

BIDDING DOCUMENT FOR

De-stringing of existing Panther Conductor and Restranging and Supply of ACSR Conductor of 132KV Depota-Dhekiajuli TL (Loc No 314 to Loc No 425)



(E-Tender)

VOLUME -2

<https://assamtenders.gov.in>

BID IDENTIFICATION NO: AEGCL/MD/CGM/CAR/Panther/Depota-Dhekiajuli

Fund : AEGCL Own Source

ASSAM ELECTRICITY GRID CORPORATION LIMITED

CONTENTS

Sl. No.	Section	Particulars	Page
1.	SECTION-1	SCOPE AND GENERAL TECHNICAL CONDITIONS	3
2.	SECTION-2	SCOPE AND GENERAL TECHNICAL CONDITION FOR TRANSMISSION LINES	5
3.	SECTION-3	ERECTION OF TRANSMISSION TOWER	17
4.	SECTION-4	TECHNICAL SPECIFICATION ACSR CONDUCTORS AND ACCESSORIES FOR CONDUCTORS	23
5.	SECTION-5	TECHNICAL SPECIFICATION FOR INSULATOR STRING HARDWARE	30
6.	SECTION-6	TECHNICAL SPECIFICATION OF DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS	46

SECTION-1

SCOPE AND GENERAL TECHNICAL CONDITIONS

1.1.0 INTENT OF THE SPECIFICATION

1.1.1 This volume of the specification deals with the general technical information & criteria for design, manufacture, supply & delivery of equipment/material, erection, testing & commissioning and setting to work of construction on "Design, Supply and Install" basis as defined in Volume-1.

1.1.2 The provisions of this section shall supplement all the detailed Technical Specifications and requirements brought out herein. The CONTRACTOR's proposal shall be based on the use of materials complying fully with the requirements specified herein.

1.2.0 SCOPE

1.2.1 The work involves design, engineering, manufacture, assembly, inspection, testing at manufacturer's works before dispatch, packing, supply, including insurance during transit, delivery at site, subsequent storage and erection & commissioning at site of various equipment and materials including associated works and civil foundations for equipment as specified in subsequent Clauses and Sections.

1.2.2 It is not the intent to specify completely herein all details of design and construction of the equipment and accessories. However, the equipment and accessories shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation up to the bidder's guarantees in a manner acceptable to the Purchaser. The Purchaser will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material, which in his judgement is not in full accordance therewith.

1.2.3 The major items of works included in the scope of this specification are listed below: -

- i) Design & supply of all equipment as per this bidding document/BoQ.
- ii) Installation and commissioning services including civil works as specified in BoQ.
- iii) Other associated works as specified in BoQ.

1.2.4 The various items of supply are described very briefly in the schedule of Bid Form, Prices & Other Schedules and annexure. The various items as defined in these schedules shall be read in conjunction with the corresponding section in the technical specifications including amendments and, additions if any.

1.2.5 The bidder is required to fill up the BOQ/price schedule as given in the e-tendering portal.

1.3.0 DESIGN IMPROVEMENTS

1.3.1 The Employer or the Contractor may propose changes in the specification and if the parties agree upon any such changes and the cost implication, the specification shall be modified accordingly.

1.4.0 DESIGN CO-ORDINATION

1.4.1 Wherever, the design is in the scope of Contractor, the Contractor shall be responsible for the selection and design of appropriate material/item to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

1.5.0 DESIGN REVIEW MEETING

1.5.1 The contractor will be called upon to attend design review meetings with the Employer, and the consultants of the Employer during the period of Contract. The contractor shall attend such meetings at his own cost at Assam or at mutually agreed venue as and when required. Such review meeting will be held generally minimum once a

month or the frequency of these meeting shall be mutually agreed between the Employer and the Contractor. Frequency of Design Review Meetings shall depend upon the project requirement to ensure project implementation as per the Master Programme.

1.6.0 PACKING

- 1.6.1 All the materials shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. The CONTRACTOR shall be responsible for any loss or damage during transportation, handling and storage due to improper packing.
 - 1.6.2 The CONTRACTOR shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during transport by air, sea, rail and road.
 - 1.6.3 All packing shall allow for easy removal and checking at site. Wherever necessary, proper arrangement for attaching slings for lifting shall be provided. All packages shall be clearly marked for with signs showing 'up' and 'down' on the sides of boxes, and handling and unpacking instructions as considered necessary. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea.
 - 1.6.4 The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbols, i.e., fragile, handle with care, use no hook etc. wherever applicable.
 - 1.6.5 Each package shall be legibly marked by the-CONTRACTOR at his expenses showing the details such as description and quantity of contents, the name of the consignee and address, the gross and net weights of the package, the name of the CONTRACTOR etc.
-

SECTION-2

SCOPE AND GENERAL TECHNICAL CONDITION FOR TRANSMISSION LINES

A. Nature of work

The work covered by this Specification is for 400 kV and/or 220 kV and/or 132 kV transmission lines as specified herein and in the attached Schedules. The overhead transmission lines will form part of the AEGCL Transmission System.

B. General particulars of the system

The following are the general particulars governing the design and working of the complete system of which the Works will form a part —

1. Electrical energy is generated at interconnected power stations as three-phase current at a frequency of 50 Hz, and transmitted therefrom by means of overhead lines.
2. The system will be in continuous operation during the varying atmospheric and climatic conditions occurring at all seasons as mentioned in the bidding document.

2.1.0 SCOPE-

Construction of 400 KV, 220 KV and 132 KV

As indicated in the Bidding Proposal Sheet & scope of work.

2.2.0 SURVEY (detail & check, estimating of quantities & spotting of towers)

2.2.0.1 General: Preliminary route alignment in respect of the proposed transmission lines has been fixed by the employer subject to alteration of places due to way leave or other unavoidable constraints. The Right of way shall be solved by the contractor and all expenses there of shall be paid by the contractor, which will be reimbursed by AEGCL time to time. However, AEGCL shall render all helps in co- ordination with law and order department for solving the same. Forest clearance if any shall be arranged by AEGCL.

2.2.0.2 Provisional quantities/numbers of different types of towers have been estimated and indicated in the BOQ Schedule given. However final quantities for work shall be as determined by the successful bidder, on completion of the detail survey, preparation of route profile drawing and designing of the different types of towers as elaborated sin the specification and scope of work.

2.2.0.3 The contractor shall undertake detailed survey on the basis of the tentative alignment fixed by the employer. The said preliminary alignment may, however, change in the interest of economy to avoid forest and hazards in work. While surveying the alternative route the following points shall be taken care by the contractor.

- a) The line is as near as possible to the available roads in the area.
- b) The route is straight and short as far as possible.
- c) Good farming areas, religious places, forest, civil and defence installations, aerodromes, public and private premises, ponds, tanks, lakes, gardens, and plantations are avoided as far as practicable. The line is far away from telecommunication lines as reasonably possible. Parallelism with these lines shall be avoided as far as practicable.
- d) Crossing with permanent objects are minimum but where unavoidable preferably at right angles.
- e) Difficult and unsafe approaches are avoided.
- f) The survey shall be conducted along the approved alignment only in accordance with IS: 5613 (Part-II/Section-2), 1985.
- g) For river crossing/ Crossing of Nallas: Taking levels at 20 metre intervals on bank of river and at 40 metre intervals at bed of river so far as to show the true profile of the ground and river bed. The levels may be taken with respect to the nearest existing towers, pile foundation of towers, base or railway/road bridge, road culvert

etc. The levels shall be taken at least 100 m. on either side of the crossing alignment. Both longitudinal and cross sectional shall be drawn preferably to a scale of 1:2000 at horizontal and 1:200 vertical.

- h) After completing the detailed survey, the contractor shall submit the final profile and tower schedule for final approval of the employer. The final profile and tower schedule shall incorporate position of all type of towers. To facilitate checking of the alignment, suitable reference marks shall be provided. For this purpose, concrete pillars of suitable sizes shall be planted at all angle locations and suitable wooden/iron pegs shall be driven firmly at the intermediate points. The contractor shall quote his rate covering these involved jobs.
- i) Only approved sag template shall be used for tower spotting and the final profiles. However preliminary survey has been done by AEGCL and any further survey required shall be done by the contractor.

2.2.0.4 PROFILE PLOTTING AND TOWER SPOTTING

2.2.0.4.1 The profile shall be plotted and prepared to the scale 1 in 2,000 for horizontal and 1 in 200 for vertical on squared (mm) paper. If somewhere the difference in levels be too high, the chart may be broken up according to the requirements. A 10 mm overlap shall be shown on each following sheet. The chart shall progress from left to right for convenience in handling. The sheet size may be conveniently chosen.

2.2.0.4.2 With the help of sag template, final tower location shall be marked on the profiles and while locating the tower on survey chart, the following shall be kept in mind:

The contractor shall also submit the land schedule on revenue (if required) maps indicating alignment therein duly authenticated by Revenue Inspector & Tahasildar, enumeration of trees with the help of Forest officer and other prominent features required for alignment of the proposed 132 KV line. Final route to be plotted on 1:50000 topo sheet for approval. Detail GIS (Geographical Information System) of towers to be included.

2.2.0.4.3 The number of consecutive spans between the section points shall not exceed 10 in case of straight run on a more or less plain stretch.

2.2.0.4.4 Individual span shall be as near as to the normal design ruling span.

2.2.0.4.5 In different crossing the contractor shall take into consideration the prevailing regulations of the respective authorities before finalizing type and location of the towers. While carrying out survey work, the contractor has to collect all relevant data, prepare and submit drawings in requisite number for obtaining clearance from the PTCC, road, aviation, railways, river and forest authorities.

2.2.0.4.6 The contractor shall remain fully responsible for the exact alignment of the line. If after erection, any tower is found to be out of alignment, the same shall have to be dismantled and re- erected after correction by the contractor at his own cost, risk and responsibility, including installation of fresh foundation, if belt necessary by the employer.

2.2.0.4.7 After peg marking of the angle tower or tension towers, the contractor shall obtain approval from the employer and thereafter pegging of suspension type tower shall be done by the contractor and pegging of all the four legs of each type of towers at all the locations shall be done.

2.2.0.5 SCHEDULE OF MATERIALS

When the survey is approved, the contractor shall submit to the employer a complete detail schedule of all materials to be used in the line. Size and length of conductor etc. are also to be given in the list. This schedule is very essential for finalizing the quantities of all line material. The contractor shall furnish the same.

2.2.1 DETAILED SURVEY/CHECK SURVEY:

The contractor will have to carry out detailed survey of the line for which route map indicating the proposed alignment of the transmission line will be handed over by the Employer. If the detailed survey is already conducted by the Employer for some portion of the line, the profiles for such portion will be handed over to the Contractor for carrying out check survey. It may please be noted that no check survey is required to be conducted for the portion of line for which detail survey is conducted by the contractor himself.

