CHAPTER 43: TECHNICAL SPECIFICATION ACSR CONDUCTORS AND ACCESSORIES FOR CONDUCTORS

43.1.0 SCOPE

43.1.1 This Section of the Specification covers the technical parameters for design, manufacture, testing at manufacturer's works and supply of Conductor, and accessories for Power Conductors.

43.2.0 POWER CONDUCTOR

43.2.1 TYPE OF CONDUCTOR

The ACSR Conductor shall generally conform to IEC: 61089/ IS: 398 (relevant part)/ ASTM:B-232 except where otherwise specified herein.

Conductor conforming to a standard other than the Indian Standard specification then an English version of the Standard in addition to the original standard if written in a language other than English should be submitted indicating clearly the advantage, if any, that would be obtained by the Employer for adopting this standard instead of the said India Standard.

43.2.2 STANDARD TECHNICAL PARTICULARS

All ACSR Conductor shall satisfy all the parameters as furnished in Technical Data Sheet.

All the aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

The steel strands shall be hot dip galvanised and shall have a minimum zinc coating.

43.2.3 MATERIAL

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity and copper content as per the values indicated in the STP. They shall have the same properties and characteristics as prescribed in IEC: 60889.

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC : 60888.

The zinc used for galvanizing shall be electrolytic High Grade Zinc of purity. It shall conform to and satisfy all the requirements of IS:209.

43.2.4 JOINTS IN WIRE

In the Aluminium wires no joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However, joints are permitted in the inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand as per STP.

In the Steel wires there shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

43.2.5 STRANDING

The wires used in construction of a ACSR conductor shall, before and after stranding, satisfy all requirements as per IS 398.

The lay ratio of the different layers shall be within the limits as per the said Standard. In all constructions, the successive layers shall have opposite directions of lay, the outer most layer being right-handed. The wires in each layer shall be evenly and closely stranded. In aluminium alloy stranded conductors having multiple layers of wires, the lay ratio of any layer shall not be greater than the lay ratio of the layer immediately beneath it.

43.2.6 TYPE/ROUTINE/ACCEPTANCE TESTS

Type Test:

The following tests shall be conducted on a sample/samples of the conductor(s) required under the package from each stranding machine from which the conductor is to be manufactured & supplied:

a) DC resistance test on stranded conductor

b) UTS test on stranded conductor

c) Corona extinction voltage test (dry)

d) Radio interference voltage test (dry)

Acceptance Test:

a) Visual and dimensional check on drum

b) Visual check for joints, scratches etc. and length measurement of conductor by rewinding

c) Measurement of diameters of individual Steel and Aluminium strands

Galvanizing test on steel strands

Check for lay Ratios of various layers

Torsion and Elongation tests on steel strands

Breaking load test on steel and Aluminium strands

Wrap test on Steel & Aluminium strands

DC resistance test on Aluminium strands

Procedure qualification test on welded joint of Aluminium strands

Drum strength test (steel drum)

Barrel Batten strength test (wooden drum)

The above acceptance tests shall be repeated on one conductor sample taken from site in presence of AEGCL's representative for each 500km progressive supply. The tests shall be carried out by the supplier at his cost at its own premises or any other tests centre having required facilities. The sample shall be selected by AEGCL's site representative and the tests shall be witnessed by AEGCL's representative.

Routine Tests:

Check to ensure that the joints are as per Specification

Check that there are no cuts, fins etc. on the strands

Check that drums are as per Specification

All acceptance test as mentioned above to be carried out on aluminium and steel strands of 20% of drums

Tests During manufacture:

Chemical Analysis of Zinc used for galvanising

Chemical Analysis of Aluminium used for making Aluminium Strands

Chemical Analysis of Steel used for making Steel Strands.

43.2.7 REJECTION AND RETESTS

Stipulations made in the IS 398 (Part-IV) on Rejection and Retests shall be followed.

43.2.8 PACKING

All conductor reels shall conform to latest edition of IS : 1778 and be of dimensions approved by the Employer and made of seasoned wood sufficiently strong to ensure arrival at site, intact withstanding normal handling and hazards inland and ocean transit. The reels shall be of such size as to provide at least 12.5 mm clearance at all points from the conductor to the inner surface of the laggings.

All reels shall have two coats of aluminium paint on both inside and outside surface and shall be fitted with malleable iron Hub-bushings.

All reels shall be a layer of waterproof paper around the hub under the cable and another layer over the outermost layer of the cable, that is next to the lagging.

