

**SUPPLY OF 9.9 KM OF 11kV ALUMINIUM CONDUCTOR STEEL REINFORCED
RABBIT CONDUCTOR**

AT

**1 X 800 MW SUPER CRITICAL EXPANSION UNIT, DEEN BANDHU CHOTU RAM TPP YAMUNA
NAGAR, HARAYANA**

**VOLUME – I
CONSISTING OF:**

- **Volume-IA: Technical Conditions of Contract,**



Bharat Heavy Electricals Limited
(A Govt. Of India Undertaking)
Power Sector – Northren Region,
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TECHNICAL CONDITIONS OF CONTRACT (TCC)

BHARAT HEAVY ELECTRICALS LIMITED



TECHNICAL CONDITIONS OF CONTRACT (TCC)

Scope of Work

1.0 SCOPE OF WORK

This specification covers design, engineering, manufacturing, testing, inspection before dispatch, packing, forwarding, transportation, insurance during transit, delivery to site/ stores for Aluminium Conductor Steel Reinforced (ACSR) RABBIT Conductor for 11kV Over-head line Distribution system.

2.01 MATERIAL:

- a. The material shall be of best quality and workmanship. The stranded steel reinforced conductors shall be manufactured from hard-drawn Aluminium wires and galvanized steel wires, which have the mechanical and electrical properties specified in Technical Specification.
- b. The coating of the galvanized steel wires shall be applied by the hot process or electrolysis process in accordance with or latest amendment thereof. The wires shall be smooth and free from all imperfections such as soils and splits.

2.02 SIZE AND PROPERTIES:

The sizes of Aluminium Conductor Steel Reinforced " conductors shall be as given in Technical Specification which also indicates the values of resistance and strengths etc. Aluminium size 6/3.35 mm (50 mm² nominal Aluminium area,) 1/3.35 mm steel wire equivalent to Conductor .

2.03 TOLERANCES:

The following tolerance shall be permitted:

- a. Tolerance on nominal diameter of aluminium wires: $\pm 1\%$ (one) percent.
- b. Tolerance on nominal diameter of galvanized steel wires: $\pm 2\%$ (two) percent.

2.04 MODULUS OF ELASTICITY & CO-EFFICIENT OF LINEAR EXPANSION:

The values of the final modulus of elasticity and Co-efficient of linear expansion for ACSR shall be as given hereunder:

No. of Wires (Al./Steel)	Final Modulus of Elasticity GN/m ² (Practical)	Co-efficient of linear expansion/°C
ACSR 6/1	79	19.1×10^{-6}

2.05 JOINTS IN WIRES:

There shall be no joints of any kind in any wire of a stranded conductor, accept those made in base rod or wire before final drawing.

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2.06 STRANDING:

- a. The wires used in manufacturing of stranded conductors shall satisfy all requirements of IS: 398/ 1996 (Part-I & II) before stranding. For ACSR, the lay ratio of the different layers shall be within the limit given under clause No. 2.08 below.
- b. In all constructions, the successive layers shall have opposite directions of lay and the outer most layers being right handed. The wires in each layer shall be evenly and closely stranded.
- c. In conductor having multiple layers of Aluminium wires, the lay ratio of any Aluminium layers shall be not greater than the lay ratio of the Aluminium layer immediately beneath it.

2.07 LAY RATIO:

The lay ratio (Ratio of the aerial length of a complete turn of the helix formed by an individual wire in a stranded conductor to the external diameter of the helix) shall be within the limits given below:

No. of Wires		Lay ratio for Steel core		Lay ratio for outside layer		Aluminium Wire inner most layer	
Al.	Steel	Max.	Min.	Max.	Min.	Max.	Min.
6	1	-	-	14	10	-	-

2.08 GROSS WEIGHT:

- a. The gross weight of each wooden drum containing conductor of all sizes shall not exceed 500 kg with a tolerance limit of $\pm 10\%$.
- b. Drums containing conductor having gross weight above 550 kg will not be accepted in any case. Also more than two lengths in one conductor drum will not be accepted.

2.09 STANDARD LENGTH:

Standard length of ACSR RABBIT should be 1(one) km per Drum. Longer lengths are also acceptable provided they are within gross weight limit. The conductor supplied shall be in standard lengths of not less than 95% of the total quantity.

2.10 TESTS:

- a. Selection of test sample shall be done as per relevant IS.
- b. The conductors shall be subjected to routine and acceptance test in accordance with the relevant IS with latest amendments if any.

2.11 REJECTION AND RE-TESTING:

- a. As per relevant IS with latest amendment if any.
- b. BHEL also reserves the right to check length of the conductor at Store/ Site.

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- c. The entire cost of testing for acceptance & routine tests and checking of length etc. shall be borne by the supplier.