A. Detailed Survey:-

(a) At the starting point of the commencement of route survey, an angle iron spike 65 x 65 x 1000mm shall be driven firmly into the ground to show only 150mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the surveying instrument. Teak wood pegs 50 x 50 x 650 mm shall be driven at prominent positions at intervals of not more than 750 meter along the transmission line to be surveyed up to the next angle point. 125 mm wire nails should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to show only 100 mm above ground level. At angle positions, stones shall be put up for easy identification. Paint mark in white lead paint shall be put in, about 300 mm squares with a direction indication, on nearby boulders, rocks, or trees, along the complete line alignment. At peg position, identification marks giving the peg position, with reference to painting marks, shall be given. The white lead paint mark shall indicate to the individual the direction of alignment from either direction.

(b) Routing/Re-routing of transmission line through protected/reserved forest area should be avoided. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that cutting of trees is minimum.

(c) The route should have minimum crossings of Major river, Railway lines, National/State highways, overhead EHV power line and communication lines.

(d) The number of angle points shall be kept to minimum.

(e) The distances between the terminal points specified shall be kept shortest possible, consistent with the terrain that is encountered.

(f) Marshy and low lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.

(g) It would be preferable to utilize level ground for the alignment.

(h) Crossing of power lines shall be minimum. Alignment will be kept at a minimum distance of 300 m from power lines to avoid induction problems on the lower voltage lines.

(i) Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them

(j) Areas subjected to flooding such as nalah shall be avoided.

(k) Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches.

(l) All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.

(m) Certain areas such as quarry sites, tea, tobacco and saffron fields and rich plantations, gardens and nurseries which will present the Employer problems in acquisition of right of way and way leave clearance during construction and maintenance should be avoided.

(n) Angle points should be selected such that shifting of the point within 100 m radius is possible at the time of construction of the line.

(o) The line routing should avoid large habitations, densely populated areas, Forests, Animal/Bird sanctuary, reserve coal belt areas, oil pipe, line/underground inflammable pipe lines etc to the extent possible.

(p) The areas requiring special foundations and those prone to flooding should be avoided.

(q) From the field book entries, the route plan and level profile shall be plotted and prepared to the scales of 1:2000 horizontal and 1:200 vertical on 1 mm/5 mm/1 cm square paper.

(r) If the difference in levels be too high, the chart may be broken up according to requirement. A 400 meter overlap shall be shown on each following sheet. The chart shall progress from left to right. For convenience in handling, the sheet size may be limited to 594x841 mm (A1) size.

(s) After completing the detail survey, profiles shall be submitted to the Employer duly spotted with tower for approval. While submitting the profiles after conducting the detail survey, the contractor will also submit a copy of

route alignment on the route map indicating the surveyed route.

B. Check Survey:

- (a) The Contractor shall conduct the check survey after the profiles are handed over to the Contractor. The check survey shall include checking of deviation angles, checking of levels at critical points. After completing the check survey, the tower spotting shall be carried out by the Contractor and profiles shall be submitted to the purchaser for final approval. The Contractor shall be responsible for correct setting of stubs. Discrepancies, if any, shall be brought to the notice of purchaser and final approval shall be taken before execution of work.
- (b) The requirement of tower site levelling and revetment work, if required, shall also be marked by the Contractor on the profiles while carrying out the detail or check survey work.
- (c) If due to site conditions any change in the tower location/provision of extension is considered necessary compared to approved profiles, the contractor shall bring the same to the knowledge of the purchaser well in time and get revised approval of the profile before setting the stubs. The revised approval shall be conveyed to the Contractor by the Purchaser.

C. Soil Resistivity:-

While carrying out detailed/ check survey work, the Soil Resistivity values will have to be measured at convenient points along the route, not exceeding 2.50 Km between adjacent points. The Soil Resistivity will be measured using 4 electrode method with an inter electrode spacing of 50 M.

The following formula shall be used:

$$P = 2 \pi a R$$

Where a = Interelectrode spacing = 50M

R = Earth resistance measured in Ohms

P = Soil Resistivity in Ohm- m

The soil resistivity values shall be submitted duly marked on the route map and also in the form of statement. The quoted rates for detailed survey/ check survey work shall be inclusive of cost of measuring soil resistivity values along the proposed route and the contractor will not be paid separately for this work.

D. RIGHT OF WAY (ROW)

As per bid.

2.2.2 SUB-SOIL INVESTIGATION

To ascertain soil parameters in various stretch, inter, the contractor shall carry out sub-soil investigation through reputed soil consultant as approved by the employer.

2.2.2.1 SCOPE OF WORK

The scope of sub-soil investigation covers execution of complete soil exploration for the transmission line under this contract including boring, drilling, collection of undisturbed soil sample where possible, otherwise disturbed samples, conducting laboratory test of soil samples to find out the various parameters as detailed in this specification and submission of detailed reports in 6 copies along with specific recommendation regarding suitable type of foundation for each bore-hole along with recommendation for soil improvement where necessary.

2.2.2.2 QUALIFYING REQUIREMENTS OF SOIL CONSULTANTS

The soil consultants shall provide satisfactory evidence concerning the following as and when asked for. That, he/they has/have adequate technical knowledge and previous practical experience in carrying out complete soil investigation jobs in any kind of soil. That he/they has/have well equipped, modernized soil testing laboratory of his/their own. If asked for by the employer, the contractor shall arrange inspection of such laboratory of the soil consultant by the representative of the employer. If in the opinion of the employer, the soil consultant (proposed by the contractor) is not well equipped or capable to undertake the sub-soil investigation job relating to this contract, then such soil consultant shall not be engaged to undertake the job. In that case, they shall have to engage other

agency as will be approved by the employer.

2.2.3 TEST BORING

The boring shall be done at the major locations/crossing, special towers. However, it is desirable that there should be at least one sub-soil investigation bore-hole for the line. Such locations for sub-soil investigation shall be selected and finalized in consultation with the employer.

The test boring through different layers of all kinds of soil shall have to be carried out by the contractor through the approved soil consultant as briefed hereunder.

- I. Method of boring, selection of sampling tubes, sampling, recording of boring, protection, handling, leveling of samples shall be done as specified in IS: 1892/1977, if any, after obtaining approval from the employer. The contractor/consultant shall furnish in the soil report in details, the equipment and method of boring actually adopted.
- II. Depth of boring below ground level shall be 15 M. only unless continuous bedrock is encountered earlier. In case rock is encountered at any depth within 15 M. adequate study of rock and assessment of strength characteristics shall be done and recommendation shall be given.
- III. Undisturbed soil samples shall be obtained for the initial 4M depths at every 1.5M interval and at change of strata. After these initial 4M depths, samples shall be obtained preferably at every 3M or where there is a change of strata, or as advised by the employer.
- IV. In case collection of undisturbed samples becomes difficult/impossible detailed soil testing on remoulded soil samples is to be considered and reported in the soil report.
- V. Standard penetration test as per IS: 2131 with latest amendment shall have to be conducted in different strata and recorded properly.
- VI. The ground water table shall be recorded during boring operation and incorporated in the bore log. If possible, the position of the water table just after monsoon period be ascertained from local people and indicated in the report.
- VII. Plate Load test shall have to be conducted at special tower location.

2.3.0 LABORATORY TESTS OF SOIL SAMPLES

The method and procedure of testing of soil sample to be followed shall be as per relevant IS codes. Adequate volume of test samples shall be collected from site. Ample shall be properly sealed immediately after recovery as specified in relevant IS code and transported carefully to laboratory for carrying out necessary laboratory tests to find out the following parameters of every samples. Data and time of taking of the sample shall be recorded in the test report.

- 1 Natural moisture content, Liquid limit, Plastic limit and Plasticity index.
 - 2 Bulk, dry and buoyant density of soil.
 - 3 Void ratio (e-long P curve shall be submitted)
 - 4 Specific gravity.
 - 5 Grain size distribution (Sieve analysis and hydrometer analysis)
 - 6 Tri-axial and consolidation tests (consolidation undrained and consolidated drained as and when application in table, graph and drawing.
 - 7 Permeability tests
 - 8 Chemical tests for both water and soil samples at different layers.
-

- 9 Evaluation of safe bearing capacity at different strata for square footings shall be done for a maximum value of 25-mm. settlements.
- 10 At depths. From 3M to 10M be different strata.
- 11 Factor of safety shall be considered as 3 for evaluation of safe bearing capacity of soil.
- 12 Unconfined compression test for cohesive soil ($=0$) if encountered.

▪ REPORT ON SUB-SOIL INVESTIGATION

The contractor shall make analysis of soil samples and rock cores as collected by him in the field and approved by the employer as collected by him in the field and approved by him in the field and approved by the employer as well as field tests and laboratory tests. A comprehensive report shall have to be prepared by him, finally incorporating all the data collected in proper tabular forms or otherwise along with the analysis.

The 3(three) copies of report in the draft form shall be submitted for employer's approval. 6(six) copies of final report incorporation employer's comments, if any shall be submitted within 3(three) weeks after completion of this work.

Recommendations shall include but not be limited to the following items (a) to (p)

- I. Geological information of the region.
- II. Past observations and historical data, if available, for the area or for other areas with similar profile or for similar structures in the nearby area.
- III. Procedure of investigations employed and field and field as well as laboratory test results.
- IV. Net safe bearing capacity and settlement computation for different types of foundations for various widths and depths of tower.
- V. Recommendations regarding stability of slopes, during excavations etc.
- VI. Selection of foundation types for towers.
- VII. Bore hole and trial pit logs on standard proforma showing the depths, extent of various soil strata etc.
- VIII. A set of longitudinal and transverse profiles connecting various boreholes shall be presented in order to give a clear picture of the site, how the soil/rock strata are varying vertically and horizontally.
- IX. Modulus of sub grade reaction from plate load test for pressure ranging up to 6 kg/cm. The recommended values shall include the effect of size, shape and depth of foundations.
- X. Deformation modulus from plate load test in various test depth/stratification.
- XI. Coefficient of earth pressure at rest.
- XII. Depth of ground water table and its effect on foundation design parameters.
- XIII. Recommendations regarding stability of slopes, during shallow excavation etc.
- XIV. Whether piles are necessary or not. If piles are necessary, recommendation of depth, diameter and types of piles to be used.
- XV. Recommendations for the type of cement to be used and any treatment to the underground concrete structure based on the chemical composition of soil and sub-soil water.

