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सत्यमेव जयते

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SPECIFICATION No. TI/SPC/OHE/CW(Cu-Ag)/ 0130 (05/2025)

TECHNICAL SPECIFICATION FOR CONTINUOUS CAST SILVER BEARING COPPER RODS and 107 mm² SILVER BEARING GROOVED COPPER CONTACT WIRE FOR ELECTRIC TRACTION (DRAWN OUT OF CONTINUOUS CAST SILVER BEARING COPPER RODS)

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SPECIFICATION FOR SILVER BEARING GROOVED COPPER CONTACT WIRE FOR ELECTRIC TRACTION (DRAWN OUT OF CCSBC RODS)

1.0 SCOPE

1.1 This Specification covers the requirement of Silver Bearing Copper Contact Wire manufactured from Continuous Cast Silver Bearing Copper (CCSBC) Wire Rods for Electric Traction overhead lines.

1.2 The "Make in India" Policy of Government of India shall be applicable.

2.0 GOVERNING SPECIFICATIONS

2.1 In the preparation of this specification assistance has been taken from the following standards and specifications.

2.1.1	IS: 191-2007 or latest	Specification for Copper.
2.1.2	IS: 2279-1980 or latest	Specification for Fine Silver Bar, Sheet, Wire, Granules and Token
2.1.3	IS: 1778-1980 or latest	Specification for Reels and drums for bare conductors.
2.1.4	IS: 1885 (Pt.xxxii)-2019 or latest	Electro-technical Vocabulary (Electric cables)
2.1.5	IS: 9713-1983 or latest	Specification for Hot Rolled Electrolytic Copper Wire Rods for Electrical Conductors.
2.1.6	IS : 12444-1988 or latest	Specification for Continuously cast and rolled electrolytic copper wire rods for electrical conductors
2.1.7	IS: 440-1964 or latest	Methods of chemical analysis of Copper.
2.1.8	IS: 1608 Part 1-2018 or latest	Metallic Materials-Tensile Testing-Method of Test at Room Temperature
2.1.9	IS: 3476-1986 or latest	Specification for trolley & Contact Wire for Electric Traction.
2.1.10	BS EN 50149:2012 or latest	Specification for Copper & Copper alloy grooved Contact Wires.
2.1.11	NEMA WC 26-2008 or latest	Binational Wire and Cable Packaging Standard.

2.2 In case of any conflict or disparity between the contents of the above specification and this specification, the latter shall prevail.

2.3 Any deviation from this specification proposed by the manufacturer to improve upon the performance of Contact Wire shall be considered only on its merits provided full particulars with justification and financial implication are furnished by the manufacturer.

3.0 ENVIRONMENTAL CONDITIONS

3.1 The conductor shall be suitable for outdoor use in moist tropical climate and in areas subject to heavy rainfall, polluted due to industry and marine atmosphere and severe lightning. The limiting weather conditions which the conductor has to withstand in service are indicated in TABLE – 1.

TABLE – 1
ENVIRONMENTAL CONDITIONS

SN	Environmental condition	Limits
i.	Ambient air Temperature.	0^0 C to $+50^0$ C
ii.	Maximum temperature of metallic object under sun.	70^0 C
iii.	Minimum temperature.	-10^0 C
iv.	Maximum relative humidity	100%
v.	Annual Rainfall	1750 mm to 6250 mm.
vi.	Maximum number of thunder storm days per annum.	85
vii.	Maximum number of dust storm days per annum.	35
viii.	Number of rainy days per annum	120
ix.	Basic wind pressure	216 kgf/m^2
x.	Altitude	2500 m above mean sea level.

4.0 MATERIAL

4.1 The Silver Bearing Copper Contact Wire shall be drawn out of CCSBC Rods manufactured by any of the following processes:

(a) Continuous Cast & Roll (CCR) Process
(b) Vertical upward continuous casting with graphite crucible chamber process followed by further processing (hot rolling/cold rolling/extrusion/cold drawing)

Diameter of the rod so obtained, shall be as given in Table-3.

Copper used, should be Electrolytic grade Copper cathodes conforming to the requirement of LME Grade `A' copper as listed in the London Metal Exchange.

Silver used for alloying, should conform to the chemical composition of Grade 9995 or Grade 9999 of IS:2279-1980 or latest "Specification for fine silver bar, sheet, wire, granules and token".

The chemical composition of the Continuous Cast Silver Bearing Copper (CCSBC) Rod shall be as given in Table-2.

The manufacturer of CCSBC Wire Rod which is used in the manufacture of prototype Contact Wire will be treated as approved vendor for CCSBC Wire Rod once the prototype and field trial of 4 months of Contact Wire manufactured by this CCSBC Wire Rod is approved. Trial scheme as per annexure 1.

Procurement of CCSBC wire rod on job work basis is not allowed.

TABLE – 2

CHEMICAL COMPOSITION OF CCSBC ROD

Element	%/ppm
Cu	Remaining*
Ag	0.08 to 0.12%
Bi	< 5 ppm
Oxygen	< 400 ppm
Other elements	<0.03%

*copper percentage is defined as remaining. Means 100% minus Silver, Bismuth, Oxygen percentage minus 0.03% impurities.

5.0 PHYSICAL CONSTANTS OF SILVER BEARING COPPER CONTACT WIRE

5.1 SILVER BEARING COPPER

5.1.1 VOLUME RESISTIVITY

The resistivity of Silver Bearing Copper Contact Wire is a function of the tensile strength. Within a range of 30 – 50 kg/mm^2 tensile strength, the following formula has been found to express sufficiently closely the results obtained in practice and been adopted in calculating the resistance specified in IS : 3476-1986 or latest.

P= T/16
Where
P= Percentage increase in resistivity of the hard drawn silver bearing copper over its resistivity when annealed and
T = Tensile strength of the hard drawn silver bearing copper in kg/mm^2.

5.1.1.1 The resistances given in the TABLE–3 are based on standard resistivity of annealed Silver Bearing Copper at 20°C modified in accordance with the above formula.

