Wires".

4.5 Elongations Test:

The minimum elongation at rupture shall be 40% for Bare size: 6.9x3.3 mm & 38% for Bare size: 5.5x1.4 mm on a gauge length of 250 mm when tested as per clause 6 of IS:13730(Pt-0/Sec-2):1993.

4.6 Electrical Resistivity:

The resistance at 20 ^{0} Celsius of conductor of one metre in length and of a uniform cross sectional area of one Sq.mm. shall be not greater than 0.01724 ohm-mm^2/metre which is equivalent to 100% conductivity of IACS. The requirement shall be met on Bare Conductors/ Insulated Conductor.

4.7 Hardness Test: Test to be done as per IS: 1501'02 with load of 5 kg / 10 kg and test value should be **55 HV (max).**

5.0 Test on Covering Insulation:

5.1 The conductor shall be covered with one layer of heat sealable polyimide film type **KAPTON 150 FN 019** of **DuPont** make of suitable width 1.5 mil thick comprising of 1 mil 'H' type tape with 0.5 mil layer of Fluorinated Ethylene Propylene (FEP) adhesive on one side. Alternatively, heat sealable Polyimide film of **Grade 150 AF 019** of **M/s Kaneka Corp/USA/Japan** may be used. Width of tape proposed to be used by the manufacture shall be indicated by the tenderer in their offer.

5.2.1 Before covering, the surface of the copper conductor shall be completely free from copper dust, extraneous matter, black spots end bends etc. Cleanliness of copper is extremely important to achieve optimum adhesion.

5.2.2 The tape shall be lapped on the conductor tightly, evenly and free from creases or wrinkles, with adhesive on the inside. The covered conductor shall have smooth surface free from embedded particles of dust and other deleterious materials. The surface shall be free from abrasion, tears and edge lifting, The number of detects of all types per 100 metre length shall not exceed three. The purchaser, however, reserves the right to accept the material with defects marginally more than the stipulated value by deducting weight of 1.6 metre length of conductor per defect from the total quantity of the lot. The number of defects will be worked out based on the average number of defects per reel out of the sample reels inspected,

5.2.3 The tape shall be applied with 1/2 positive overlap (51% to 55%) or 2/3 positive overlap (**67% to 70%**) as specified in tender enquiry/contract,,

5.2.4 After lapping, the tape shall be heat-sealed by .suitable means to form an adherent and continuous sheath.

5.2.5 The tape joints shall be made in such a way that the higher dimensions over joint shall be limited only over a length of 20 mm (Max.).

5.2.6 The tenderer shall however indicate clearly in their offer the detailed scheme of insulation and manufacturer's technical data of the insulating material used.

5.2.7 The manufacturer should submit proof of import of **polyimide film**,

5.3 **Flexibility and adherence of covering insulation:**

5.3.1 **Mandrel winding test :**

Samples of polyimide covered copper conductor in as received condition shall be bent through 180^0 round a mandrel having a diameter 4 times the bare width of the conductor when bent on the edge or 4 times the bare thickness when it is bent on the flat. Separate samples from different reels shall be bent on edge and on flat and when so tested the covering shall not open to expose bare conductor. There shall be no loosening of the insulation. There shall be no cracks, edge lifting, wrinkles, delamination of the insulation etc. The bending apparatus and method of bending shall be generally as per clause No.5.1.5 of IS: 13778(Pt-3):1993, .

CHKD.	SPECIFICATION FOR POLYIMIDE COVERED COPPER CONDUCTOR FOR CLASS 'C' TRACTION MOTOR (TYPE HS· 15250A)		**CHITTARANJAN LOCOMOTIVE WORKS** WEST BENGAL, INDIA
DRN.		DY.CEE/TMD	NO. 4TMS.095.002,REV.0 DATE : 23.06.2011

5.3.2 HEAT SHOCK.:

Samples prepared as in 5.3.1 shall be heated for 1 hour in an oven at a temperature of 240°-245°C and then allowed to cool to room temperature. The samples shall show no opening, cracks or delamination. There shall be no appreciable wrinkles and edge lifting, curling on the insulation.