▪ MEASUREMENT OF SOIL RESISTIVITY

For the purpose of grounding design, soil resistance measurement shall be taken in the locations as stated under clause 1.0 above and based on which the value of soil resistance shall be derived. Wenner's four (4) electrode method shall be used for earth resistance measurement in accordance with the procedure and the calculation detailed in IS:3043 1987. At least 8(eight) test direction shall be chosen from the center of the locations to cover the whole site. The employer reserves the right to carry out separate soil investigation at his cost by engaging a separate agency for cross checking the result obtained by the contractor. In case the results are at variance, the soil parameters to be adopted for final design will be at the sole discretion of the employer and such will be binding upon the contractor.

IMP:-The material and services covered under these specifications shall be performed as per requirements of the relevant standards and codes referred hereinafter against each set of equipment and services. In case of a conflict between such codes and/or standards and the Specifications, the latter shall govern. Other Internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.

Sl. No.		Indian Standards	Title	International & Internationally Recognized Standards
1		IS 209-1979	Specification for zinc	ISO/R/752-1968 ASTM B6
2		IS 269-1976	Structural Steel (standard quality)	ISO/R/630-1967 CAN/CSA G40.21 BSEN 10025
3		IS 269-1976	Ordinary rapid hardening and low heat Portland cement	ISO/R/597-1967
4		IS 383-1970	Coarse and fine aggregates from natural sources for concrete	CSA A23.1/A23.3
5	a	IS 398-1982	Specification for aluminium conductor for overhead transmission purpose	IEC 1089-1991 Part I BS 215-1970
	b	IS 398-1982	Aluminium conductor galvanized steel reinforced	BS 215-1970 Part-II, IEC 1089-1919
	c	IS 398-1994	Aluminium alloy	BS 3242-1970

		Part-IV	stranded conductor	IEC 1089-1991 ASTM 8393M86
	d)	IS 398-1982 Part-V	Aluminium conductor galvanized steel reinforced for Extra High Voltage (400kV and above)	BS 215-1970 IEC 1089-1991
6.		IS 278-1978	Specification for barbed wire.	ASTM A 121
7.		IS 406-1964	Method of chemical analysis of Zinc slab	
8.		IS 432-1966 (Part 1 & 11)	Mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement.	BS 4449 CSA G-30. BS 4482
9.		IS 456-1978	Code of practice for plain and reinforced concrete.	ISO 3893-977

10.		IS 731-1971	Porcelain insulators for overhead power lines with nominal voltage greater than 1000 Volts.	BS 137-1982 (Part-I & II) IEC 383-1993 (Part-I& II)
11		IS 800-1962	Code fo practice for use of structural steel ingeneral building construction	CSA S 16.1 BS 5950
12. a)		IS802-(2015) part 1/section 1	Code of practice for use of structural steel in overhead transmission Line: materials, loads and permissible stresses	IEC 826 ANSI/ASCE 10-90 (1991)BS 8100
b)		IS802-(2016) (Part-I/ section 2)	Code of practice for use of structural steel in overhead transmission line, fabrication, galvanising inspection and packing	ANSI/ASCE 10-90 (1991)
c)		IS 802-Part3	Code of practice for use of structural steel in over-head transmission lines towers: testing	ANSI/ASCE 10-90 (1991) (Part III) IEC 652
13	IS 1139-1966		Hot rolled mild steel, medium tensile steel hogh yield strength deformed bars for concrete reinforcements	CAN/CSA G30.18 ASTM A615 and BS 4449
14	IS 1367-1967		Technical conditions for threaded fastners	
15	IS 1489-1976		Portland pozzolana cement	ISO/R 863-1968
16	IS 1521-1972		Method of tensile testing of steel wires	ISO 6892-1984
17	IS 1573-1976		Electroplated coating of zinc on iron and steel	BS-1559-194
18	IS 1786-1966		Cold twisted steel bars for concrete reinforcement	
19	IS 1778-1980		Reels and drum for bare conductor	
20	IS 1893-1965		Criteria of earthquake resistant design of structures	IEEE 693
21	IS 2016-1967		Plain washers	ISO/R 887-1968 ANSI B18.22.1

21	IS 2071 Part-I-1974 Part-II-1974 Part-III-1976	Method of high voltage testings	IEC 60
22	IS 2121 I. part II. Part- 1981	Specification for conductor and earthwire accessories for overhead power lines	

	I. Part-I-1981 II. Part-II-1981 III. Part-III-1992 IV. Part-IV-1991	Armour rods, binding wires and tapes for conductors. Mid-span joints and repair sleeve for conductors. Accessories for earthwire. Non-tension joints.	ASTM D 1 883
24.	IS 2131-1967	Method of standard penetration test for soils.	
25.	IS 2551-1982	Danger notice plates	
26.	IS 2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000 Volts.	
	Part-I	General requirements and tests.	BS 3288 IEC 1284
	Part-II	Dimensional requirements	IEC 120-1984
	Part-III	Locking devices	IEC 372-1984
27.	IS 2629-1966	Recommended practice for hot dip galvanizing of iron and steel.	ASTM A123 CAN/CSA G 164 BS 729
28.	IS 2633-1972	Method of testing uniformity of coating of zinc coated articles.	ASTM A123 CAN/CSA G164
29.	IS 3043-1972	Code of practice for earthing(with amendment No.1 and 2).	

30.	IS 3063-1972	Single coil rectangular DIN 127-1970 section spring washers for bolts nuts, screws.
31.	IS 3188-1965	Dimensions for disc IEC 305-1978 insulators.

32.	IS 4091-1967	Code of practice for ASCE/IEEE 691 design and construction of foundation for transmission line towers and poles.	
33.	IS 4826-1979	Galvanised coating on round steel wires.	IEC 888-1987 BS 443-1982
34.	IS 5358-1969	Hot dip galvanised coatings on fasteners.	CAN/CSG 164 ASTM A153
35.	IS 5613 (Part-II/Sec-1) -1985 (Part-III/Sec.1) -1989	Code of practice for design, installation and maintenance of overhead power lines	ANSI/ASCE 10-90(1991)
36.	IS 5613 (Part-II/Sec-2) -1985 (Part-III/Sec.2) -1989	Code of practice for design, installation and maintenance of overhead power lines (Section 2: Installation and maintenance)	
37.	IS 6610-1972	Specification for heavy washers for steel structures.	
38.	IS 6639-1972	Hexagonal bolts for steel structure.	ISO/R 272-1968 ASTM A394 CSA B33.4
39.	IS 6745-1972	Methods for determination of weight of zinc coating of zinc coated iron and steel articles.	ASTM A90 ISO 1460
40.	IS 8263-1976	Method of radio interference tests on high voltage insulator	IEC 437-1973 NEMA 107-1964
41.	IS 8269-1976	Method of switching impulse tests on HV insulators.	IEC 506-1975
42.	IS 8500-1977	Specification for weldable structural steel (medium and high strength qualities)	BSEN 10025
43.	IS 9708-1980	Specification for Stock Bridge vibration dampers for overhead power lines.	

44.	IS 9997-1988	Aluminium alloy redraw rods	IEC 104-1987
45.		Hard drawn aluminium wires for overhead line conductors.	IEC 889-1987
46.		Thermal mechanical performance tests and mechanical performance tests on string insulator units.	IEC 575-1977
47.		Salt fog pollution voltage withstand tests.	IEC 507-1991
48.		Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric.	IEC 797-1984
49.		Guide for the selection of insulators in respect of polluted conditions.	IEC 815-1986
50.		Tests on insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 Volts.	IEC 383-1993 (Part I and II)
51.		Ozone test on elastomer	ASTM D-1171
52.	IS 1363	Hexagonal head bolts, screws and nuts of product Grade – C	
	Part - 1	Hexagonal head bolts	ISO 4016
	Part - 3	Hexagonal nuts	ISO 4034
53.	IS 1367	Technical supply conditions for threaded steel fasteners	
	Part III	Mechanical properties and test methods for bolts, screws	ISO 898-1
	Part VI	and studs with full loadability Mechanical properties and test methods for nuts with full loadability	ISO/DIS 898/II
54.		Indian Electricity Rules – 1956	
55.		Indian Electricity Act - 1910	

56.	IS 1498-1970	Classification and identification of soil for general engineering purposes	
57.	IS 1888-1982	Method of load test on soils	
58.	IS 1892-1979	Code of practice for subsurface investigation for foundation	
59.	IS 2911-1979 (Part-I)	Code of practice for design and construction of pile foundations	
60.	IS 4453-1980	Code of practice for exploration by pits, trenches, drifts and shafts	
61.	IS 6935-1973	Method for determination of water level in a bore hole	
62.	IS 8009-1976 (Part-I)	Code of practice for calculation of settlement of foundation subjected to symmetrical vertical loads (Shallow Foundation)	
63.	IS 2386-1963 (Part-3)	Methods of test for aggregates for concrete : Specific gravity, density, voids, absorption and bulking	ISO 9000-1994
64. 65.	IS 14000-1994	Quality management and quality assurance standards GRIDCO Safety Manual (draft)-1997	
66.		Composite insulators for a.c. overhead lines with a nominal voltage greater than 1000 V : Definition, test methods and acceptance criteria	IEC 1109-1992 ANSI C29-11 IEEE 987

SECTION-3 ERECTION OF TRANSMISSION TOWER

TECHNICAL SPECIFICATIONS FOR ERECTION OF TRANSMISSION LINES

3.01 INDIAN STANDARDS/ CODE :

The material and services under this section shall conform to the requirements of the latest revisions and amendments available at the time of placement of order of all the relevant Indian standards/codes listed here under or equivalent International Standards, except as modified in this document.

S.No.	Indian standards	Title
1	IS:5613-1995 (part- II)	Code of practice for design, installation and maintenance of overhead power lines. Sec.-1 - Designs. Sec.-2 - Installation & Maintenance
2	IS:269-1967	Ordinary rapid hardening and low heat Portland cement.
3	IS:456-2000	Code of practice for plain and reinforced concrete
4	IS:1786-1966	Cold twisted steel bars for concrete reinforcements
5	IS:4091-1967	Code of practice for design & construction of foundation for transmission line towers & poles

3.02 LINE MATERIALS:

3.02.1 Conductor:

The Conductor used in the line will be ACSR Moose Conductor. The Conductor size is 54/3.53mm A1. + 7/3.53 mm Steel.

3.02.2 Ground-wire (OPGW):

The Ground-wire to be used on the line shall be 7/3.66 mm; 95 kg/mm² quality galvanized steel stranded wire.

For OPGW please refer to this bid document.

3.02.3 Insulator Strings with Hardware Fittings:

(i) Single suspension and double tension strings will be used on the line as under:

(a) At Suspension Locations:

23 Disc single suspension strings having 120KN E&MS of 255x145 mm size Disc Insulators with AGS type clamps will be used.