5.1.1.2 At a temperature of 20°C the volume resistivity of standard annealed Silver Bearing Copper is 1/58 = 0.017241 ohm mm^2/m.

5.1.1.3 Silver Bearing Copper which has a resistivity at 20°C of 1/58 = 0.017241 ohm mm^2/m is said to have a conductivity of 100%.

5.1.2 DENSITY

At a temperature of 20°C the density of Silver Bearing Copper has been taken as 8.89 g/cm^3.

5.1.3 CO-EFFICIENT OF LINEAR EXPANSION

At a temperature of 20°C the co-efficient of linear expansion of Silver Bearing Copper has been taken as 0.000017/ °C. This co-efficient may be used over a temperature range from 0°C to 150°C.

5.1.4 CONSTANT MASS TEMPERATURE CO-EFFICIENT OF RESISTANCE

At a temperature of 20°C, the co-efficient of variation of the resistance with temperature of Silver Bearing Copper, measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0.00381/k as per BS EN-50149:2012.

6.0 SIZES, SHAPES, DIMENSIONS, WEIGHTS AND OTHER PROPERTIES OF CONTACT WIRE

6.1 The size, shape and dimension for the Contact Wire shall be as indicated in Figure – 1 & 2.

6.2 The cross-sectional areas, weights, maximum resistances and other properties shall be as detailed in TABLE – 3. Tolerance on weight shall be ±3%

TABLE – 3

PROPERTIES OF SILVER BEARING COPPER CONTACT WIRE

Cross Section	Dia of CCSBC rod		Standard weight/ Km	Resistance km at 20°C	Tensile strength	Conventional limit of elasticity	Elongation in 200 mm	Nos of bending	Hardness
1	2		3	4	5	6	7	8	9
Nom	min	max	Nom.	Max	Min.	Min.	Min.	Min.	Min.
Mm^2	mm	mm	kg	Ohms	Kgf/mm^2	Kgf/mm^2	%	Nos	BHN
107	19.1	21.5	951.2	0.171	36.5	31.0	3	7	107

Note – 1: The values given in column-3 correspond to the nominal cross–sectional area of Contact Wire. The values given in column-4 correspond to minimum cross–sectional area of the Contact Wire.

Note – 2 : The conventional limit of elasticity indicated in column 6 is for information only. The conventional limit of elasticity is defined as the maximum tensile load which the test piece may withstand for a period of 10s without under–going a permanent elongation of more than 0.2% of the original gauge length.

6.3 MECHANICAL AND ELECTRICAL PROPERTIES

6.3.1 The tensile strength, elongation and hardness when tested in accordance with Clauses 10.6, 10.7 & 10.9 respectively, shall not be less than the appropriate values given in TABLE-3. The Contact Wire shall also comply with the requirements of the bending test specified in Clause 10.8.

6.3.2 The Electrical Resistance per Kilo meter of the sample, multiplied by the appropriate constant in TABLE-5 and corrected for the cross-sectional area, shall not exceed the values given in TABLE-3.

6.4 JOINTS

There shall be no joints in Contact Wire made out of CCSBC Rods.

6.5 FREEDOM FROM DEFECTS

6.5.1 The Contact Wire shall be clean, smooth and free from harmful defects, such as scales, peelings, sharp edges and defects in the groove.

6.5.2 The groove shall be uniform and free from twists. Any defect in the groove noticed at the time of or subsequent to erection of the Contact Wire shall entail heavy penalty on the manufacturer. To check on this, suitable means shall be employed by the manufacturer by way of provision of a mirror or other suitable means and monitor during the drawing out of the Contact Wire.

6.5.3 The wire drawing of Contact Wire shall be done by 5 or 6 stage wire drawing machine.

7.0 TESTS

7.1 After a purchase order is placed for supply of wire for overhead Railway Traction, the internal test results for all the tests specified in clauses-8.1 & 9.1 shall be furnished by the successful manufacturer to

the Director General (TI)/RDSO within the period stipulated for prototype approval in the order

7.2 Any changes required to be done in the prototype as required by the Director General (TI)/RDSO shall be carried out expeditiously by the manufacturer.

7.3 Type-Testing Schedule:- Prior to giving a call to the Director General (TI)/RDSO for inspection and testing of the prototype, the manufacturer shall submit a detailed test schedule consisting of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the test shall invariably be done accordingly. However during the process of type testing or even later, the purchaser reserves the right to conduct any additional test(s) besides those specified herein, on Wire Rod/Contact Wire so as to test Wire Rod/Contact Wire to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement arises between the manufacturer and representative of the Director General (TI)/RDSO during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type test, it shall be brought to the notice of the Director General (TI)/RDSO, whose decision shall be final and binding.

7.4 All the tests specified, unless otherwise mentioned elsewhere, in the specification shall be carried out at the manufacturer works. The manufacturer shall arrange all the necessary machinery, apparatus, labour and assistance required for conducting the tests without any extra cost.

7.5 BULK MANUFACTURE

Only after clear written approval of the results of the tests on the prototype is communicated by the Director General (TI)/RDSO to the manufacturer, manufacturer shall take up bulk manufacture of the Contact Wire which shall be strictly with the same material and process as adopted for the prototype.

7.6 TECHNICAL DATA

The Contact wire manufacturer shall furnish along with the offer the guaranteed performance data and other technical particulars of the Contact Wire as per para 13.0 of the specification. The guaranteed values shall have to be proved by test.

8.0 TESTS ON CCSBC RODS

8.1 TYPE TESTS

8.1.1 The following type tests shall be carried out on three samples of the CCSBC rods taken in accordance with IS: 191-2007 or latest.

i) Visual Examination
ii) Measurement of dimensions
iii) Compression Test
iv) Tensile strength/elongation Test
v) Chemical composition
vi) Micro-structure examination
vii) Ultrasonic testing at the time of wire drawing
viii) Electrical Resistivity Test

8.2 ACCEPTANCE TESTS

8.2.1 "CUSTOMER HOLD POINT(CHP)"

The manufacturer shall include in his quality assurance plan (QAP) a CHP stage beyond which the manufacturing process shall proceed only after CCSBC rods pass the acceptance test duly verified by the Designated Authority in accordance with Clause No.8.2.2.