The reels shall be properly reinforced with galvanized steel wires or iron straps over the lagging in two places in an approved manner.

The wooden drums shall preferably be given protective coating of a reliable organic wood preservative before painting with Aluminium paint and the laggings shall also be given a similar treatment before being fixed on the drum. There shall be one standard length of Conductor in each drum.

43.2.9 TECHINCAL DATA SHEET FOR CONDUCTOR

ACSR MOOSE

Sl. No	DESCRIPTION	PARTICULARS
I	II	III
1	Type of Conductor	Aluminium Conductor Steel Reinforced (ACSR)
2	No of Strand x size	54 x 3.53 mm
3	Conductor over all diameter	31.77 mm
4	Total sectional area	597 mm2
5	Approx. weight	2004 kg/km
6	Minimum UTS	161.2 kN
7	Modulus of Elasticity (Final)	0.7034 kg/cm2
8	Coefficient of linear expansion	19.3 x 10-6 /0C
9	Calculated maximum resistance/Km of Conductor at 20°C	0.05552 ohms/km
10	Layer and No of Wire	
	Steel core	1
	1st steel layer	6
	1st Aluminium layer	12
	2nd Aluminium layer	18
	3rd Aluminium layer	24
11	Aluminum strands after stranding	
(a)	Diameter	
	Nominal	3.53
	Maximum	3.55
	Minimum	3.51
(b)	Minimum breaking load of strand	
	Before stranding	1.57
	After stranding	1.49
12	Steel strand after stranding	
(a)	Diameter	
	Nominal	3.53
	Maximum	3.59
	Minimum	3.47
(b)	Minimum breaking load of strand	
	Before stranding	12.86
	After stranding	12.22
13	DC resistance of the conductor at 20°C	0.05552
14	Direction of lay of outer layer	Right Hand
15	Linear mass of the conductor	
	Standard	2004
	Minimum	1969

Sl. No	DESCRIPTION	PARTICULARS
	Maximum	2040

ACSR Zebra

1.	Code Name	ZEBRA	
2.	Equivalent area of Aluminium (sq.mm.)	418.6	
3.	Wire Strand (Al./Steel)	54/7	
4.	Nominal diameter of strand (Al./Steel)(mm.)	3.18/3.18	
5.	Weight (Kg/Km)	1621	
6.	Co-eff. of linear expansion per oC	19.30x10 -6	
7.	Ultimate Tensile Strength (kgf.)	13316	
8.	Maxm. DC resistance at 20oC (■/Km) (Calculated from maxm. Value of resistivity and min. Cross-sectional area)	0.0680	
9.	Zinc coating of steel :		
	i)	No. of one minute dip	3
	ii)	Min. wt. of zinc.(gm.m2)	260
	iii)	Purity of zinc (%)	99.95
10.	Diameter of conductor (mm)	28.62	
11.	Standard Length (meter)	1100	

ACSR Panther

Sl. No.	DESCRIPTION	ACSR 'PANTHER'
1	Code name	PANTHER
2	Number of strands & size	Al: 30/ 3.00 mm St: 7/ 3.00 mm
3	Overall diameter	21.00 mm
4	Breaking load	130.32 kN
5	Weight of conductor	974 kg / km
6	Co-efficient of linear expansion	19.35x10-6 /0C
7	Number of strand	
	Steel centre	1
	1st Steel Layer	6
	1st Aluminium Layer	12
	2nd Aluminium Layer	18
	3rd Aluminium Layer	-
8	Sectional area of Aluminium	212.10 mm2
9	Total sectional area	261.50 mm2
10	Calculated d.c. resistance at 200 C	0.1400 ohm/km
11	Ultimate tensile strength	89.67

43.3.0 GROUND WIRES

Optical ground wire (OPGW) shall be used as per chapter 47.

43.4 FITTINGS AND ACCESSORIES FOR CONDUCTORS

The accessories for conductors shall conform to IS: 2121 and 2486 (Latest version) in all respects

Mid Span Compression Joint

• Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistivity less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part there of at a load less than 95% of the ultimate tensile strength of the conductor.

• The joint shall be made of steel and aluminium sleeves for jointing the steel core and aluminium wires respectively. The steel sleeve should not crack or fail during compression. The steel sleeve shall be hot dip galvanised. The aluminium sleeve shall have aluminium of purity not less than 99.5%. The dimensions and dimensional tolerances of mid span compression joint shall be as per Standard Technical Particulars.