(b) At Tension Locations :

- i. 24 Disc double tension strings with 160 KN E&MS Disc insulators of 280x170 mm size Disc Insulators will be used with compression type dead end clamp.
- ii. Pilot strings will be used at deep angle tower locations for restraining the swing of jumpers.
- iii. In cases of Railway/Road/River/Other transmission line crossings, double suspension insulator strings will be used.

3.02.4 Conductor Accessories:

(i) AGS (armour grip suspension) type suspension clamps shall be used with suspension strings.

(ii) Vibration Dampers (4-R type) and Spacers or Spacer-Dampers shall be used for Conductors.

3.02.5 Miscellaneous Items:

Enamelled Number Plates, Phase Plates and Danger Board, Bolts and Nuts, Spring washers, Pack washers and other tower accessories like 'D' Shackle, Hanger, U-Bolts and fasteners etc., shall be provided with the tower by the Contractor. The Contractor shall supply anticlimbing device (including Barbed wire) separately. Copper earth bond will be used for connecting Ground wire suspension and tension clamp with tower body, which shall also be provided by the Contractor.

3.03 APPROVED PROFILE:

(Applicable for check survey only)

2.03.1 The detailed survey has been conducted by the Purchaser or any other agency appointed by the Purchaser and the profiles shall be handed over to Contractor progressively for carrying out check survey and submission of profiles for approval of the purchaser. The profiles shall be prepared on cm. graph paper on scale 1:2000 horizontal and 1:200 vertical.

3.03.2 The route alignment surveyed by the Purchaser shall be marked at angle points. At angle points concrete blocks shall be provided and in the straight alignment marking will be done by pegs.

6.03.3 The Contractor will be responsible for the correct setting of towers as shown in approved profiles. If towers after erection are found to be out of the approved alignment/position in the profile, the Contractor will dismantle and re-erect them correctly fully at his own cost and without extension of time.

3.04 INSULATOR HOISTING:

Suspension insulator strings shall be used on suspension towers and tension insulator strings on angle and dead-end towers. They shall be fixed on all the towers just prior to the stringing. Damaged Insulators and fittings, if any, shall not be used in the assemblies. Before hoisting, all Insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the Insulator, but in no case shall any oil be used for the purpose. Security clips shall be fitted in position for the Insulators before hoisting. Arcing Horns shall be fitted in an approved manner. Torque wrench shall be used for fixing different line materials and their components, like suspension clamps etc. For Conductor and Ground-wire etc.

3.05 HANDLING OF CONDUCTOR AND EARTHWIRE:

3.05.1 The Contractor shall be entirely responsible for any damage caused to the towers or Conductors during stringing. While running out the Conductors, proper care shall be taken ensuring that the Conductors do not touch and rub against the ground or objects which could cause scratches or damage to the Conductor strands. The Conductors shall be run out of the drums from the top in order to avoid damage due to chafing. The drum stand shall be provided with a suitable braking device to avoid damage, loose running out and kinking of Conductor. Proper care shall be taken to avoid injury to Conductor while making it pass over the bull wheel of tensioner. After the tensioner, the Conductor will be pulled by pull cable and consequently pass over the running out blocks. The groove of the running out blocks will be of such a design that the seat is semi-circular and larger than the diameter of the Conductor and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to Conductor and shall be mounted on properly lubricated bearings.

3.05.2 The running blocks shall be suspended in a manner to suit the design of the cross arm. All running out blocks especially those at the tensioning end, will be fitted on the cross arm with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work. The Conductor shall be continuously observed for loose or broken strands or any other kind of damage. When approaching towards end of a drum length, at least

three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully if another length is required to be run out, new length may be joined to the length already run out by the compression joint in approved manner. The Conductor joints and clamps shall be erected in such a manner that no bird caging, over tensioning of individual wires or layers or other deformities or damage to the conductor shall occur. Clamps or bracing devices shall under erection conditions allow no relative movement of strands or layers of the conductors.

3.05.3 Repairs of Conductors, in the event of damage being caused to isolated strands of a conductor during the course of erection, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of Conductor surface with repair sleeve shall be done only in case of minor damage, scuff marks etc., keeping in view both electrical and mechanical safety requirements. Number of damaged strands shall not exceed $1/6^{\text{th}}$ of the total strands in the outer layer. The final Conductor surface shall be clean, smooth and shall be without any projections, sharp points, cuts, abrasions etc. Repair sleeves may be used when the damage is limited to the outermost layer of the Conductor and is equivalent to the severance of not more than one third of the strands of the outermost layer. No repair sleeve shall be fitted within 30 m of tension or suspension clamp or fittings. Further, more than one repair sleeve per Conductor shall not be normally used in any single span.

3.05.4 Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The Contractor shall use only such equipment/ methods during Conductor stringing which ensures complete compliance in this regard.

3.05.5 Derricks shall be used where roads, rivers, canals, telecommunication or overhead power lines, railway lines, fences or walls have to be crossed during stringing operations. It shall be seen that normal services are not interrupted, and no damage is caused to property. Shut down shall be obtained when working at crossing of overhead power lines.

3.05.6 The sequence of running out shall be from top to downwards, i.e. the Ground-wire shall be run out first followed by the Conductors in succession. Imbalances of loads on towers shall be avoided as far as possible i.e. both Ground-wires, then both bundles of top Conductor and then both bundles of middle Conductor followed by both bundle Conductors of bottom Cross-arm should be strung.

3.05.7 The proposed transmission line may run parallel for certain distance with the existing 400/220/132KV lines which will remain energized during the stringing period. As a result, there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling cables, Conductors and Ground-wires, which although comparatively small in magnitude during normal operations, can be severe during switching and ground fault conditions on the energised lines. It shall be the Contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.

3.06 STRINGING OF CONDUCTOR AND EARTHWIRE:

3.06.1 The stringing of the Conductor shall be done by control in tension method by means of tension stringing equipments. The equipments shall be capable of maintaining a continuous tension. The maximum tension imposed on a conductor during stringing operations shall not exceed than that necessary to clear obstructions on the ground. The contractor shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of stringing equipment he would deploy exclusively for this work.

3.06.2 After being pulled, the Conductor/Ground-wire shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

3.06.3 The Contractor shall give complete details of the stringing methods, which he proposes to follow. At least one month in advance of the commencement of stringing, the Contractor will submit the stringing charts for the Conductors and Ground-wire showing the initial and final sags and tension for various temperatures and spans, alongwith equivalent spans in the lines, for the approval of the purchaser. The stringing shall be carried out as per the stringing charts approved by the purchaser and in accordance with relevant IS. All the tolerances for the line shall conform to IS :5613 (Part-2/Sec-2) 1995.

3.06.4 In hilly terrain and thick forest, where deployment of tension stringing machine is not possible, manual stringing may be adopted after getting approval of Purchaser's site Engineer. The contractor shall deploy appropriate tools/equipments/machinery to ensure that the stringing operation is carried out without causing damage to conductor/earth wire and conductor/earth wire is installed at the prescribed sag-tension as per the approved stringing charts.

3.07 JOINTING:

3.07.1 The number of joints in Conductor/Ground-wire shall be kept to minimum possible by properly selecting the drums from available lot of respective drums. All the joints on the Conductor and Ground-wire shall be of compression type. Each part of the joint shall be cleaned by wire brush to make it free of rust or dirt etc. and properly greased with anti-corrosive compound, as approved by our Engineer before the final compression is done with the compressors. The cost of such grease etc. used for joints shall not be paid extra and shall be deemed to be included in the stringing rates.

3.07.2 All joints shall be made at least 30 meters away from the structures. No joints shall be made in the spans crossing over the main roads, railways, rivers etc. Not more than one joint per Conductor shall be allowed in one span. Care shall be taken to mark the conductor for properly centering the compression clamp before compressing. During compression operation, the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After pressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

3.07.3 Suitable protector shall be used during stringing of Conductor to avoid any damage to the joint while it passes over the reveller.

3.08 SAGGING IN OPERATION:

3.08.1 The Conductors shall be pulled up to the desired sag and left in running block for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductor from the running out blocks to the suspension clamps. The Conductors shall be clamped within 36 hours of sagging in.

3.08.2 The sag will be checked in the first and the last span of the section in case of sections up to eight spans and in one intermediate span also for sections with more than eight spans. The sag shall also be rechecked when the Conductor have been drawn up and transferred from running blocks to the insulator clamps.

3.08.3 The running out blocks, when suspended from the transmission structure for sagging shall be so

adjusted that the Conductors on running out blocks will be at the same height as that of the suspension clamps to which it is to be secured.

3.08.4 At sharp vertical angles, the sags and tensions shall be checked on both sides of the angle. The Conductor and Ground-wire shall be checked on the running out blocks for equality of tension on both sides. The suspension insulator assemblies will normally assume vertical positions when the Conductor is clamped.

3.08.5 Tensioning and sagging operations shall be carried out in calm weather, when rapid changes in temperature are not likely to occur.

3.09 TENSIONING & SAGGING OF CONDUCTOR AND EARTHWIRE:

The tensioning and sagging shall be done in accordance with the approved stringing charts before the Conductor and Ground-wire is finally attached to the towers through the insulator strings for the Conductor and Ground-wire clamps for the Ground-wire Dynamometers shall be used for measuring tension in the Conductor and Ground-wire.

3.10 CLIPPING IN:

3.10.1 Clipping of the Conductors in position shall be done in accordance with the method approved by our Engineer. At suspension location free center type suspension clamp with Armour rod set or AGS type suspension clamp shall be used.

3.10.2 The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator string shall be used, if necessary, to restrict the jumper swings to the design values. Jumper connections of transposition towers shall be so made that adequate clearances are available from tower body as well as phase conductors.

3.10.3 Fasteners in all fittings and accessories shall be secured in position. The security clip shall be properly opened and sprung into position.

3.11 FIXING OF CONDUCTORS AND EARTHWIRE ACCESSORIES:

Spacers, spacer dampers, Vibration dampers (4-R type) and other Conductor and Ground-wire Accessories supplied by the purchaser shall be installed by the Contractor as per the design/drawing requirement and as per instructions of the Engineer. Spacers shall be fitted within 24 hours of the Conductor clamping. While installing the Conductor and Ground-wire Accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the Accessories.