The QAP shall have the approval of the Director General (TI), RDSO before taking up the manufacture.

8.2.2 The following tests shall be carried out on the samples of CCSBC rods drawn in accordance with IS: 9713-1983 or latest (for the purpose of sampling only).

i) Visual Examination
ii) Measurement of dimensions
iii) Compression Test
iv) Tensile strength/elongation Test
v) Chemical Composition
vi) Micro-structure Examination
vii) Electrical resistivity test

In addition weighment of every empty drums (to be used for Contact Wire) for tare weight, either at the time of stage inspection/Acceptance Test of CCSBC Rods or on call given by the manufacturer. Identification mark with Tare weight should be provided by Inspecting official on each drum. Record of the result of weighment shall be maintained.
The Inspector shall verify physical raw material purchased by the supplier with the copy of its invoice. Inspector shall check with CCSBC rod, coil no./batch no. mentioned in raw material purchase invoice are actually matching with raw material. Record of the invoices shall be maintained.

The Inspector shall check calibration certificate of counter meters of all available contact wire drawing machine, the accuracy and calibration of the counter meters by passing the wire of known length.

8.3 MANUFACTURER'S TESTS

8.3.1 The manufacturer shall test all the CCSBC rods for visual examination and measurement of dimensions. All the wire rods shall be free from any piping, crow feet, indentation, foreign particles or inclusions, surface defects, twists and entanglements.

8.3.2 The manufacturer shall test every lot of CCSBC rods for tensile/elongation and compression. These tests shall be carried out on the samples of wire rods drawn in accordance with IS: 9713-1983 or latest. A lot shall be as stipulated in IS: 9713-1983 or latest.

8.3.3 The manufacturer shall test every lot of CCSBC rods for chemical composition and micro-structure examination. The samples will be drawn in accordance with IS : 9713-1983 or latest.

8.3.4 Records of the results of the tests shall be maintained by the manufacturer and checked by the Inspector.

8.4 CRITERIA FOR ACCEPTANCE

8.4.1 Criteria for acceptance of the lot shall be in accordance with Clause-9 of IS: 9713-1983 or latest.

8.5 METHODS OF TESTS

8.5.1 VISUAL EXAMINATION

The surface of CCSBC Rod shall be fairly smooth, free from inclusions or foreign particles, indentation, surface defects, scales, twists, entanglements etc.

8.5.2 MEASUREMENT OF DIMENSIONS

Discard approximately 2.5 meter length from the end of the coil. Three measurements at 60° angular displacement shall be made around the circumference at two places 4 meter apart. An average of six readings shall be considered as the diameter of the CCSBC wire rod. The diameter shall be as specified in table-3.

8.5.3 COMPRESSION TEST

A sample of length twice the diameter of the CCSBC rod shall be cut from the coil and then compressed till its length becomes half the original length. Curved surface, after test, shall not show any crack or defect on visual check.

8.5.4 TENSILE STRENGTH/ELONGATION TEST

When tested in accordance with IS: 1608-Part 1 : 2018 or latest "Metallic Materials-Tensile Testing-Method of Test at Room Temperature" for tensile strength and elongation, the material shall have a tensile strength of 20.4 kgf/mm^2 (min.) and a minimum of 42% elongation. But the gauge length of the sample for this test shall be of 250 mm.

8.5.5 CHEMICAL COMPOSITION

The material shall have the chemical composition as given in Table-2. The trace elements shall be determined by Spectrometric method. The copper shall be determined in accordance with IS: 440-1964 or latest. Oxygen content may be determined by oxygen analyzer or Spectrometer.

8.5.6 MICRO-STRUCTURE EXAMINATION

The sample of CCSBC Rod cut along transverse section polished and etched shall show equiaxed re-crystallised fine grains having grain size finer than ASTM-5. The presence of cast columnar grains in the micro-structure shall not be permitted.

8.5.7 ELECTRICAL RESISTIVITY TEST

Electrical Resistivity of CCSBC rod shall be determined in accordance with IS 613-2000 or latest. Resistivity shall not be greater than 0.017241 ohm mm^2/m at 20^{0}C.

8.5.8 ULTRASONIC/EDDY CURRENT TEST

The CCSBC Wire Rod shall be ultrasonic/eddy current tested by the CCR rod manufacturer continuously during production.

The CCSBC Rod shall be ultrasonic/eddy current tested by the manufacturer continuously during production of Contact Wire for the entire length. The defect if any, observed shall require that complete rod to be discarded. Records shall be maintained for the purpose and produced before the inspector on demand. The Contact Wire drawing machine should stop automatically if any defect is observed during ultrasonic/eddy current testing.

8.6 PROOF OF PURCHASE OF CCSBC ROD

Supplier shall be required to submit following documents at the time of Routine Inspection/Acceptance Test which shall be part of Inspection Certificate.

8.6.1 Proof of purchase (Invoice) of CCSBC Rod/Copper Cathode from the approved Vender and Test Certificate.

8.6.2 For imported CCSBC Rod/Copper Cathode the Supplier shall submit proof of import i.e.

i) Bill of Entry.
ii) Bill of Lading/Air way bill.
iii) Payment details to overseas CCSBC Rod/Copper Cathode manufacturer.
iv) Declaration that he has and will not use these Documents for any other consignment or purpose.

8.6.3 The CCSBC rod, either Indigenous or imported, has to be procured directly from the OEM

8.6.4 Procurement of CCSBC rod/Copper Cathode from indigenous manufacturer is preferable.

8.6.5 Procurement of CCSBC rod/Copper Cathode from any distributor/trader/channel partner of manufacturer is not permitted to ensure quality of material.

8.6.6 Procurement of CCSBC Rod on Job Work Basis is not allowed.

8.6.7 Inspecting Engineer shall verify the authenticity of proof of purchase from OEM.

9.0 TESTS ON CONTACT WIRE

9.1 TYPE TESTS

The CCSBC rods shall be drawn into the prototype Contact Wire in presence of the Inspector. The following tests shall be carried out on the samples cut at random from the Contact Wire coil produced. Each test shall be conducted on three samples.

