ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

CONSTRUCTION OF TRANSMISSION LINES

1)132 KV SC/DC,

2)220 KV SC/DC AND

3)400 KV DC

TRANSMISSION LINES

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 OPTCL Transmission System.

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 —

a) 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.

b) The system will be in continuous operation during the varying atmospheric and climatic conditions occurring at all seasons

1.0 SCOPE-

Construction of 400 KV, 220 KV and 132 KV

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

Important: Contractor has to obtain project license from the competent authority in respect of the mentioned works prior to commencement of the works. The expenses towards the project license have to be borne by the contractor.

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

2.1.1 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 borne by him. However, OPTCL shall render all helps in co-ordination with law and order department for solving the same. Forest clearance if any shall be arranged by OPTCL.

2.1.2 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.

2.1.2.1 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.

© 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.

(d) The line is far away from telecommunication lines as reasonably possible. Parallelism with these lines shall be avoided as far as practicable.

(e) Crossing with permanent objects are minimum but where unavoidable preferably at right angles.

(f) Difficult and unsafe approaches are avoided.

(g) The survey shall be conducted along the approved alignment only in accordance with IS: 5613 (Part-II/Section-2), 1985.

(h) For river crossing/ Crossing of Nallas : Taking levels at 20 metre interval on bank of river and at 40 metre interval 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.

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.Thecontractor shall

Only approved sag template shall be used for tower spotting and the final profiles.
However preliminary survey has been done by OPTCL and any further survey required shall be done by the contractor.

2.1.2.2 PROFILE PLOTTING AND TOWER SPOTTING

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.

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.

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

(b) Individual span shall be as near as to the normal design ruling span.

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.

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.

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.

2.1.2.3 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.

2.1.2.4 CHECK SURVEY

The contractor shall undertake the check survey during execution on the basis of the alignment profile drawing and tower schedule approved by the employer. If during check survey necessity arises for minor change in route to eliminate way leave or other unavoidable constraints, the contractor may change the said alignment after obtaining prior approval from the employer.

The contractor, while carrying out the check survey, shall peg mark the power position on ground conforming to the survey charts. In the process, it is necessary to have the pit centers marks according to the excavating marking charts to be prepared by the contractor and approved by the employer. The levels up or down of each pit center with respect to the center of the tower location shall be noted and recorded for determining the amount of earth work required to meet the design. At the charting point of the route

survey, an angle iron spite shall be driven firmly into the ground showing a little above the ground level.

2.1.2.5 WAY-LEAVE AND TREE CUTTING

Way-leave permission which may be required by the contractor shall be arranged at his cost. While submitting final-survey report for approval, proposals for way-leave right of way shall be submitted by the contractor. Employer may extend help to get the permission within a reasonable time as mutually agreed upon for which due notice shall be given by the contractor in such a way so that obtaining permission from appropriate authority do not hinder the continued and smooth progress of the work.

The employer shall not be held responsible for any claim on account of damage done by the contractor or his personnel to trees, crops and other properties.

The contractor shall take necessary precaution to avoid damage to any ripe and partially grown crops and in the case of unavoidable damage, the employer shall be informed and necessary compensation shall be paid by the contractor.

All the documents required for application to the statutory authorities must be prepared by the contractor & submission to the employer for Submission of the application towards approval of PTCC, Railway Crossing etc. However, the responsibilities lies with the contractor to get the clearance.

Trimming of tree branches or cutting of a few trees en-route during survey is within the scope of survey to be done by the contractor. Contractor shall arrange for necessary way-leave and compensation in this regard. During erection of the line, compensation for tree cutting, damage caused to crops, actual cutting and felling of the trees including way-leave permission for such route clearance shall be arranged by the contractor at his cost. The contractor will identify the number of trees and detail of obstructions to be removed for erection of the line and intimate the employer well in advance in case of any help. Other related works like construction of temporary approach roads, etc. as required, shall be done by the contractor and the same will lie within the scope of contractor's work and such cost shall be considered to be included in the rates quoted by him.

While quoting the rate for detailed and check survey as per bidding activity schedule, the contractor shall include all costs involved in different activities described herein earlier.

2.0 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.

2.1 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.

2.1.1 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.

2.1.3 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.

(a) 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.

(b) 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.

(c) 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.

(d) 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.

(e) Standard penetration test as per IS: 2131 with latest amendment shall have to be conducted in different strata and recorded properly.

(f) 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.

(g) Plate Load test shall have to be conducted at special tower location.

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.

(a) Natural moisture content, Liquid limit, Plastic limit and Plasticity index.
(b) Bulk, dry and buoyant density of soil.
(c) Void ratio (e-long P curve shall be submitted)
(d) Specific gravity.
(e) Grain size distribution (Sieve analysis and hydrometer analysis)
(f) Tri-axial and consolidation tests (consolidation undrained and consolidated drained as and when application in table, graph and drawing.
(g) Permeability tests
(h) Chemical tests for both water and soil samples at different layers.
(i) Evaluation of safe bearing capacity at different strata for square footings shall be done for a maximum value of 25-mm. settlements.
(j) At depts. From 3M to 10M be different strata.
(k) Factor of safety shall be considered as 3 for evaluation of safe bearing capacity of soil.
(l) Unconfined compression test for cohesive soil (=0) if encountered.