5.3.3 ADHERENCE TEST:

The insulation covering on samples of 250 mm gauge length from different reels shall be cut through circumferentially at a point approximately half way along with measured length. The samples are then stretched in tensile strength testing machine for an elongation of 20%. The covering shall not become detached for a distance exceeding the following:-

1) For conductors of thickness less than 2 mm or more – Thickness of conductor.
2) For conductors of thickness less than 2 mm – Width of conductor.

5.3.4 TWIST TEST : Samples of 300 mm length shall be twisted by 4 (four) complete turns along with longitudinal axis of the insulated conductor,keeping one end clamped. There shall be no appreciable delamination, edge lifting or wrinkles on the insulation.

5.3.5 PEEL OF TESTS :

A test specimen of about 300 mm length shall be taken and reasonably flattened. The insulation at the corners of the conductor should be removed/cut using sharp knife. The insulation over the width shall be cut and lifted at the correct end of the conductor as shown in FIG-3.

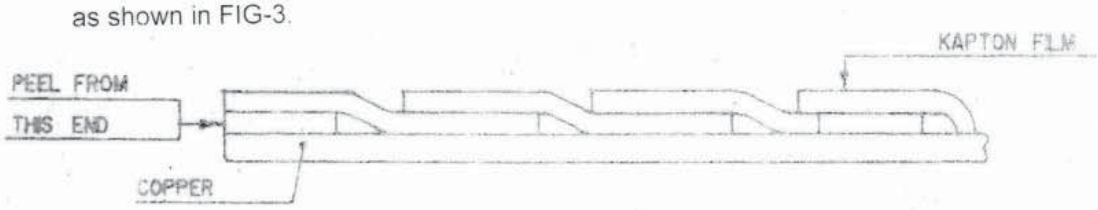

FIG-3 SHOWNING THE CORRECT END OF WIRE FOR PEEL TEST

The polyimide film layer shall be carefully peeled for about 1-2 inches. The specimen shall then be clamped and a pan attached/ clipped to the lifted end of the insulation layer as shown in FIG-4.

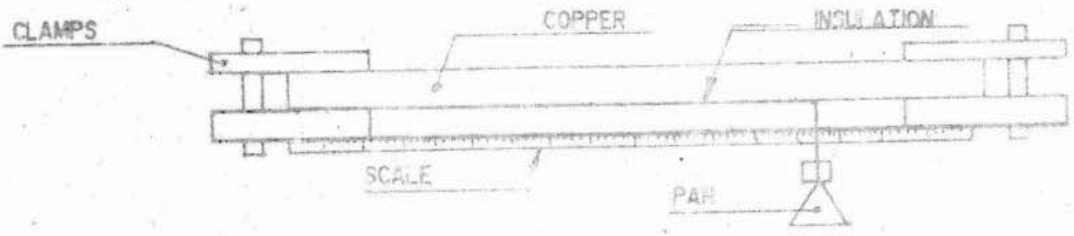

FIG-4 SHOWNING THE CORRECT END OF WIRE FOR PEEL TEST

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DRN.			

Standard weights shall be added in the pan until the layer starts peeling off. The insulation shall not peel off at a weight less than 100 g/mm width of insulation at a rate of 300 mm per minute.

The manufacturers are advised to equip themselves with a suitable apparatus by which the insulation layer may be peeled off at a constant rate of 300 mm /minute and the corresponding peel load may be recorded/observed as recommended by M/s. DUPONT.

5.4 DELECTRIC STRENGTH:

5.4.1 Dielectric strength on straight samp1es:

The test is a routine proof dielectric test followed by a routine puncture dielectric test. Five test specimens of 300 mm (approx) length each shall be placed one over the other on width and bound tightly over a distance of 200 mm(approx) along the central portion with unimpregnated glass fibre tape. The ends of the conductor shall be bent outward in such a manner as to prevent flash over during D.E. Test. The covering shall be removed from one end of each conductor for the application of the test voltage. The assembly shall then be placed, in a well ventilated air circulating oven, and heated for about 6 hrs. at 180^0 C and allowed to cool down to room temperature,

Test voltage AC 50c/s shall be applied between pairs of adjacent conductors and gradually increased to 5000 Volts on 1/2 lap conductor or 7000 volts on 2/3 lap conductor and maintained for 2 minutes. There shall be no breakdown of insulation during this period.