9.1.1 Visual examination.
9.1.2 Verification of dimensions.
9.1.3 Measurement of weight.
9.1.4 Electrical resistance test.
9.1.5 Hardness test.
9.1.6 Tensile test.
9.1.7 Elongation test.
9.1.8 Bending test.
9.1.9 Chemical analysis.
9.1.10 Micro-structure examination.
9.1.11 Ultrasonic testing of Contact wire

9.2 ACCEPTANCE TESTS

Same as type tests except that indicated in Clause 9.1.11. In addition weighment of each offered Contact Wire drums for acceptance tests, for gross weight. The Inspector shall verify the results of manufacturer's tests.

The Inspector shall check calibration certificate of counter meters of all available contact wire drawing machine, the accuracy and calibration of the counter meters by passing the wire of known length.

9.3 ROUTINE TESTS

9.3.1 Visual examination.
9.3.2 Verification of dimensions.
9.3.3 Measurement of weight.
9.3.4 Tensile test.
9.3.5 Elongation test.
9.3.6 Bending test.
9.3.7 Chemical analysis using the spectrometric method, which includes the determination of Oxygen content.
9.3.8 Micro-structure examination.

9.4 MANUFACTURER'S TESTS

9.4.1 The manufacturer shall test every lot of CCSBC rod for chemical composition. A lot shall be as stipulated in IS: 9713-1983 or latest. The results shall be checked by the Inspector.

9.4.2 Every CCSBC Rod shall be thoroughly inspected for blow holes, pipes, oxide-inclusions and other defects before drawing. In case of defects Contact Wire shall be rejected.

9.4.3 The manufacture shall weigh every drum of the Contact Wires for tare weight and gross weight. Records of the results of weighment shall be checked by the Inspector at the time of Acceptance Tests.

10.0 TEST METHODS

10.1 VISUAL EXAMINATION

The surface finish of the grooved Contact Wire shall be checked for defects, such as chips, scales, sharp edges, bubbles, peelings, scratches, pin holes. The Contact Wire shall have no twists or kinks.

10.2 VERIFICATION OF DIMENSIONS

10.2.1 The diameter of the grooved Contact Wire shall be measured by means of a ratchet micrometer or a dial micrometer between two circular flat studs having a diameter of not less than 5 mm. The value of the diameter shall be the mean of two readings made in two directions perpendicular to each other and situated approximately at the same cross section.

10.2.2 CHECKING OF DIMENSIONS AT THE BOTTOM OF THE GROOVE

The dimensions at the bottom of the groove in the Contact Wire shall be measured by means of either a special caliper made in accordance with Fig. 2 or by shadowgraph projection of not less than 10X. The method shall be subject to agreement between the purchaser and the manufacturer.

The dimension shall be as given in Figure 1.

10.3 MEASUREMENT OF WEIGHT

The weight of the Contact Wire, per km shall be calculated by weighing a piece of 50 cm length by a balance of accuracy of ±1gm, by a digital balance. The weight of the Contact Wire shall be as specified in TABLE-3. Tolerance on weight shall be ±3%.

10.4 ELECTRICAL RESISTANCE TEST

The electrical resistance of three samples shall be measured by means of a double Kelvin Bridge. The current terminals shall be sufficiently away from the voltage terminals. The electrical resistance of test sample multiplied by W x C/K shall not exceed the appropriate values indicated in TABLE-3.

Where
W = weight per km of test sample in kg
K = standard weight of Contact Wire per km in kg
C = multiplying constant for temperature variation indicated in TABLE-5.

Note : The Inspector shall check the accuracy and calibration of the measuring equipment by resistance of known value.

10.5 HARDNESS TEST

Hardness of sample of Contact Wire shall be determined on Brinell Scale with 2.5 mm dia. balls and load of 62.5 kg. in accordance with IS: 1500 –-Part 1:2019 "Metallic Material- Brinell Hardness Test-Test Method". The hardness shall be measured at mid radius of the cross section of Contact Wire and average of 3 such values shall be considered for qualifying purpose. The hardness of the Contact Wire shall be not less than values specified in TABLE-3.

10.6 TENSILE TEST

A sample of Contact Wire which is straight and of length such that when it is held in the jaws of the Tensile Testing Machine the distance between the jaws is not less than 250mm shall be taken. A gauge length of 200mm shall be marked on the test piece for the purpose of measuring the elongation. The load shall be applied gradually until the test piece breaks. The tensile strength of the Contact Wire shall be not less than values specified in TABLE-3.

10.7 ELONGATION TEST

The elongation shall be measured on the same test piece which was subjected to tensile test upto its fracture as specified in Clause- 10.6. The elongation of the sample after tensile test shall be measured with reference to the gauge length after the fractured ends have been fitted together provided fracture occurs within the gauge length. The values of percent elongation measured shall be not less than the values specified in TABLE-3. If the fracture occurs outside the gauge length and the required elongation is not achieved, another sample

shall be tested. If this sample also fails, the lot shall be rejected.

10.8 BENDING TEST

The test consists of bending by hand/machine, a straight length of 200 mm long Contact Wire through 90° and back, alternately on either side of the vertical with the axis of the straight and bent portions of the Contact Wire remaining in the same plane. The test piece shall be held in blocks of the type shown in Fig.3 having a radius of 30 mm. A tube whose inside diameter is slightly higher than the diameter of the Contact Wire and one end of which is closed shall be put over the contact wire, the lower end of the tube being about 20 mm above the surface of the blocks. The first bending operation shall be carried out in a direction such that the top lobe of the wire is in tension. One bend shall be construed as including all operation between two consecutive passages of the test piece through the vertical position. During each bending operations the entire length of the Contact Wire and in particular the length adjacent to the clamping plane shall touch the face of the block on the side to which the Contact Wire is bent. There shall not be any twisting of the wire during bending. There shall not be more than one bending operation per second. The test piece shall withstand the appropriate number of bends indicated in TABLE-3 without fracture. One bend consists of bending the free end of the test specimen through 90° and returning it to its original position.