3.12 REPLACEMENT:

If any replacements are to be affected after stringing and tensioning or during maintenance, members and bracing shall not be removed without reducing the tension on the tower with proper guying or releasing the Conductor. If the replacement of cross arms becomes necessary after stringing, the Conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

3.13 FINAL CHECKING TESTING AND COMMISSIONING:

After completion of the works, final checking of the line shall be done by the Contractor to ensure that all the foundation works, tower erection, and stringing have been done strictly in accordance with the

specification and as approved by the purchaser. All the works shall be thoroughly inspected keeping in view the following main points:

- (a) Sufficient back-filled earth is lying over each foundation pit and it is adequately compacted.
- (b) Concrete chimneys and their copings are in good finely shaped conditions.
- (c) All the tower members are correctly used, strictly according to approved drawing and are free from defects or damages, whatsoever.
- (d) All bolts are properly tightened and punched/tack welded as per this specification.
- (e) The stringing of the Conductors and Ground-wire has been done as per the approved sag and tension charts and desired clearances are clearly available.
- (f) All Conductor and Ground-wire Accessories are properly installed.
- (g) All other requirements to complete the work like fixing of Danger Plate, Phase Plate, Number Plate, Anti-climbing devices, Aviation Signal (wherever required) etc. are properly installed and the painting has been done wherever required as per Aviation Rules.
- (h) It should be ensured that revetment is provided, wherever required.
- (i) The line insulation is tested by the Contractor by providing his own equipment labour etc. to the satisfaction of the purchaser to ascertain the insulation condition of the line.
- (j) Conductor continuity test is carried out to verify that each Conductor of the overhead line is properly connected electrically also.

The line may be charged at a low value of Power Frequency Voltage for the purpose of testing.

SECTION- 4

TECHNICAL SPECIFICATION ACSR CONDUCTORS AND ACCESSORIES FOR CONDUCTORS

4.1.0 SCOPE

4.1.1 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.

4.2.0 POWER CONDUCTOR

4.2.1 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.

4.2.2 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.

4.2.3 MATERIAL

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

4.2.4 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.

4.2.5 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.

4.2.6 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
- 1. Galvanizing test on steel strands
- 2. Check for lay Ratios of various layers
- 3. Torsion and Elongation tests on steel strands
- 4. Breaking load test on steel and Aluminium strands
- 5. Wrap test on Steel & Aluminium strands
- 6. DC resistance test on Aluminium strands
- 7. Procedure qualification test on welded joint of Aluminium strands
- 8. Drum strength test (steel drum)
- 9. 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:

- a) Check to ensure that the joints are as per Specification
- b) Check that there are no cuts, fins etc. on the strands
- c) Check that drums are as per Specification
- d) All acceptance test as mentioned above to be carried out on aluminium and steel strands of 20% of drums

Tests During manufacture:

- a) Chemical Analysis of Zinc used for galvanising
- b) Chemical Analysis of Aluminium used for making Aluminium Strands
- c) Chemical Analysis of Steel used for making Steel Strands.

4.2.7 REJECTION AND RETESTS

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

4.2.8 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.

4.2.9 TECHNICAL 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 mm ²
5	Approx. weight	2004 kg/km
6	Minimum UTS	161.2 kN
7	Modulus of Elasticity (Final)	0.7034 kg/cm ²
8	Coefficient of linear expansion	19.3 x 10 ⁻⁶ /°C
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

Sl. No	DESCRIPTION	PARTICULARS
I	II	III
	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
	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 °C	19.30×10^{-6}
7.	Ultimate Tensile Strength (kgf.)	13316
8.	Maxm. DC resistance at 20°C (Ω/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.m ²)	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	$19.35 \times 10^{-6} / ^\circ\text{C}$
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 mm ²
9	Total sectional area	261.50 mm ²
10	Calculated d.c. resistance at 20 ^o C	0.1400 ohm/km
11	Ultimate tensile strength	89.67

4.3.0 GROUND WIRES

Optical ground wire (OPGW) shall be used as per bid specification.

4.4 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 thereof 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.

4.5 FITTINGS AND ACCESSORIES FOR GROUND WIRES

Fittings and accessories for OPGW shall be used as per bid specification.

SECTION-5

TECHNICAL SPECIFICATION FOR INSULATOR STRING HARDWARE

5.1.0 HARDWARE

Each insulator string assembly shall generally include the following hardware:

Anchor shackle for attachment of suspension string assembly to the tower hanger and tension string assembly to the tower strain plate. Suitable top and bottom yoke assemblies with the arrangement of fixing a set of arcing horns.

- Set of arcing horns
- Suspension or tension clamp
- Bolts, nuts, washers, split pins etc.
- Other fittings necessary to make the strings complete such as ball clevis, socket clevis, chain links etc.

The tenderer shall be responsible and satisfy himself that all the hardware included in strings are entirely suitable for the conductor offered.

5.2.0 SUSPENSION CLAMP

The suspension clamps shall be made of malleable iron or aluminium alloy, hot dip galvanised and shall be suitable to accommodate the conductor together with one set of preformed armour rods. Suitable sheet aluminium liners shall be provided. The suspension clamps shall be designed to avoid any possibility of deforming or damaging the conductor. The lips shall be rounded off and the seating and the bell mouths shall be smooth to avoid corona and radio interference noises. The suspension clamps shall be suitable to carry the bottom part of the arcing horn and to receive the fittings of the insulator string.

The suspension clamps shall be such that the conductor should not slip at a load of 25% of the breaking load of the conductor. The ultimate strength of the clamp for vertical load shall not be less than the failing load of the Disc Insulators.

5.2.1 STRAIN CLAMP

The bolted strain clamps shall also be made of malleable iron or aluminium alloy; hot dip galvanised, lined with sheet aluminium liners and shall be suitable to accommodate the conductor with necessary binding tapes etc. The lips shall be rounded off carefully and conductor seating and the ball mouth shall be smooth to avoid corona and radio interference noises. Suitable attachment for receiving one side of arcing horns and for connecting to the insulator strings shall be provided.

The strain clamps shall be such that the conductor should not slip at a load of 90% of the breaking load of the conductor. The ultimate strength of the clamp for horizontal load shall not be less than the ultimate strength of the conductor

5.2.2 ARCING HORNS:

Arcing horns of approved size and dimensions shall be provided for every string of insulators. The performance data for arcing horns to be supplied shall be made available to the Employer.

5.2.3 OTHER INSULATOR STRING HARDWARE:

The strength of other string hardware namely anchor shackle, yoke plates, socket-clevis etc. shall be co-ordinated with insulator disc strength.

5.3.0 Interchangeability

The hardware together with ball and socket fittings shall be of standard design, so that this hardware is interchangeable with each other and suitable for use with disc insulators of any make conforming to relevant Indian/International Standard.

5.4.0 Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Contractor/Manufacturer must give suitable assurance about the satisfactory corona and radio interference performance of the materials offered by him.

5.5.0 Maintenance

The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method. The Bidder should clearly establish in the bid, the suitability of his fittings for hot line maintenance.

The line side yoke plate shall have a notch & a working hole of suitable size. The design of corona control rings/grading ring shall be such that it can be easily replaced by employing hot line maintenance technique.

5.6.0 Designation

Ball and Socket Designation

The dimensions of the ball and socket shall be 16 mm (Alt-B) designation for 70 kN & 90 kN Insulators, 20 mm designation for hardware with 120 kN & 160 kN Insulators, in accordance with the standard dimensions stated in IS: 2486-(Part-II) / IEC:120. The dimensions shall be checked by the appropriate gauge after galvanising only.

5.7.0 Security Clips and Split Pins

5.7.1 Security clips for use with ball and socket coupling shall be R-shaped, hump type which provides positive locking of the coupling as per IS: 2486-(Part-III)/IEC: 372. The legs of the security clips shall be spread after assembly in the works to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall the locking devices allow separation of fittings.

5.7.2 The hole for the security clip shall be countersunk and the clip should be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall neither be less than 50 N (5 kg) nor more than 500 N (50 kg).

Split pins shall be used with bolts & nuts.

5.8.0 Arcing Horn for EHV Strings

5.8.1 The arcing horn shall be provided on tower side of the hardware fittings. The same shall be either ball ended rod type or tubular type.

5.8.2 The spark gap shall be so adjusted to ensure effective operation under actual field conditions.

5.9.0 Yoke Plates

- The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength as specified in the bid drawings.
 - The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/grading ring/arcing horn. All the corners and edges should be rounded off with a radius of at least 3 mm. Design
-

calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the Contractor/Manufacturer. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 10.2.4.2 of IS:800-2007.

5.10.0 Corona Control Rings/Grading Ring (For 220 kV & above voltage level line)

- The Corona control rings/grading ring shall be provided with hardware fittings and shall be of such design that it should cover at least one disc insulator in disc insulator strings/ metal polymer junction point in composite insulator strings so that they will reduce the voltage across the insulator units. It shall also improve corona and radio interference performance of the complete insulator string along with hardware fittings.
- The corona control rings/grading ring shall be made of high strength heat treated aluminium alloy tube of minimum 2.5 mm wall thickness. If mild steel brackets are used then the brackets shall not be welded to the pipe but shall be fixed by means of bolts and nuts on a small aluminium plate attachment welded to the pipe. The welded center of the corona control ring/grading ring shall be grinded before buffing. Alternately, Aluminium tube/flats of suitable dimensions welded to the corona control rings/grading rings may be used for connection to yoke plate.
- The Corona control rings/grading ring should have a brushed satin finish and not a bright glossy surface. No blemish should be seen or felt when rubbing a hand over the metal.
- Bidder may quote for grading ring with armour grip suspension assembly. The grading ring shall be of open type design with a gap of 125 mm. The open ends shall be suitably terminated. The outside diameter of the tube shall be 75 mm. The ends of grading ring tube shall be sealed with welded aluminum cap duly buffed.

5.11.0 Sag Adjustment Plate (For 400 kV voltage level line)

- The sag-adjustment plate to be provided with the double tension hardware fitting (for 400kV (Twin) line) shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed and safety.
- The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150 mm minimum at the interval of 6 mm shall be possible with the sag adjustment plate.
- Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by Contractor/Manufacturer. The hole provided for bolts should satisfy shear edge condition as per Clause No. 10.2.4.2 of IS:800-2007.

5.12.0 Turnbuckle

5.12.1 The turn buckle is to be provided with single tension hardware fitting. The threads shall be of sufficient strength to remain unaffected under the specified tensile load.

5.12.2 The maximum length of the turn buckle from the connecting part of the rest of the hardware fittings shall be 380 mm for 132KV and 220KV Line and 520mm for 400KV Line. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing submitted with the bid. An adjustment of 135 mm minimum for 132KV and 220KV Line and 150mm minimum for 400KV Line shall be possible with turnbuckle.

5.13.0 Suspension Assembly

5.13.1 The suspension assembly shall include free center type suspension clamp along with standard preformed armour rods or armour grip suspension clamp; except for Pilot insulator string for

which only suitable Envelope type suspension clamp shall be used.

5.13.2 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

5.13.3 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth and without any cuts, grooves, abrasions, projections, ridges or excrescence which might damage the conductor.

5.13.4 The suspension assembly/clamp shall be so designed so that it minimises the static and dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs and have required level of Corona/AIV performance.

5.14.0 Free Center Type Suspension Clamp

For the Free Center Suspension Clamp seat shall be smoothly rounded and curved into a bell mouth at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together.