On completion of proof test on all the adjacent conductors the following routine puncture test is to be carried out on the same bunch of conductors. The test voltage shall then be gradually increased further until break down occurs. The minimum break down voltage shall be 7000 volts on 1/2 lap conductors and 10000 volts on 2/3 lap conductors on two thicknesses.

5.4.2. DIELECTRIC TEST ON BENT SAMPLES :

This test is a routine puncture dielectric test. The test specimens as bent flat wise and edge-wise as in Para 5.3.1 from as received conductor shall be placed in a well ventilated air circulating, oven and heated for about 6 hrs. at 180^0 C and then tested for dielectric strength by keeping them in a suitable trough, filled with lead balls of 1 mm diameter The ends of the specimen projecting sufficiently outside the trough. The total length of the specimen immersed in the lead balls shall be about 90 mm; The specimen shall be surrounded at least 5 mm around by the lead balls. Test voltage AC 50' c/s sinusoidal shall be applied between the conductor and lead balls. The voltage shall be gradually increased till break down occurs. The minimum acceptable breakdown voltage is 5000 volts on 1/2 lap conductor and 8000 volts on 2/3 lap conductor.

5.4.3 PIN HOLES :

The covered conductors shall be checked for pin holes and for continuity of covering continuously during final stage of manufacture by an apparatus similar to the one described in clause No.5.2 of IS:13778(Pt-5):1993. The number of faults shall not exceed 2 per 100 metre length of conductor. The faulty locations shall be marked with coloured plastic adhesive tape for easy identification. The manufacturers are advised to equip themselves with a suitable pin hole tester /fault detector which will continuously 'monitor insulation defects such as tears, cuts, etc, after the 'conductor is taped and just prior to wind up on the reel. The operation of such a detector shall be at 1500V, 3000 c/s as recommended by M/s. Du-Pont/USA and shall be suitable, as an INPROCESS' equipment.

5.5 HEAT AGEING TEST :

Straight samples of 300 mm. length and bent samples edgewise and flat wise as prepared in 5.3.1 shall be heated for 20 hrs. in an oven at a temperature of 240-245^0 C and then allowed to cool at room temperature. The samples shall show no appreciable cracks, opening, delamination of covering, edge lifting and edge curling,

5. 5.1 DIELECTRIC TEST ON HEAT AGED SAMPLES :

The samples heat aged as in 5.5 shall be treated for dielectric strength as in 5.4.1 and 5.4.2. The minimum, acceptable break down voltage is 6000 volts on 1/2 lap conductor and 9000 volts on 2/3 lap conductor on two thicknesses, of insulation and that on bent samples is 4000 volts on 1/2 lap conductor and 6000 volts on 2/3 lap conductor on single thickness of insulation.

5.5.2 INFORMATIVE TEST :

5.5.2.1 Proof dielectric strength on straight & bent samples :

Straight samples of 200 mm long and bent samples, edgewise and flat wise, as prepared in. 5. 3.1. Shall be subjected to AC 50 c/s sinusoidal voltage of 6 KV, 7KV & 8 KV on three sets of samples separately. The period from the time of attaining full voltage till the break down occurs shall be recorded. The uniformity of this test results will indicate consistency in the quality of the covered conductor

6. INSPECTION :

6.1. The inspection of the material shall be done by the authorised representative of CLW/Chittaranjan at the manufacturer's premises. All the tests as indicated above shall be conducted on each lot and the results evaluated.

6.2 10% of the reels shall be re-reeled for checking the visual defects if any and samples from each of these reels to be taken for checking and judging the quality requirements, stipulated in this standard. If these reels meet the specification, the lot represented would be accepted

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DRN.			

6.3 CLW reserves the right to carry out stage inspection also at firm's premises, particularly with reference to manufacturing process, quality control and compliance with various clause of the specification.

6.4 CRITERIA FOR CONFORMITY & INTERPRETATION OF TEST RESULTS:

The supplies offered for inspection shall be considered to be satisfactory and acceptable, if all the test results presented by the manufacturer and these obtained by the inspector on the sample selected by him are within the specified limit arid statistically satisfactory.

If the results of any of the test is not within the specified limit , the test shall be repeated on twice the number of samples.