T-Connector

T-Connector of compression type shall be used for jumper connection at transposition tower. It shall be manufactured out of 99.5% pure aluminium and shall be strong enough to withstand normal working loads. The T-connector shall have a resistivity across jumper less than 75% resistivity of equivalent length of conductor. The T-connector shall not permit slipping off, damage to or failure of complete conductor. The welded portions shall be designed for 30 kN axial tensile load. Leg sleeve of T-connector should be kept at an angle of 15 deg. from vertical and horizontal plane of the conductor in order to minimise jumper pull at the welded portion. The dimensions and dimensional tolerances of T-connector shall be as per Standard Technical Particulars.

Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions and dimensional tolerances of repair sleeve shall be as per Standard Technical Particulars.

Vibration Damper (Applicable for 400kV D/C (Twin Moose), 220kV & 132kV Lines)

• Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified Aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s shall be used at suspension and tension points on each conductor in each span along with bundle spacers to damp out Aeolian vibration as mentioned hereinafter.

• Alternate damping systems or “Dogbone” dampers offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

• One damper minimum on each side per Conductor/Sub-conductor for suspension points and two dampers minimum on each side per conductor/sub-conductor for tension points shall be used for ruling design span.

• The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chafing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

• The damper mass shall be made of hot dip galvanised mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blowholes etc. The surface of the damper masses shall be smooth.

• The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

• Preformed type armoured rods shall be provided for the conductors at all suspension points. Vibration dampers of stock bridge type shall be used for power conductors.

Bundle Spacer (for Twin Bundle Conductor) & Rigid Spacer (for Hexa/Quad / Triple/ Twin Bundle Conductor)

• Armour grip bundle spacers shall be used to maintain the spacing of 450 mm (for 400 kV voltage level line twin bundle conductor) between the two sub-conductors of each bundle under all normal working conditions.

• Spacers offering equivalent or better performance shall also be accepted provided offer meets the qualifying requirements stipulated in the Specification.

• The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span shall be kept more than 30 km/hr and to avoid clashing of sub conductors. The placement shall ensure bundle stability under all operating conditions.

• Spacer shall restore normal spacing of the sub conductors after displacement by wind, electromagnetic and the electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation damage either to conductor or to the assembly itself. They shall have uniform grip on the conductor

• For spacer requiring retaining rods, the retaining rods shall be designed for the specified conductor size. The preformed rods shall be made of high strength, special aluminium alloy of type 6061/65032 and shall have minimum tensile strength of 35 kg/sq.mm. The ends of retaining rods should be ball ended. The rods shall be heat- treated to achieve specified mechanical properties and give proper resilience and retain the same during service.

• Four number of rods shall be applied on each clamp to hold the clamp in position. The minimum diameter of the rods shall be 7.87 + 0.1 mm and the length of the rods shall not be less than 1100 mm.

• Where elastomer surfaced clamp grooves are used, the elastomer shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061/65032. The insert shall be duly heat treated and aged to retain its consistent characteristics during service.

• Any nut used shall be locked in an approved manner to prevent vibration loosening. The ends of bolts and nuts shall be properly rounded for specified corona performance or suitably shielded.

• Clamp with cap shall be designed to prevent its cap from slipping out of position when being tightened.

• For the spacer involving bolted clamps, the manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.

• Universal type bolted clamps, covering a range of conductor sizes, will not be permitted.

• The spacer shall be suitably designed to avoid distortion or damage to the conductor or to themselves during service.

• Rigid spacers shall be acceptable only for jumpers.

• The spacer tube shall be made of aluminium alloy of type 6061/65032 or 6063/63400. If fasteners of ferrous material are used, they shall conform to and be galvanised conforming to relevant Indian Standards. The spacer involving ferrous fasteners shall not have magnetic power loss more than that stipulated in the Standard Technical Particulars.

• Elastomer, if used, shall be resistant to the effects of temperature up to 95 deg.C, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. It shall have good fatigue characteristics. The physical properties of the elastomer shall be of approved standard.

• The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly in case of spacer having elastomer clamp grooves shall be suitably selected by the manufacturers to ensure satisfactory electrical performance and to avoid deterioration of elastomer under all service conditions.

• The spacer assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.

• The spacer assembly shall be capable of being installed and removed from the energised line by means of hot line technique.

43.5 FITTINGS AND ACCESSORIES FOR GROUND WIRES

Fittings and accessories for OPGW shall be used as per chapter 47.