3.1 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)

(a) Geological information of the region.
(b) 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.
(c) Procedure of investigations employed and field and field as well as laboratory test results.

(d) Net safe bearing capacity and settlement computation for different types of foundations for various widths and depths of tower and building.
(e) Recommendations regarding stability of slopes, during excavations etc.
(f) Selection of foundation types for towers, transformers and buildings etc.
(g) Bore hole and trial pit logs on standard proforma showing the depths, extent of various soil strata etc.
(h) 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.
(i) 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.
(j) Deformation modulus from plate load test in various test depth/stratification.
(k) Coefficient of earth pressure at rest.
(l) Depth of ground water table and its effect on foundation design parameters.
(m) Recommendations regarding stability of slopes, during shallow excavation etc.
(n) Whether piles are necessary or not. If piles are necessary, recommendation of depth, diameter and types of piles to be used.
(o) 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.

3.1.2 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 recognised Standards.

1.		2.	3.	4.
1.		IS 209-1979	Specification for Zinc	ISO/R/752-1968 ASTM B6
2.		IS 226-1975	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 **/**A23.2
5.	a)	IS 398-1982 Part-I	Specification for aluminium conductors for overhead transmission purposes	IEC 1089-1991 BS 215-1970
	b)	IS 398-1982 Part-II	Aluminium conductor galvanised steel reinforced	BS 215-1970 IEC 1089-1991
	c)	IS 398-1994 Part-IV	Aluminium alloy stranded conductor	BS 3242-1970 IEC 1089-1991 ASTM 8393M86
	d)	IS 398-1982 Part-V	Aluminium conductor galvanised 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 of practice for use of structural steel in general building cons-	CSA S 16.1 BS 5950

		ruction.	
12.	a) IS 802-1995 (Part-I/Sec.I) (Part-I/Sec.II) -1992	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) IS 802-1978 (Part-II)	Code of practice for use of structural steel in overhead transmission line: Fabrication, galvanising, inspection and packing.	ANSI/ASCE 10-90 (1991)
	c) IS 802-1978 (Part-III)	Code of practice for use of structural steel in overhead transmission line towers: Testing.	ANSI/ASCE 10-90 (1991) IEC 652
13.	IS 1139-1966	Hot rolled mild steel, medium tensile steel and high yield strength deformed bars for concrete reinforcements.	CAN/CSA G30.18 ASTM A615 BS 4449
14.	IS 1367-1967	Technical supply conditions for threaded fasteners	
15.	IS 1489-1976	Portland pozzolena 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	
18.	IS 1786-1966	Cold twisted steel bars for concrete reinforcement.	
19.	IS 1778-1980	Reels and drums for bare conductors	BS 1559-194
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
22.	IS 2071 Part-I-1974 Part-II-1974 Part-III-1976	Method of high voltage testings	IEC 60
23.	IS 2121	Specification for conductor and earthwire accessories for overhead power lines.	
	a) Part-I -1981	Armour rods, binding wires	

		and tapes for conductors.	
	b) Part-II -1981	Mid-span joints and repair sleeve for conductors.	
	c) Part-III-1992	Accessories for earthwire.	
	d) Part-IV-1991	Non-tension joints.	
24.	IS 2131-1967	Method of standard penetration test for soils.	ASTM D 1 883
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 galvanising 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 section spring washers for bolts nuts, screws.	DIN 127-1970
31.	IS 3188-1965	Dimensions for disc insulators.	IEC 305-1978
32.	IS 4091-1967	Code of practice for design and construction of foundation for transmission line towers and poles.	ASCE/IEEE 691
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/CSA G 164 ASTM A153
35.	IS 5613 (Part-II/Sec-1) -1985 (Part-III/Sec.1)	Code of practice for design, installation and maintenance of overhead power lines (Section-I:	ANSI/ASCE 10-90(1991)

	-1989	Designs)	
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 insu-lators in respect of polluted conditions.	IEC 815-1986
50.		Tests on insulators of ceramic material or glass for overhead lines with a nominal voltage	IEC 383-1993 (Part I and II)

		greater than 1000 Volts.	
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 and studs with full loadability	ISO 898-1
	Part VI	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	
64.	IS 14000-1994	Quality management and quality assurance standards	ISO 9000-1994
65.		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

SUPPLY OF TOWER STRUCTURES FOR THE TRANSMISSION LINES

1.0 SCOPE

1.1 This specification provides for design, proto fabrication, galvanizing and delivery FOR (destination) of transmission line towers including super-structure stubs, tower extensions, stub-templates, tower accessories (Hangers, U-bolts, bird guards, anti-climbing devices), bolts and nuts, step bolts, flat and spring washers etc. as described hereinafter in this volume.

THE PRELIMINARY SURVEY WORK HAS ALREADY DONE AND THE FOLLOWING TOWERS HAVE BEEN DECIDED.