If the results of the repeat tests are not within the specified limits, the entire supplies shall be rejected. The purchaser shall have however the right to reject the supplies in full or in part.

If the results of the repeat tests are within the specified limit, the supplies shall be considered to be acceptable.

7.0 PACKING:

7.1 The conductor shall be delivered in continuous lengths. Each reel or drum shall contain not more than two lengths of conductor. If the reel or drum contains two length this shall be indicate on the label. If the contents of the reel consists of two lengths a slip of paper shall be inserted between the layers to indicate the commencement of the Second length. The net weight of the conductor per drum shall be 90 ± 20 kgs. Cut pieces of minimum weight of 20 kgs each will be accepted subject to 10 % of the ordered quantity.

7 2 The covered conductor shall be wound evenly and compactly on reels. Separators shall be inserted in each layer of wire and a band of suitable number of layers of thick paper shall be given over the last layer of wire to protect the conductor from external damages. The construction of the drum shall generally conform to IS: 2069-1991. "Specification for rums for covered winding wires and strips for Electrical purposes".

7.3 Each drum shall be labelled at a distance location easily visible on the drum indicating the following information.

a) Name and address of the manufacturer.
b) Purchase order reference and date.
c) Description and nominal dimensions of the conductor.
d) Date of manufacture of the conductor.
e) Date of inspection of the lot and lot size.
f) Gross weight of the drum; tare weight of the drum.
g) Net weight of the conductor and number of lengths.
h) Special precautions, if any, for storage.
i) Number of faults noticed on continuity of covering test.

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DRN.

SPECIFICATION FOR POLYIMIDE COVERED COPPER CONDUCTOR FOR CLASS [illegible] TRACTION MOTOR (TYPE [illegible])

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WEST BENGAL INDIA
NO. 4TMS.095.002,REV.0
DATE 23.06.2011

8.0. INFORMATION TO BE FURNISHED BY THE TENDERER:

While submitting the offer the tender shall farnish the following information:-

i) Full details of the materials used in the construction viz :-
   a) Type with full technical details, size and source of supply of Polyimide film used for covering.
   b) Details of Copper Conductor.
   c) Details of manufacturing process.

ii) Name of electrical equipment manufactures to whom such/similar conductors have already been supplied and also the quantities supplied with references.

iii) Service experience/feed back information obtained on such supplies as at (ii) above.

iv) A list of deviation, if any, form this specification. Even if tenderer has no particular deviation in their offer, a 'NIL' statement shall be' submitted.

v) The offer shall be accompanied by a sample of at least 6 meters of Polyimide Covered Copper Conductor developed/supplied by them for other customers

9.0 TEST PLAN: Polyimide Covered Copper Conductor may be tested as per test schedule & test method given below:

SN	Test Parameters	Test Method (Clause No.)	TEST		
			Routine* (Manufacturer)	Acceptance (Bulk inspection)	Type (Prototype)
1.	Dimensions	3.0	√	√	√
2.	Material	4.1	√	√	√
3.	Edgewise Bending	4.2	√	√	√
4.	Resistance to Alternate Bends	4.3	√	√	√
5.	Springiness Test	4.4	√	√	√
j	Elongations Test	4.5	√	√	√
7.	Electrical Resistivity	4.6	√	√	√
8.	Hardness Test	4.7	√	√	√
9.	Covering Insulation	5.0	√	√	√
10.	Mandrel Winding Test	5.3.1	√	√	√
11.	Heat Shock	5.3.2	√	√	√
12.	Adherence Test	5.3.3	√	√	√
13.	Twist Test	5.3.4	√	√	√
14.	Peel of Test	5.3.5	√	√	√
15.	Dielectric strength on straight samp1es	5.4.1	√	-	√
16.	Dielectric strength on bent samp1es	5.4.2	√	-	√
17.	Pin Holes test	5.4.3	√	-	√
18.	Heat Ageing Test	5.5	√	√	√
19.	Dielectric Test on Heat aged samples	5.5.1	√	√	√
20.	Informative Test	5.5.2	√	-	-

* Routine Test to be treated as Firm's Internal Inspection which to be submitted by Firm during Acceptance Test (Bulk/Regular inspection) as well as Type Test (Prototype)

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DRN.

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WEST BENGAL INDIA
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