10.9 CHEMICAL ANALYSIS

The samples taken from the Contact Wire shall be tested for chemical composition in accordance with Clause 8.5.5 of this specification. The chemical composition shall be as per Table-2.

10.10 MICRO-STRUCTURE EXAMINATION OF CONTACT WIRE

A sample of the finished Contact Wire shall be transversely sectioned, polished and etched and it shall show equiaxed re-crystallised fine grain structure to ASTM No. 7 or finer. Presence of cast columnar grains or dentritic structure representing improper breakdown of the original structure will not be permitted.

10.11 The contact wire shall be ultrasonic tested by the manufacturer continuously during production for the entire length. The defect if any, observed shall require that entire tension length of Contact wire to be discarded. Records shall be maintained for the purpose and produced before the inspector on demand. The Contact Wire drawing machine should stop automatically if any defect is observed during ultrasonic current testing.

10.12 SELECTION OF SAMPLE FOR TESTS & CRITERIA OF APPROVAL

10.12.1 BATCHES

10.12.2 The Contact Wire shall be offered for inspection in a batch of 6 drums at a time or as per P.O/RgC, whichever is less.

10.12.3 One sample of Contact Wire shall be cut from each drum in the presence of the Inspector for the tests. No treatment shall be given to any sample before tests except that it may be straightened, if necessary.

10.12.4 Three samples of Contact Wire shall be subjected to acceptance tests as given below:

10.12.4.1 Visual examination.
10.12.4.2 Verification of dimensions.
10.12.4.3 Measurement of weight
10.12.4.4 Electrical resistance test.
10.12.4.5 Hardness test.
10.12.4.6 Microstructure examination

Thereafter one sample from each drum shall be subjected to the following tests:

10.12.4.7 Tensile and Elongation Tests.
10.12.4.8 Bending Test.

10.12.4.9 After destruction one of the sample shall be subjected to the chemical composition test.
10.12.4.10 Acceptance of records maintained for tests in accordance with 8.5.8 & 10.11 will form a part of the acceptance tests for the Contact Wire.

10.12.5 Should a sample of Contact Wire fail in any one of the test, a second sample of the Contact Wire shall be taken from the same drum from which the sample which had failed was taken. This sample shall be subject to the same test in which the first sample had failed. If the second sample passes the test the batch shall be deemed to have complied with the requirement of this clause. Should failure occur in more than one test, the batch shall be deemed to be rejected.

11.0 PACKING AND MARKING

11.1 PACKING OF CCSBC RODS

The material shall be supplied in coils strapped with loops or as required by the Purchaser.

11.2 MARKING OF CCSBC ROD COILS

On the coil suitable tags/coil sticker with markings made on them shall be provided with each coil and shall carry the following information.

i Name and trade mark of manufacturer
ii Size of wire rod and weight of coil
iii Lot number
iv Date of manufacture
v Any other information required by the purchaser.

11.3 PACKING AND MARKING OF CONTACT WIRE

11.3.1 Type of Drums

11.3.1.1 The contact wire shall be supplied properly wound on either wooden drums or corrugated steel drums (type of drum required whether wooden or steel to be specified by the purchaser in his purchase order) in specified weights as required by the purchaser, the turns of the wire being close and continuous without any overriding except on the first and last turns of each layer.

11.3.1.2 A drum shall carry only one continuous length of contact wire.

11.3.1.3 In order to avoid any damage to Contact Wire, corrugated paper sheet of min. 3.00 mm thickness shall be provided on the outer diameter of barrel & at the top layer of Contact wire, after winding of entire length has been completed.

11.3.1.4 Inner side of flanges shall also be provided with corrugated paper sheet of Min. 3.00 mm thickness pasted/tied to flange.

11.3.1.5 Top surface of finished drum shall also be provided with plastic sheet for additional protection. On top of plastic sheet, additional corrugated paper sheet to be provided for enhanced protection to Copper Conductor before final packing.

11.3.1.6 Any damage in the Contact Wire shall be to supplier's account.

11.3.2 The Contact Wire shall be so wound on the drum that the top (smaller) lobe of the Contact Wire is on the top. The manufacturer shall ensure that the top and the bottom lobes of the Contact Wire are not disturbed during winding on the drum and the Contact Wire is not twisted to change the orientation of the top lobe on the drum.

11.3.3 The length of the Contact Wire for each drum shall be specified by the purchaser. The specified length shall not be more than 2000m.

11.3.4 The length of the Contact Wire in a drum, after the test pieces required for the various tests have been cut and taken out shall be not less than values specified by the purchaser.

11.3.5 The wooden drum shall comply with IS: 1778-1980 or latest "Specification for Reels and Drums for bare conductors" and shall have the dimensions as indicated in TABLE-4.

TABLE – 4

DRUM DIMENSION FOR DIFFERENT SIZE OF CONTACT WIRE

Size of Contact Wire (mm^2)	Length of* Contact Wire (m)	Flange** dia(mm)	Barrel dia (mm)	Traverse (mm)
107	1600	1530	1200	600
107	2000	1575	1200	600

*These are higher limits which may not exceed by more than 50m.
** Flange diameter subject to a maximum of 1900mm.

11.3.6 Corrugated Steel drums shall be of maximum capacity 3570 Kg as per Table 2.2 type RM of NEMA WC 26-2008 or latest. Size of the selected drum for 107 mm2 (HDGSBC) Contact Wire is as per table below:

Flange	Barrel Dia	Traverse
72 inch	48 inch	36 inch
1828.8 mm	1219.2 mm	914.4 mm

11.3.7 Gross Weight of Steel Drum specified in Para 11.3.6 above, after winding contact wire shall be limited to 2800 kg.

11.3.8 Each drum of Contact Wire shall be provided with two colour bands alternatively each of red and yellow paint of approximately 75mm width each, at the top layer of Contact Wire for identification. Top end of the Contact Wire shall also be provided with lead seal by inspection authority by making hole in the Contact Wire, in addition to punch mark provided by the manufacturer for identification of end. On receipt of Contact Wire drums the colour bands, sealing at the end of Contact Wire and punch mark shall be verified by the consignee to ascertain correct receipt of length of Contact Wire.