5.15.0 Standard Preformed Armour Rod Set

5.15.1 The Preformed Armour Rod Set suitable for Conductor shall be used to minimise the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localised heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

5.15.2 The preformed armour rods set shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor in order to gently but permanently grip the conductor. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions, etc.

5.15.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

5.15.4 The conductivity of each rod of the set shall not be less than 12% of the conductivity of the International Annealed Copper Standard (IACS).

5.16.0 Armour Grip Suspension Clamp

- The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminum reinforcements and AGS preformed rod set.
- Elastomer insert shall be resistant to the effects of temperature up to 95oC, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.
- The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength as specified in the Standard Technical Particulars and shall not introduce unfavourable stress on the conductor under all operating conditions.

5.17.0 Envelope Type Suspension Clamp

- The seat of the envelope type suspension clamp shall be smoothly rounded & suitably curved at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp.

5.18.0 Dead End Assembly

5.18.1 The dead-end assembly shall be suitable for Conductor as detailed in the document.

5.18.2 The dead-end assembly shall be compression type with provision for comprising the jumper terminal at one end. The angle of the jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I²R losses. The resistance of the clamp when compressed on Conductor shall not be more than 75% of the resistance of equivalent length of Conductor.

5.18.3 The assembly shall not permit slipping of, damage to, or failure of the complete conductor or any part thereof at a load less than 95% of the ultimate tensile strength of the conductor.

5.19.0 Fasteners: Bolts, Nuts and Washers

5.19.1 All bolts and nuts shall conform to IS: 6637. All bolts and nuts shall be galvanised as per IS-1367 -(Part 13)/IS-2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

5.19.2 Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS-12427. Bolts should be provided with washer face in accordance with IS: 1363 Part-1 to ensure proper bearing.

5.19.3 Nuts should be double chamfered as per the requirement of IS: 1363 Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for size up to M16

5.19.4 Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

5.19.5 All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.

5.19.6 For parts/ components requiring grip strength viz. arcing horn, corona rings & dead-end jumper assembly, fully threaded bolts can be used as an alternative. Bolts & nuts for these parts/ components shall be of minimum 4.6 grade conforming to IS 6639 or equivalent International standards.

5.19.7 Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanised. The thickness of washers shall conform to IS: 2016.

5.19.8 The Bidder shall furnish bolt schedules giving thickness of components connected, the nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

5.19.9 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter.

5.19.10 Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

5.19.11 Fasteners of grade higher than 8.8 are not to be used.

5.20.0 Materials

The materials of the various components shall be as specified hereunder. The Bidders shall indicate the material proposed to be used for each and every component of hardware fitting stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards.

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1	Security Clips	Stainless Steel/ Phosphor Bronze	-	AISI 302 or 304-L/ IS-1385	
2	Arcing Horn	Mild Steel Rod/ Tube Type	Hot dip galvanised	As per IS-226 or IS-2062	
3	Ball Fittings, Socket, all shackles links cleves	Class-IV Steel	Drop forged & normalized Hot dip galvanised	As per IS: 2004	
4	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
5	Sag Adjustment plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
6(a).	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or 65032/ 63400 Type)	Heat treated Hot dip galvanized	ASTM-B429 or as per IS	Mechanical strength of welded joint shall not be less than 20 KN
6(b).	Supporting Brackets & Mounting Bolts	High Strength Al Alloy 7061/ 6063/ 65032/63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	
7(a).	Envelope type Clamp: Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/65032 or 6063/63400	Casted or forged & Heat treated	IS:617 or ASTM- B429	
7(b).	Envelope type Clamp: Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanised	As per IS-226 or IS-2062	
7(c)	Envelope type Clamp: U Bolts	Stainless Steel or High Strength Al alloy 6061/ 6063 or 65032/63400	Forged & Heat treated	AISI 302 or 304-L ASTM- B429	
8(a).	Dead End Assembly: Outer Sleeve	EC grade Al of purity not less than 99.50%			
8(b).	Steel Sleeve	Mild Steel	Hot Dip Galvanised	IS:226/ IS-2062	

9.	AGS clamp (a) Supporting house	High strength corrosion resistant Al. alloy LM6, 4600 or equivalent 6061	Cast/forged heat treated.	IS:617 or equivalent	
	(b) Al insert and retaining strap	High strength Al alloy type 6061 or equivalent	Forged and Heat treated	ASTM:B429	
	(c) Elastomer cushion	Moulded on Al reinforcement			
10.	P. A. rod	High strength Al alloy type 6061 or equivalent	Heat treatment during manufacturing	ASTM:B429	Min. tensile strength of 35 kg/mm ²
11.	Turn Buckle	Class-II Steel	Forged hot dip galvanized	IS:2004	

5.21.0 Workmanship

5.21.1 All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for rated voltage of transmission lines and will give continued good performance.

5.21.2 The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

5.21.3 All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanizing and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanizing. Galvanizing shall be done in accordance with IS: 2629 / IS-1367 (Part 13) or equivalent International Standards and shall satisfy the tests mentioned in IS: 2633-1986 or equivalent International Standards. Fasteners shall withstand four dips while spring washers shall withstand three dips of one-minute duration in the standard Preece test. Other galvanized materials shall have a minimum average coating of zinc equivalent to 610 gm / sq.m shall be guaranteed to withstand at least six successive dips each lasting one (1) minute under the standard price test for galvanizing.

5.21.4 Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.

5.21.5 The zinc coating shall be perfectly adherent of uniform thickness, smooth, reasonably bright. Continuous and free from imperfections such as flux, ash, rust, stains, bulky white deposits and blisters. The zinc used for galvanizing shall be grade Zn 99.95 as per IS: 209 or equivalent International Standards.

5.21.6 Pin balls shall be checked with the applicable "GO" gauges in at least two directions. one of which shall be across the line of die flashing, and the other 90° to this line. "NO GO" gauges shall not pass in any direction.

5.21.7 Socket ends, before galvanizing, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions, of high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS: 2486 or equivalent

International Standards.

The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.

5.21.8 In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm

5.21.9 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

5.21.10 No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the inductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

5.21.11 All the holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

5.21.12 All fasteners shall have suitable corona free locking arrangement to guard against Vibration loosening.

5.21.13 Welding of aluminium shall be by inert gas shielded tungsten arc or inert gas shielded metal arc process. Welds shall be clean, sound, smooth, uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, undercutting or inclusions. Porosity shall be minimised so that mechanical properties of the aluminium alloys are not affected. All welds shall be properly finished as per good engineering practices.

5.22.0 Bid Drawings

5.22.1 The Bidder shall furnish full description and illustrations of materials offered.

5.22.2 Fully dimensioned drawings of the complete insulator string hardware and their component parts showing clearly the following arrangements shall be furnished in five (5) copies along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

- (i) Attachment of the hanger or strain plate.
- (ii) Yoke Plate
- (iii) Suspension or dead-end assembly.
- (iv) Arcing horn attachment to the string
- (v) Hardware fittings of ball and socket type for inter connecting units.
- (iv) Corona control rings/grading ring attachment to conductor and other small accessories.

5.22.3 All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include:

- (i) Dimensions and dimensional tolerance.
 - (ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.
 - (iii) Catalogue No.
 - (iv) Marking
 - (v) Weight of assembly
 - (vi) Installation instructions
 - (vii) Design installation torque for the bolt or cap screw.
 - (viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.
-

(ix) The compression die number with recommended compression pressure.

(x) All other relevant terminal details.

5.22.4 After placement of award, the Contractor shall submit fully dimensioned drawings including all the components in four (4) copies to the Employer for approval. After getting approval from the Employer and successful completion of all the type tests, the Contractor shall submit thirty (10) more copies of the same drawings to the Employer for further distribution and field use at Employer's end.

5.23.0 Completeness of works

Bidder shall assess the complete requirement of line hardware, hardware accessories and assemblies in complete for the erection of the lines as per the recommended erection practices.

The hardware assemblies shall be supplied complete with components, sub-components, nuts, bolts, washer etc. fittings and accessories for conductor & earth wire like Mid Span Joints, Repair Sleeves, and Stockbridge Vibration Dampers.

The Contractor shall also supply all line and tower accessories.

5.24.0 Standards

5.24.1 The Hardware Fittings, conductor and earth wire accessories shall conform to the following Indian Standards or equivalent International Standards, which shall mean latest revisions, amendments/changes adopted and published unless specifically stated otherwise in the specification.

1. IS: 209 Specification for Zinc.
2. IS: 398 Specification for Aluminum Conductors.
for Overhead Transmission Purposes,
3. IS: 1327 Method of Determination of Weight of
Zinc Coating on Tin Plate.
4. IS: 1573 Electroplated Coating of Zinc on Iron and Steel
5. IS: 2121 Specification for Conductors and Earthwire
Accessories for Overhead Power Lines
(Part-1) Armour Rods, Binding Wires and Tapes for
Conductors
(Part-2) Mid-span joints and Repair Sleeves for
Conductors
6. IS : 2486 Specification for Insulator Fittings for Overhead Power Lines
With a Nominal Voltage Greater than 1 000 V
(Part 1) General Requirements and Tests
7. IS:2629 Recommended Practice for Hot Dip
Galvanizing of Iron and Steel
8. IS:2633 Method of Testing Uniformity of Coating
on Zinc Coated Articles
9. IS:4826 Galvanized Coating on Round Steel Wires
10. IS : 6639 Hexagonal Bolts for Steel Structures
11. IS: 6745 Methods for Determination of Weight of Zinc Coating on
Zinc Coated Iron and Steel Articles
12. IS : 8263 Method for Radio Interference Tests on High Voltage Insulators
13. IS : 9708 Specification for Stock Bridge vibration Dampers for Overhead Power Lines

5.25.0 TESTS

The insulator discs and hardware fittings shall be subjected to the tests before despatch, in accordance with the relevant standards. The successful contractor shall submit the test results in quadruplicate to

the Employer.

5.26.0 MARKING

Each insulator disc shall be legibly and indelibly marked with the following:

- Name or trade mark of the manufacturer.
- Month and year of manufacture.
- Minimum failing load in Newton.
- Country of manufacture
- Standard certification mark, if any.

The marking of the porcelain shall be printed and shall be applied before firing.