2.12 INSPECTION:

- a. The purchaser's representative shall be entitled to have access to the works and all places of manufacturer. The said representative shall have full facilities for un-restricted inspection of supplier's works, raw materials, manufacture of conductor and conducting necessary tests. The supplier shall keep the purchaser informed well in advance of the time of starting and process of manufacture of conductor in its various stages. The acceptance of any quantity of materials shall in no way relieve the supplier of his responsibility for meeting all requirements of the specification and shall not prevent subsequent rejection, if such materials are later found to be defective. The supplier shall give an 07 (seven) days' notice to BHEL for the readiness of material for inspection through BHEL online inspection system. The details shall be shared with the successful bidder.
- b. No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested, unless the inspection is waived off, by the purchaser in writing.

2.13 PACKING & MARKING

PACKING

- a. The conductor shall be wound on non-returnable drum strong enough and provided within lagging of adequate strength, constructed to protect the conductor against all displacement during transit, storage and subsequent handling and stringing operation in the field. The drum shall conform to IS: 1778: 1980 as amended up to date and the dimensions shall be as per drum under column 9 of Table- 2 of the IS.
- b. The drum shall be suitable for wheel mounting.
- c. The general construction of drum shall be as shown in IS: 1778: 1980. However, the drum shall be suitable for letting off the conductor under controlled tension of the order of 300 kg minimum.
- d. After application of bituminized and plastic paper protective lagging or circumferential batten of minimum 50 mm thickness shall be provided suitably, in order to protect conductor from damage during transit in the event of breakage/detachment of the external protective lagging. The thickness of the external protective lagging or circumferential batten shall be sufficient to nail across grains as far as possible to the flange edges with at least one nail per end. The length of the nails shall be not less than twice the thickness of the battens. The nails shall not protrude above general surface and shall not expose sharp edges or allow the battens to be released due to correction.

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- e. Outside the protective lagging, there shall be minimum two binders consisting of hoop iron or galvanized steel wire. Each protective lagging shall have recesses to accommodate hoop binders.
- f. The conductor ends shall be properly sealed and secured with the hoop of “B” nails or bolts on the side of one of the flanges to avoid loosening of the conductor layers during transit and handling.

MARKING:

Each drum shall have the following information stenciled on it in indelible ink along with other essential details:

- a. Purchase Order number
- b. Name and address of the consignee
- c. Manufacturer's name or trade mark
- d. Drum number
- e. Code name and size of the conductor
- f. Length of the conductor
- g. Gross weight of the drum
- h. Weight of empty drum with protective lagging
- i. Net weight of the conductor
- j. Arrow marking for unwinding
- k. Position of the conductor end
- l. Lot number
- m. Before dispatch, property identification mark 'BHEL' shall be engraved in each drum.

CONSTRUCTION OF DRUMS:

- a. **FLANGES:**
 - i. The flanges shall be of two ply construction with such ply at right angle of the other and nailed together. The nails shall be driven from the inside face of flanges, punched and then cleaned on the outer face. There shall be at least 3 nail per plank of ply with maximum nail spacing 70-75 mm.
 - ii. There will be a slot in the flange to receive the inner end of the conductor; the entrance shall be in line with the periphery of the barrel.
- b. All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative treatment shall be applied to the entire drum with preservative of such a quality which is not harmful to the conductor.
- c. Spindle hole shall be provided at the center of the middle planks of the plies and spindle planets with 100 mm diameter holes shall be fitted on either side of both the flanges.

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d. **DRUM AND SUPPORTS:**

The end supports shall be securely fixed by nailing and may be disc or segmental type. The middle barrel support of the two ply construction of disc type with a 100 mm diameter concentric with the holes in flanges shall be provided at the centers of the barrel supports.

e. **DRUM:**

The wooden batons used for making the barrel of the conductor shall be segmental type. These shall be nailed to the barrel supports with at least two nails. The batons shall be closely butted and shall provide a round barrel with smooth surface. The edges of the batons shall be rounded or compared to avoid damage to the conductor.

f. **DRUM STUDS:**

Barrel studs shall be used for the construction of drum. The flanges shall be holed and the barrel supports slotted to receive them. The barrel studs shall be threaded over a length on either end sufficient to accommodate washers, spindle plates and nuts for fixing at the required spacing.

g. **IRON COMPONENTS:**

Normally, the nuts on the studs shall stand pound of the flange. All the nails used on the inner surface of the flanges and the drum barrel shall be counter sunk at least 5 mm. deep. The ends of barrel shall generally be flushed with the top of the nuts.

PROTECTIVE ARRANGEMENT:

- The inner side of the flanges and drum barrel surfaces shall be painted with bitumen based paint.
- Before reeling, cardboard of double corrugated or thick bituminized water proof bamboo paper shall be secured to the drum barrel and inside the flanges of drum by means of suitable adhesive materials. These protective wrappings and the adhesive material used shall be of a quality which is not harmful to the conductor.
- After reeling the conductor, the exposed surface of the outer layer of the conductor shall be wrapped with water proof, thick, bituminized bamboo paper and also with thick plastic sheet to prevent the conductor from dirt, grit and damage during transport and handling.