11.3.9 The emblem/identification mark of the Contact wire manufacturer and CCSBC Rod manufacturer with year of manufacture in 3 mm letter size shall be provided on the top lobe of the Contact Wire on regular intervals – not less than 40m and not exceeding 50m so as to facilitate identification. The marking shall be provided in the format mentioned in Clause 11.3.10 below and shall be such that it is not detrimental to the strength of the Contact Wire.

11.3.10 The identification mark in format CCC/MMM/YY/AG shall be provided as mentioned in Clause 11.3.9 above.
Where, First abbreviation i.e CCC shall indicate identification for manufacture of CCSBC rod followed by slash
Second abbreviation i.e 'MMM' shall indicate identification for manufacture of Contact wire followed by slash
Third abbreviation i.e 'YY' shall indicate year of manufacture for example 80 for 1980 and 10 for 2010.
The abbreviation for manufacturer should be first three alphabets of Vendor name as indicated in Vendor Directory against each firm.
Fourth abbreviation is for alloy element being used i.e. AG for silver.

11.3.11 The following particulars shall be marked in indelible paint on each drum:

i Purchaser's order number.
ii Size of Contact Wire.
iii Length of Contact Wire.
iv Gross and net weights.
v Drum number and
vi Consignee and other particulars as required by the purchaser.
vii Make, batch no. and month & year of procurement of CCSBC rod.

11.4 DISPOSAL OF REJECTED CONTACT WIRE

Contact Wire which is rejected shall be cut into pieces of length not greater than 300 m or drawn again into thinner wire. This shall be done in the presence of the Inspector.

12.0 MULTIPLIER CONSTANT FOR HARD DRAWN SILVER BEARING COPPER WIRE

TABLE – 5

Multiplying constant and its reciprocal for converting resistance of copper Contact Wire various temperatures to that at standard temperature of 20° C and to that and for converting resistance at 20°C to that at any other temperature respectively:

Temperature ^{0}C	Multiplier Constant	Reciprocal of constant
5.0	1.0606	0.9429
5.5	1.0585	0.9448
6.0	1.0563	0.9467
6.5	1.0542	0.9486
7.0	1.0521	0.9505
7.5	1.0500	0.9524
8.0	1.0479	0.9543
8.5	1.0458	0.9562
9.0	1.0437	0.9581
9.5	1.0417	0.9600
10.0	1.0396	0.9524
10.5	1.0376	0.9638
11.0	1.0355	0.9657
11.5	1.0335	0.9676
12.0	1.0314	0.9695
12.5	1.0294	0.9714
13.0	1.0274	0.9733
13.5	1.0254	0.9752
14.0	1.0234	0.9771
14.5	1.0214	0.9790
15.0	1.0194	0.9810
15.5	1.0174	0.9829
16.0	1.0155	0.9848
16.5	1.0135	0.9867
17.0	1.0116	0.9886
17.5	1.0096	0.9905
18.0	1.0077	0.9924
18.5	1.0057	0.9943
19.0	1.0038	0.9962
19.5	1.0019	0.9981
20.0	1.0000	1.0000
20.5	0.9981	1.0019
21.0	0.9962	1.0038
21.5	0.9943	1.0057
22.0	0.9924	1.0076
22.5	0.9906	1.0095
23.0	0.9887	1.0114
23.5	0.9868	1.0133
24.0	0.9850	1.0152
24.5	0.9831	1.0171
25.0	0.9813	1.0191
25.5	0.9795	1.0210
26.0	0.9777	1.0229
26.5	0.9758	1.0248
27.0	0.9740	1.0267
27.5	0.9722	1.0286
28.0	0.9704	1.0305

28.5	0.9686	1.0324
29.0	0.9668	1.0343
29.5	0.9651	1.0362
30.0	0.9633	1.0381

NOTE – 1: If the resistance of Contact Wire at T°C is measured, the resistance at 20°C is obtained by multiplying the resistance at T°C by the multiplying constant against the value of T°C given in column 2. If the resistance at 20°C is known, the resistance at T°C is obtained by multiplying the resistance at 20°C by reciprocal indicated against T°C given in column 3.

NOTE – 2: The temperature co-efficient of resistance of copper varies slightly from sample to sample according to its conductivity. The figures given above are based on a co-efficient of 0.00381 per °C at 20° C which is an average value for copper of 97% conductivity. The error in using this for copper in the range of conductivity of 96% to 98% will not exceed 0.06%.

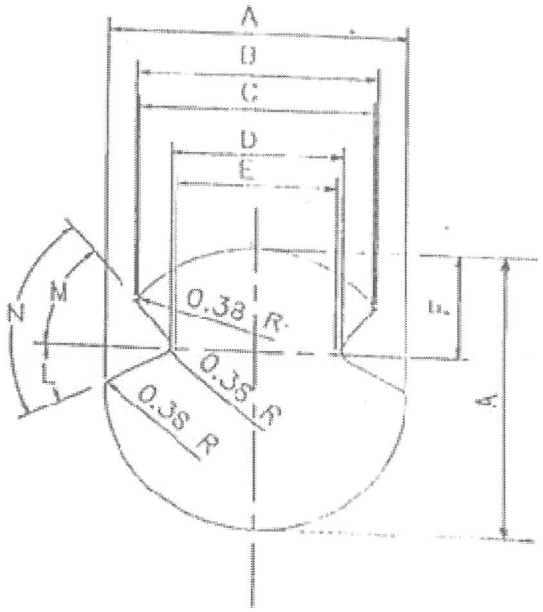
13.0 SCHEDULE OF GUARANTED TECHNICAL PARTICULARS

The Schedule of guaranteed technical particulars (SOGP) for Hard Drawn Grooved Silver Bearing Copper Contact Wire for overhead electric traction drawn out of CCSBC rods.