5.27.0 STANDARDIZED TECHNICAL PARAMETERS

A. 220 kV Transmission Line with ACSR ZEBRA conductor

1. Suspension hardware fittings for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value				
			Single "I" Suspension Fittings with		Double "I" Suspension Fittings with		Single suspension Pilot Fitting with
			AGS clamp	Free Centre clamp	AGS clamp	Free Centre clamp	Envelope clamp
1.	Maximum magnetic power loss of one suspension assembly at sub-conductor current of 500 amperes	Watt	2	2	2	2	4
2.	Slipping strength of suspension assembly	KN	16-24	16-24	16-24	16-24	16-24
3.	Particulars of standard/ AGS preformed armour rod set for suspension assembly						
	a) No. of rods per set	No.	12	12	12	12	NA
	b) Direction of lay		Right hand	Right hand	Right hand	Right hand	NA
	c) Overall length after fitting on conductor	mm	2080	2540	2080	2540	NA
	d) Diameter of each rod	mm	7.87	7.87	7.87	7.87	NA
	e) Tolerance in						
	i) Diameter of each rod	±mm	0.10	0.10	0.10	0.10	NA
	ii) Length of each rod	±mm	25	25	25	25	NA
	iii) Difference of length between the longest and shortest rod in a set	±mm	13	13	13	13	NA
	f) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032	6061/ 65032	6061/ 65032	6061/ 65032	NA
	g) Minimum UTS of each rod	Kg/mm ²	35	35	35	35	NA
4.	Particulars of Elastomer (For AGS Clamp only)						
	a) Type of elastomer		Chloroprene/	NA	Chloroprene	NA	NA

			Neo prene Rubber		/Neo prene Rubber		
	b) Shore hardness of elastomer		65 to 80	NA	65 to 80	NA	NA
	c) Temperature range for which elastomer is designed		Upto 95° C	NA	Upto 95° C	NA	NA
	d) Moulded on insert		Yes	NA	Yes	NA	NA
5.	Mechanical strength of suspension fitting(excluding suspension clamp)	KN	70		2 x 70		70
6.	Mechanical strength of suspension clamp	KN	70		70		70
7.	Galvanising						
a)	Weight of Zinc coating for steel parts	gm/m ²	600				
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209: 1992) or 98.5 (IS 13229:1991)				
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute				

2. Tension hardware fittings for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value	
			Single Tension	Double Tension
1.	Mechanical strength of Tension fitting(excluding dead end clamp)	KN	120	2x120
2.	Type of dead end assembly		Compression	
3.	Compression pressure	MT	100	
4.	Maximum electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%	75	
5.	Slip strength of dead end assembly	KN	123.80	
6.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600	
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)	
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute	

B. Accessories for ACSR ZEBRA conductor for 220 kV transmission line

1. Mid span compression Joint for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value	
			Aluminium Sleeve	Steel Sleeve
1.	Material of Joint		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinell hardness)	BHN	From 100 to 200	

3.	Dimension of sleeve Before compression		<u>Aluminum sleeve</u>	<u>Steel sleeve</u>
i)	Inside diameter	mm	31.00 ± 0.5	10.00 ± 0.2
ii)	Outside diameter	mm	48.00 ± 1.0	20.00 ± 0.5
iii)	Length	mm	710 ± 5	241 ± 5
4.	Dimensions of Sleeve after compression		<u>Aluminum sleeve</u>	<u>Steel sleeve</u>
i)	Outside dimension(Corner to corner)	mm	47.00 ± 0.5	19.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5	16.00 ± 0.5
5.	Slip strength	KN	123.8	
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
7.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	154	
8.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 154 kV (rms) under dry condition	Micro Volts	1000	
9.	Galvanising			
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600	
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)	
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute	

2. Repair sleeve for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value
1.	Material		Aluminium of minimum purity 99.5%
2.	Dimension of Aluminum sleeve Before compression		
i)	Inside diameter	mm	31.00 ± 0.5
ii)	Outside diameter	mm	48.00 ± 1.0
iii)	Length	mm	275.00 ± 5.0
3.	Dimensions of Aluminum Sleeve after compression		
i)	Outside dimension(Corner to corner)	mm	47.00 ± 0.5
ii)	Outside dimension (face to face)	mm	41.00 ± 0.5
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	154
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 154 kV (rms) under dry condition	Micro Volts	1000

3. Vibration Damper for ACSR ZEBRA Conductor

Sl.	Description	Unit	Particulars/ Value
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/ mild steel hot dip galvanised / Zinc

			alloy
	b) Clamp		Aluminum alloy 4600
	c) Messenger cable		High tensile strength galvanized steel
3.	Number of strands in stranded messenger cable	Nos.	19
4.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm ²	135
5.	Slip strength of stranded messenger cable (mass pull off)	KN	5
6.	Slipping strength of damper clamp		
	(a) Before fatigue test	KN	2.5
	(b) After fatigue test	KN	2
7.	Resonance frequencies range	Hz	5 to 45
8.	Maximum magnetic power loss per vibration damper watts for 500 amps, 50 Hz Alternating Current	Watts	1
9.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	154
10.	Maximum Radio Interference Voltage (RIV) at 1 MHz for phase to earth voltage of 154 kV (rms) under dry condition	Micro Volts	1000
11.	Percentage variation in reactance after fatigue test in comparison with that . before fatigue test	%	+/-40 (Maximum)
12.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
13.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute

C. Accessories for 7/3.15 mm GS Earthwire for 220 kV and 132 kV transmission line

1. Mid span compression Joint for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value	
			<u>Aluminium / Filler Sleeve</u>	<u>Steel Sleeve</u>
1.	Material of Joint		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinell hardness)	BHN	From 100 to 200	

3.	Dimension of sleeve Before compression				
			<u>Aluminium Sleeve</u>	<u>Steel Sleeve</u>	<u>Alu filler sleeve</u>
i)	Inside diameter	mm	22.00 ± 0.5	10.00 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	30.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	315 ± 5	230 ± 5	25 ± 2
4.	Dimensions of Sleeve after compression				
			<u>Aluminium Sleeve</u>	<u>Steel Sleeve</u>	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
5.	Slip strength	KN	53.20		
6.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earthwire	%	75		
7.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute		

2. Flexible Copper Bond for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Stranding		19 (12+6+1) / dia 2.54
2.	Cross sectional area	Sq.mm	95
3.	Minimum copper equivalent area	Sq.mm	750 + 5
4.	Length of copper cable	mm	Aluminium alloy
5.	Material of lugs		19 (12+6+1) / dia 2.54
6.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

3. Vibration Damper for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Type of Damper		4R-Stockbridge type
2.	Materials of components		
	a) Damper masses		Cast iron/ mild steel hot dip galvanised / Zinc alloy
	b) Clamp		Aluminum alloy 4600
	c) Messenger cable		High tensile strength galvanized steel
3.	Number of strands in stranded messenger cable	Nos.	19
4.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm ²	135
5.	Slip strength of stranded messenger	kN	2.5

	cable (mass pull off)		
6.	Slipping strength of damper clamp		
	(a) Before fatigue test	kN	2.5
	(b) After fatigue test	kN	2
7.	Resonance frequencies range	Hz	10 to 60
8.	Percentage variation in reactance after fatigue test in comparison with that . before fatigue test	%	+/-40 (Maximum)
9.	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)
10.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute

4. Suspension Clamp for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value
1.	Material of components		
	(a) Shackle		Forged Steel
	(b) Clamp Body & Keeper		Malleable cast iron / SGI
	(c) U- Bolt		Mild Steel (Fe 410, IS 2062)
2.	Total Drop (Maximum)	mm	150
3.	Breaking Strength (Minimum)	kN	25
4.	Slipping Strength	kN	9 to 14
5.	Galvanising		
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute

5. Tension Clamp for 7/3.15 mm GS Earthwire

Sl.	Description	Unit	Particulars/ Value		
1.	Material of components				
	(i) Anchor Shackle			Forged Steel	
	(ii) Compression Clamp				
	a) Steel Sleeve			Mild Steel (Fe 410, IS 2062)	
	b) Aluminium sleeve			Aluminium of purity 99.5%	
	c) Aluminium Filler sleeve			Aluminium of purity 99.5%	
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN		100-200	
3.	Dimension of sleeve Before compression				
			<u>Aluminium Sleeve</u>	<u>Steel Sleeve</u>	<u>Alu filler sleeve</u>
i)	Inside diameter	mm	22.00 ± 0.5	10.00 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	30.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5

iii)	Length	mm	220 ± 5	180 ± 5	25.0±2
4.	Dimensions of Sleeve after compression				
			<u>Aluminium Sleeve</u>	<u>Steel Sleeve</u>	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
5.	Slip strength	KN	53.20		
6.	Minimum Breaking strength of assembly (excluding clamp)	KN	70		
7.	Compression Pressure	Ton	100		
8.	Galvanising				
a)	Minimum weight of Zinc coating for steel parts	gm/m ²	600		
b)	Purity of Zinc used for galvanising	%	99.95 (IS 209) or 98.5 (IS 13229)		
c)	Min. No. of dips in standard preece test the ferrous parts can withstand (wherever applicable)	No.	a) Fasteners: 4 dips of 1 minute b) Spring washers: 3 dips of 1 minute & c) all others: 6 dips of 1 minute		

SECTION-6

TECHNICAL SPECIFICATION OF DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS

6.1.0 SCOPE.

6.1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery at site, testing and commissioning for manufacturers of disc Insulators as per technical requirements furnished in this specification.

These insulators are to be used in suspension and tension insulator strings for the suspension and anchoring of the conductors on EHV transmission line towers.

6.1.2 Following are the list of documents constituting this package.

- (i) Technical specification.
- (ii) Technical data sheet.
- (iii) Drawings of insulators

6.1.3 All the above volumes along with amendments there of shall be read and interpreted together. However, in case of a contradiction between the “Technical Specification” and any other volume, the provisions of this volume will prevail.

6.1.4 The insulators shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which in his judgment, is not in full accordance therewith.

6.2.0 STANDARDS:

6.2.1 Except as modified in this specification, the disc/porcelain long rod insulators shall conform to the following Indian Standards, which also includes latest revisions and amendments if any. Equivalent International and Internally recognized standards to which some of these standards generally correspond are also listed below.