2.14 WEIGHTS OF ALUMINIUM AND STEEL PER KM LENGTH OF CONDUCTOR IS GIVEN BELOW:

		Weight in kg/km		
Item No.	Description of materials	Aluminium	Steel	Total
1	ACSR:RABBIT	144.80	68.80	214

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2.15 SIZES & PROPERTIES OF ALUMINIUM CONDUCTOR STEEL REINFORCED:

Nominal Al. Area (mm ²)	Stranding and wire diameter (mm)		Sectional Area of Al. (mm ²)	Total Sectional area (mm ²)	App. overall dia. (mm)	App. mass (kg/km)	Calculated resistance at 20°C Max. (Ω/km)	App. Calculated breaking Load (kN)
	Al. (Nos. of wires/dia.)	Steel (Nos. of wires/dia.)						
50	6/3.35	1/3.35	52.88	61.70	10.05	214	0.5524	18.25

2.16 SIZES & PROPERTIES OF STEEL WIRES USED IN THE CONSTRUCTION OF ALUMINIUM CONDUCTOR STEEL REINFORCED:

Diameter (mm)			Cross sectional area of nominal dia. of wire (mm ²)	Mass (kg/km)	Breaking Load (Min.) (in kN)	
Nominal	Min.	Max.			Before Stranding	After Stranding
3.35	3.28	3.42	8.814	68.75	11.58	11

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STANDARDS APPLICABLE

2.0 LIST OF STANDARDS APPLICABLE

S. No.	List of IS applicable	Description
1	IS: 2121: 1981 (Part-I)	Conductors and earth wire accessories for overhead power lines Armour rods, binding wires and tapes for conductors
2	IS: 2121: 1981 (Part-II)	Conductors and earth wire accessories for overhead power lines Mid span joints and repair sleeves for conductors
3	IS: 2121: 1991 (Part-II)	Conductors and earth wire accessories for overhead power lines Non tension joints
4	IS: 2121: 1992 (Part-II)	Conductors and earth wire accessories for overhead power lines Accessories for earth wire
5	IS: 2629: 1985	Recommended Practice for Hot-Dip Galvanizing of Iron and Steel
6	IS: 2633: 1986	Methods for testing uniformity of coating of zinc coated articles
7	IS: 398: 1976 (Part-III)	Aluminium conductors for overhead transmission purposes: Part 3 Aluminium conductors, aluminized steel reinforced
8	IS: 398: 1994 (Part-IV)	Aluminium conductors for overhead transmission purposes: Part 4 Aluminium alloy stranded conductors (aluminium magnesium silicon type)
9	IS: 398: 1996 (Part-I)	Aluminium conductors for overhead transmission purposes: Part 1 Aluminium stranded conductors
10	IS: 398: 1996 (Part-II)	Aluminium conductors for overhead transmission purposes: Part 2 Aluminium conductors, galvanized steel reinforced
11	IS: 5613: 1985 (Part-I) Sec-I	Code of Practice for Design, Installation and Maintenance of Overhead Power Lines - Part 1 Lines Up to and Including 11 kV - Section 1 Design
12	IS: 800: 2007	General Construction in Steel - Code of Practice
13	IS: 4826: 1979	Specification for Hot-Dipped Galvanized Coatings on Round Steel Wires
14	IS: 1778: 1980	Reels and drums for bare conductors (superseding IS:2889)

NOTE: This list of standards applicable is indicative in nature and cannot be taken as a comprehensive list. All the other standards which are applicable as per the statutory rules and regulations are applicable to this scope.

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TECHNICAL SPECIFICATION

3.0 TECHNICAL SPECIFICATION

S. No.	Description	Value	UoM
Aluminium			
1	Number of wires	6	nos.
2	Nominal aluminium wire diameter	3.35	mm
3	Nominal aluminium area	52.88	mm ²
4	Weight of all aluminium wires combined	144.80	kg/km
Steel			
1	Number of wires	1	no
2	Minimum wire diameter	3.28	mm
3	Nominal wire diameter	3.35	mm
4	Maximum wire diameter	3.42	mm
5	Approximate weight of single wire	68.75	kg/km
6	Cross sectional area of nominal diameter of wire	8.814	mm ²
7	Minimum Breaking Load before stranding	11.58	kN
8	Minimum Breaking Load after stranding	11.00	kN
ACSR Conductor			
1	Calculated sectional area	61.70	mm ²
2	Approximate overall diameter	10.05	mm
3	Total weight	214	kg/km
4	Calculated electrical resistance at 20°C	0.5524	Ω/km
5	Approximate calculated Breaking Load	18.25	kN
6	Co-efficient of Linear Expansion/°C	19.1 x 10 ⁻⁶	

LAY RATIO

No. of Wires		Lay ratio for Steel core		Lay ratio for outside layer		Aluminium Wire inner most layer	
Al.	Steel	Max.	Min.	Max.	Min.	Max.	Min.
6	1	-	-	14	10	-	-