S.N.	Item description	Unit of measurement	Value as per RDSO's specification	Offered value by tenderer
1	Chemical composition (a) CCSBC Rod & Contact Wire i) Cu ii) Ag iii) Bi iv) Oxygen v) Other elements	%/ppm % % ppm ppm %	 Remaining 0.08 to 0.12 <5 400 max 0.03	
2	Maximum resistivity of CCSBC rod at 20°C	ohm mm²/mm	0.017241	
3	Minimum tensile strength of CCSBC rod	kgf/mm²	20.4	
4	Minimum elongation on gauge length of 250mm	%	42	
5	Min. & max. dia of CCSBC rod for manufacturing of 107 mm² HDGSBC Contact Wire.	mm	19.1 to 21.5	
6	Grain size micro structure of CCSBC rod.	ACTM	Finer than ASTM-5	
7	Standard weight/ km of 107 sq.mm HDGSBC Contact Wire	Kg	951.2 ±3.0%	
8	Resistance /km of 107 mm² HDGSBC Contact Wire at 20°C	Ohm	0.171 (max.)	
9	Minimum tensile strength of 107 mm² HDGSBC Contact Wire	Kgf/mm²	36.5	
10	Minimum elongation of HDGSBC Contact Wire in 200 mm	%	3	
11	Min. conventional limit of elasticity (theoretical value for information only)	Kgf/mm²	31.0	
12	Min. No. of bends of 107 mm² HDGSBC Contact wire to withstand with	Nos	7	

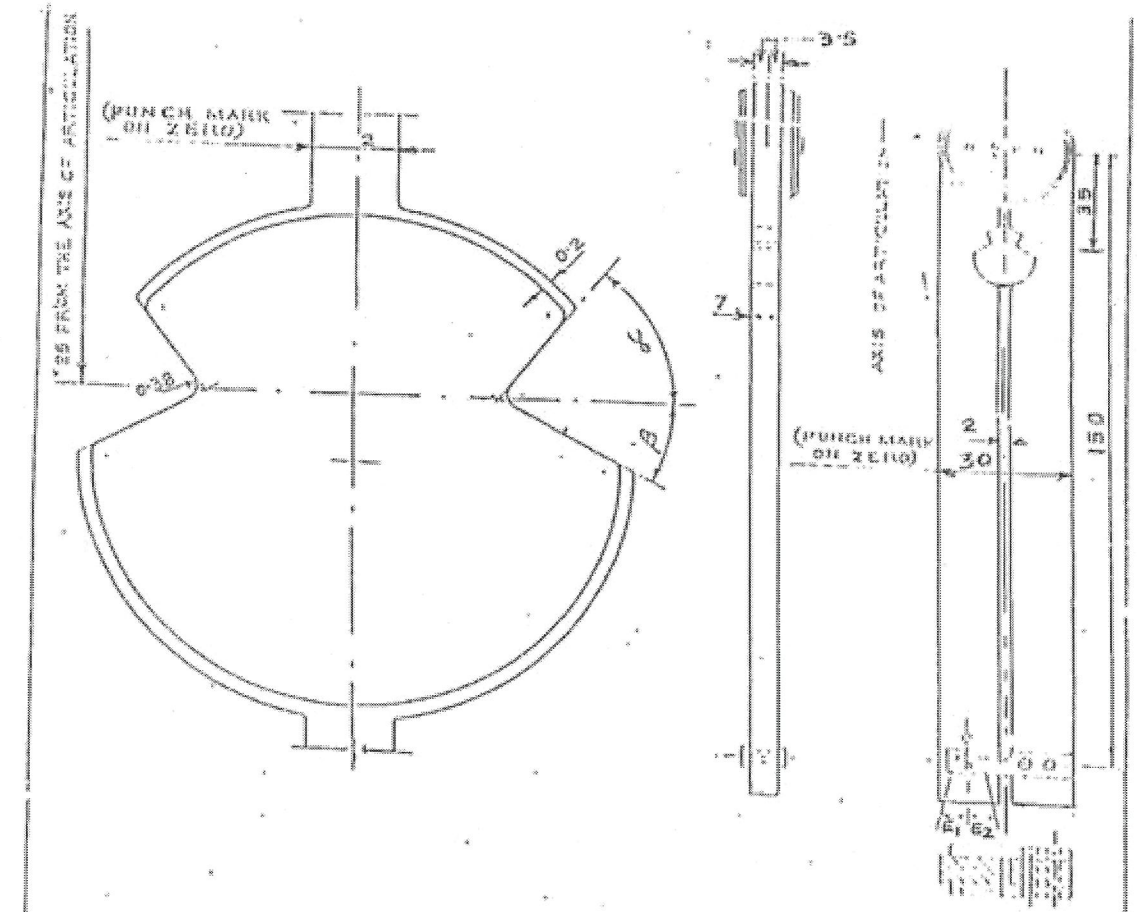
13	Minimum hardness of 107 mm^2 HDGSBC Contact Wire	BHN	107	
14	Grain size of micro-structured 107 mm^2 Contact Wire	ASTM	Finer than ASTM-7	
15	Diameter of 107 mm^2 HDGSBC Contact Wire:	mm	12.24±0.16	
16	Thickness of 107 mm^2 HDGSBC Contact Wire at groove.	mm	6.92±0.15	
17	Angle of groove of 107 mm^2 HDGSBC Contact Wire	Degree	78+2 -0	

14.0 All the provisions contained in RDSO's ISO procedure laid down in document no. QO-D-8.1-11 dated 18.03.2025 or latest (Title "Vendor-change in approved status") and subsequent versions/amendments thereof, shall be binding and applicable on the successful vendor/ vendors in the contracts floated by Railways to maintain quality of the products supplied to Railways.