Sl. No.	Indian Standard	Title.	International Standard.
1.	IS: 206	Method for Chemical Analysis of Slab Zinc.	
2.	IS: 209	Specification for Zinc.	BS: 3436
3.	IS: 731	Porcelain insulators for overhead power lines with a normal voltage greater than 1000V	BS: 137(I&II); IEC 60274 IEC 60383
4.	IS: 2071 Part-(I)	Method of High Voltage Testing.	
	Part-(II)		
	Part-(III)		
5.	IS: 2121 (Part-I)	Specification of Conductors and Earth wire Accessories for Overhead Power lines. Armour Rods, Binding wires and tapes for conductor.	
6.	IS: 2486	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V.	
	Part – I	General Requirement and Tests.	BS: 3288
	Part – II	Dimensional Requirements.	IEC: 60120
	Part – III	Locking devices.	IEC: 60372

7.	IS: 2629	Recommended practice for Hot Dip Galvanisation for iron and steel.	
8.	IS: 2633	Testing for Uniformity of Coating of Zinc coated articles.	
9.	IS: 3138	Hexagonal Bolts & Nuts.	ISO/R 947 & ISO/R 272
10.	IS: 3188	Dimensions for Disc Insulators.	IEC: 60305
11.	IS: 4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R 262-1969 & R965-1969
12.	IS: 6745	Determination of weight of zinc coating on zinc coated iron and steel articles.	
13.	IS: 8263	Methods of RIV Test of HV insulators.	IEC 60437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse Test on HV insulators.	IEC: 60506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 60575
16	IEC	Ceramic Long Rod Insulators	IEC: 60433

6.2.2 The standards mentioned above are available from

Reference.	Name & Address:
BS	British Standards, British Standards Institution, 101, Pentonville Road, N- 19 ND,U.K
IEC / CISPR	International Electro technical commission Electro Technique International. 1, Rue de verembe Geneva SWITZERLAND.
IS	Bureau of Indian Standards, Manak Bhavan, 9 Bahadurshah Zafar Marg, New Delhi-110001,
ISO	International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej- 12 DK-2900 Hellestrup DENMARK.

6.3.0 PRINCIPAL PARAMETERS.

6.3.1 DETAILS OF DISC INSULATORS:

6.3.1.1 The Insulator strings shall consist of standard discs for use in three phases. 50 Hz effectively earthed 33/132/220 KV transmission system of AEGCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type. Radio interference data and have characteristics as shown in Table-I and all ferrous parts shall be hot dip galvanized as per the latest edition of IS 2629. The zinc to be used for making sleeves shall be 99.95 % pure.

6.3.1.2 The size of disc insulator, minimum creepage distance the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware shall be as follows:

PRINCIPAL PARAMETERS OF THE DISC INSULATORS:-

Sl. No.	Type of String.	Size of disc. Insulator (mm)	Minimum creepage distance of each disc (mm),	No. of standard discs 132 KV /220 KV/400kV	Electro-mechanical strength of insulator string fittings (KN)
1.	Single suspension	255 x 145	320	1x9/1x14 /-	70 KN/90 KN Normal Disc Insulator
2.	Double suspension.	-do-	-do-	2x9/2x14 /-	70 KN/90 KN Normal Disc Insulator
3	Single suspension	255 x 145	430	1x9/1x14 /-	70 KN/90 KN Antifog Insulator
4	Double suspension.	-do-	-do-	2x9/2x14 /-	70 KN/90 KN Antifog Disc Insulator
5.	Single Suspension	280 x 145	430	1x10/1x15 /-	120 KN Anti fog Disc insulator
6.	Double suspension	280 x 145	430	2x10/2x15 /-	120 KN Anti fog Disc insulator
7.	Single Tension	305 X 170	475	1x10/1x15/1x25	160 KN Anti fog Disc insulator
8.	Double Tension	305 X 170	475	2x10/2x15/2x25	160 KN Anti fog Disc insulator
9.	Single Suspension	280 x 145	430	1x10/1x15/1x25	120 KN Anti fog Disc insulator
10.	Double suspension	280 x 145	430	2x10/2x15/2x25	120 KN Anti fog Disc insulator

6.3.2 SPECIFICATION DRAWINGS:

6.3.2.1: The Specification in respect of the disc insulators are described, the specification is for information and guidance of the bidder only. The drawings to be furnished by the supplier shall be as per his own design and manufacture and in line with the specification.

6.4.1 Porcelain glaze:

The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator and shall have a good lusture, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not crack or chip by ageing under the normal service conditions. The glaze shall have the same coefficient of expansion as of the porcelain body throughout the working temperature range.

6.4.2 METAL PARTS:

6.4.2.1 Cap and Ball Pins:

Ball pins shall be made with drop forged steel caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together welded, shrink fitted or by any other process from more than one piece of materials. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade composition and mechanical properties of steel used for caps and pins. The cap and pin shall be of such design that it will not yield or distort under the specified mechanical load in such a manner as to change the relative spacing of the insulators or add other stresses to the shells. The insulator caps shall be of the socket type provided with nonferrous metal or stainless-steel cotter pins and shall provide positive locking of the coupling.

6.4.2.2 Security Clips:

The security clips shall be made of phosphor bronze or of stainless steel.

6.4.3 FILLER MATERIAL:

Cement to be used, as a filler material be quick setting, fast curing Portland cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contact with it and its thickness shall be as small and as uniform as possible.

6.4.4 MATERIALS DESIGN AND WORKMANSHIP:**6.4.4.1 GENERAL:**

(I) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw material quality control and to stage testing/ quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission lines.

(II) The design, manufacturing process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish elimination of sharp edges and corners to limit corona and radio interference voltages.

6.4.4.2 INSULATOR SHELL:

The design of the insulator shells shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

6.4.4.3 METAL PARTS:

i) The pin and cap shall be designed to transmit the mechanical stress to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of a string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blowholes and rough edges. All metal surfaces shall be perfectly smooth with no projecting part or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stress uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

6.4.4.4 GALVANIZING:

All ferrous parts, shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, smoothly adherent, reasonably light, continuous and free from impurities such as flux, ash, rust stains, bulky

white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

6.4.4.5 CEMENTING:

The insulator design shall be such that the insulating medium shall not directly engaged with hard metal. The surface of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. High quality Portland cement shall be used for cementing the porcelain to the cap & pin.

6.4.4.6 SECURITY CLIPS (LOCKING DEVICES)

The security clips to be used as locking device for ball and socket coupling shall be „R” shaped hump type to provide for positive locking of the coupling as per IS: 2486 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall resilient corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation, which placed in position, and under no circumstances shall it allow separation of insulator units and fittings. „W” type security clips are also acceptable. The hole for the security clip shall be counter sunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked positions shall not be less than 50 N (5 kg.) or more than 500 N (50 kgs.).

6.4.4.7 MARKING:

Each insulator shall have the rated combined mechanical and electrical strength marked clearly on the porcelain surface. Each insulator shall also bear symbols identifying the manufacturer, month, and year of manufacture. Marking on porcelain shall be printed, not impressed, and shall be applied before firing

6.4.5 BALL AND SOCKET DESIGNATION:

The dimensions of the ball and sockets for 70 and 90 KN insulator strings shall be of 16 mm and for 120 KN and 160 KN insulator strings shall be of 20 mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-II).

6.4.6-DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

It shall be ensured that the dimensions of the disc insulators are within the limits specified below:

Sl. No.	Diameter of Disc (mm)	Standard in Mm	Maximum	Minimum
1.	70 KN/90 KN & 120 KN	255/255 & 280	As per IS	As per IS
2.	160 KN	305	As per IS	As per IS
(b)				
Sl. No.	Ball to Ball spacing Between Discs (mm)	Standard in Mm	Maximum	Minimum
1.	70 KN/90 KN/120 KN	145	As per IS	As per IS
2.	160 KN	170	As per IS	As per IS

NOTE: Tolerance as per relevant IS (Latest edition).

(6.4.7) GUARANTEED TECHNICAL PARTICULARS FOR ANTIFOG DISC INSULATORS

Sl. No.	DESCRIPTION	70 KN	90 KN	120KN	160 KN
1.	Manufacture's name & address				

2	Type of Insulator	Ball & Socket	Ball & socket	Ball & socket	Ball & socket
3	Size of ball & socket	16B	16B	20	20
4	Dimensions				
(a)	Disc diameter	255	255	280	305
(b)	Unit spacing	145	145	145	170
(c)	Creepage distance of the single insulator-mm	430	430	430	475
5	Electro-mechanical strength of single insulator-kN	70	90	120	160
6	Materials of shell	Porcelain	Porcelain	Porcelain	Porcelain
7	Electrical value				
7.1	Power frequency Withstand Voltage Disc				
	(a) Dry-kV (rms)	80	80	85	90
	(b) Wet-kV (rms)	45	45	50	50
7.2	Power frequency Flashover Voltage Disc				
	(a) Dry-kV (rms)	85	85	90	95
	(b) Wet-kV (rms)	50	50	55	55
7.3	Impulse Withstand Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)	125	125	130	135
	(b) Negative – kV(Peak)	125	125	130	135
7.4	Impulse Flashover Voltage Disc				
	1.2/50 micro second				
	(a) Positive – kV(Peak)	135	135	140	145
	(b) Negative – kV(Peak)	130	130	135	140

6.4.8 INTERCHANGEABILITY:

The insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with hardware fittings of any make conforming to relevant Indian Standards.

6.4.9 CORONA AND RIV PERFORMANCE:

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subject to excessive localized pressure. The metal parts and porcelain shall not produce any noise-generating

corona under all operating conditions

6.5.0 SUITABILITY FOR LIVE LINE MAINTENANCE:

The insulator shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operation can be carried out with easy speed and safety.

6.5.1 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

- 1) Ball pin shake.
- 2) Cementing defects near the pin like small blow holes, small hair cracks lumps etc.
- 3) Sand fall defects on the surface of the insulator.

6.5.2 INSULATOR STRINGS:

6.5.2.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/220 KV 50 Hz effectively earthed systems in an atmosphere with pollution level as indicated in project synopsis. Suspension insulator strings for use with suspension/tangent towers are to be fitted with discs 70/90 KN EMS rating while tension insulator strings for use with Anchor/ Tension towers are to be fitted with discs of 120 KN / 160 KN EMS level rating.

6.5.2.2 STRING SIZE:

The sizes of the disc insulator, the number to be used in different types of strings, their electro-mechanical strength and minimum nominal creep age distance shall be as given in clause 10.3.1.2.

6.5.3 STRING CHARACTERISTICS

6.5.3.1 The characteristics of the complete string shall be as follows:

Sl. No.	Description.	Suspension.		Tension.	
		132KV	220kV	132KV	220KV
I	Switching surge withstand voltage (dry& wet) KV Peak	-	-	-	-
II	Lighting impulse withstand voltage (dry) KV Peak.	650	1050	650	1050
III	Power frequency without voltage (wet) KV r.m.s.	275	460	275	460
IV.	Corona extinction voltage level KV rms	-	176	-	176
V	Max. RIV for comp. Etc. strong including corona rings at 156 KV (rms). ... hours clamps etc. at 1.1. times maximum knee to ground voltage (micro volts).	-	500	-	500
VI.	Mechanical failing load for each string (kgf)	6500	11500	11500	15500
VII.	No deformation load for each string (kgf)	-	7705	-	10385
VIII	Max. voltage across any disc.	13%	13%	13%	13%

6.5.3.2 Insulator units after assembly shall be concentric and coaxial within limits as permitted by Indian Standards.

16.5.3.3 The strings design shall be such that when units are coupled together there shall be contact between the shell of one unit and metal of the adjacent unit.