CROSS-SECTION OF CONTACT WIRE (mm^2)	DIMENSION (mm)						DIMENSION IN DEGREES		
	A	B	C	D	E	F	L	M	N
107	12.24±0.18	–	–	8.92±0.18	8.50	4.43	27^{+1}_{-0}	51^{+1}_{-0}	78^{+2}_{-0}

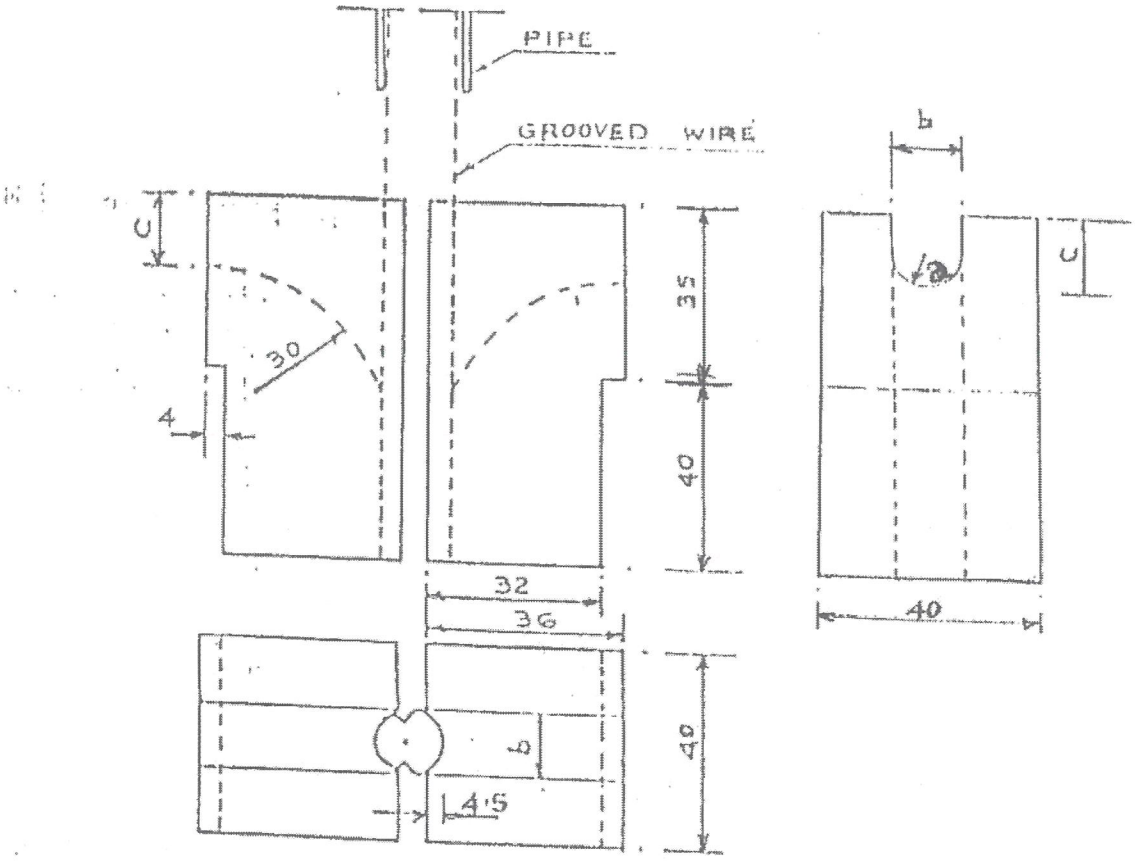
FIG. 1 CONFIGURATION OF CONTACT WIRE



SIZE OF WIRE (mm²)	VALUE OF α (DEGREE)	VALUE OF β (DEGREE)	VALUE IN	
			E1 (mm)	E2 (mm)
107	51	27	0·9	0·9

NOTE :- THE TOLERANCE ON THE MEASUREMENT OF ANGLES IS ± 5 MINUTES.

FIG. 2 SPECIAL CALIPER FOR CHECKING CONTACT WIRE



NOTE:-
ALL DIMENSIONS ARE IN mm

SIZE OF WIRE (mm^2)	a (mm)	b (mm)	c (mm)
107	6·5	13	15

FIG. 3 JAWS FOR BENDING TESTS

ANNEXURE-1

Trial Scheme:

The period of trial will be 4 months from the date of installation of item. The modalities for Field Trial of Silver Bearing Grooved Copper Contact Wire are as below:

1. Wire will be installed in any section including pollution zone and area of higher environmental temperature.
2. Wire will be installed in ML (mainline), Loop line, Sidings & Yards.
3. Suitable measures should be taken for faster failure restoration.
4. Performance of contact wire should be monitored. Performance report (format attached) should be submitted to RDSO. Performance analysis should comprise:
    a) Signs of parting of contact wire with probable reasons of such failure.
    b) Sign of kinks formation.
    c) Sign of sparking during current collection.
    d) Sign of slippage of contact wire from end clamp.
    e) Excessive sagging or hogging of contact wire.
    f) Measurement of **expansion/contraction** of Contact wire by measuring the X-Y value of ATD and compensating plate tilting with temperature, tension length and erection values.
    g) Sign of Abnormal sulphation/corrosion, hitting marks etc.
    h) Sign of melting/overheating should also be checked.
5. Precautions shall be taken that failure do not occur due to wrong erection/poor maintenance practice for correct performance analysis of Cu-Ag contact wire.

Timelines

- Field trial period – 4 months from date of Installation.
- Submission of Field Trial Report by Zonal Railway to RDSO(TI)–1 month from completion of field trial.

Format of Field Trial

Division and Section		
Name of manufacturer and Year of Manufacturing		
Date of Erection		
Tension		
Height & Stagger of Contact wire	Location	Observed Value
Diameter at the time of erection at known hardspots	Location	Observed Value
Date of Checking		
Diameter at the time of Checking at known hardspots	Location	Observed Value
Total Number of panto passed		
Tension length/Chainage (in m)		
Location of RE/ATD		
X,Y value at the time of Erection	Location	Observed Value
X,Y value at the time of checking	Location	Observed Value
No. of location where sign of melting/overheating observed	Location	Reason of melting/overheating
Sign of abnormal sulphation/corrosion		
Sign of melting/overheating		
Sign of kinks formation.		
Sign of sparking during current collection.		
Sign of slippage of contact wire from end clamp.		