The contractor shall design the tower foundation and the concreting shall be done by M-20 grade concrete.

a) Wind effects:

Tower shall be designed for **reliability Level-I, Terrain category-I & Wind Zone-V** Design wind pressure on towers, conductors, earth wire and insulator string in the range of 30.45 mt. And above 45 mt. Height shall be computed as per IS-802(Part/Sec-I) 1995 Bidder shall furnish the maximum wind pressure adopted in their design against each component mentioned above.

b) Design Temperatures:

The following temperature range for the power conductor and ground wires shall be adopted for the line design:

(i) Minimum temperature: 5 deg. C

(ii) Everyday temperature of conductor: 32 deg. C

(iii) Maximum temperature of :

a) Conductor:ACSR 75 deg. C for ACSR

Moose/Zebra/Panther 90 deg. C for AAAC.

(**Double Moose conductor in 400 KV system)

b) Ground wire exposed to sun. 53 deg. C

The above values are subject to latest revision if any made in IS-802 (part-I/Sec-I) 1995

Maximum Tension:

Maximum tension shall be based on either:

a) at 5 deg. C with 2/3rd. full wind pressure or Conform to IS 802-1995

b) at 32 deg. C with full wind pressure whichever is more stringent. Part-I/Sec-I-Clause No.10.3

Factors of Safety & Span details:

Factor of Safety: Should conform to IS-802 Part-I-1995

Normal span: The normal span of the line shall be 350 meters of 220KV and 320 meters for 132 KV.

Wind & Weight Span:The wind and weight span to be adopted in the design of the structures shall be as follows:

(i) Wind span: The wind span is the sum of the two half spans adjacent to the support under consideration. In case of towers located on a perfectly horizontal terrain, this shall be the normal span. For design purpose the wind on conductor shall be calculated on a wind span of at least 1.1 times the normal span.

Weight Span: The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower. All C and D type towers shall be designed for uplift spans (minimum weight spans in the following table) also. These are applicable both for pointed and square cross arms.

For details of cross arms and towers , the span limits given below shall prevail.

Tower type.	400KV/220 KV				132 KV			
	Normal condition.		Broken wire condition.		Normal condition.		Broken wire condition.	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
A/DA & B/DA	525	100	315	100	500	100	300	100
C/DC & D/DD	600	100	360	100	500	100	300	100

1.1.1 The design of towers and their extensions shall be done conforming to the design parameters specified herein, the scope of design also includes supply of design calculation for towers and extensions including detailed structural/shop drawings of towers extensions and stub setting templates. The bidder, who has already type tested the various tower viz: 0-2˚, +3, +6; 0-15˚, +3, +6; 0-30˚, +3, +6; 0-60˚, +3, +6 (400/220/132 KV) in any nationally or internationally recognized laboratories, and conforming to our specification, may also offer the same.

1.1.2 STANDARDS

Except as modified in this specification, the material and work covered under this specification, shall conform to the latest revision with amendments thereof of the following of Indian Standards and equivalent International Standards whenever indicated below.

Sl. No.	Bureau of Indian standards (BIS)	Title	International & Internationally recognized standard
1.	IS:209	Specification for Zinc	ISO/R/752
2.	IS: 2062	Structural steel (Standard quality)	ISO/R/660
3.	IS: 432	Mild steel and medium tensile bars and for concrete reinforcement	BS-785CSA-G-30
4.	IS: 802	Code of practice for use of structural steel in overhead transmission line Part-I/Section-I & Section2: Load and permissible stresses Part-II: Fabrication Galvanizing Inspection and Packing	
		PART-III: TESTING	
5.	IS: 1367	Technical supply conditions for threaded fasteners	
6.	IS: 1893	Criteria of Earthquake resistant design structures	
7.	IS: 2016	Plain washers	ISO/R/987
8.	IS: 2551	Danger Notice Plates	
9.	IS: 2629	Recommended practice for hot dip galvanizing of iron and steel	
10.	IS: 2633	Method of testing uniformity of casting of zinc coated articles	
11.	IS: 3063	Single coil rectangular section spring washers for bolts, bolts, screws	DIN-127
12.	IS: 5358	Hot dip galvanized coatings on fasteners	
13.	IS:5613 Part-1 & 2 Of Section-I	Code of Practices for design, installation & maintenance of overhead power line	

14.	IS: 6610	Specification for heavy washers for stell structures.
15.	IS: 6745	Methods of determination of weight of zinc coating of zinc coated iron and steel articles.
16.	IS: 12427	Hexagonal bolts for steel structures
17.		INDIAN ELECTRICITY RULES 1956
18.		Publication for Regulation for electrical crossing or railway tracks

1.1.3 The standards mentioned above are available from

Reference/ Abbreviation	Name and Address from which the Standards are available
IS	BUREAU OF INDIAN STANDARDS Manak Bhavan, 9, Bahadur Shah Zafar Marg, NEW DELHI(India)
ISO	INTERNATIONAL ORGANISATION FOR STANDARDISATION, Danish Board Standardisation, Danish Standardisening Street, Aurehoegbvej-12, DK-2900, Helleprup, DENMARK
CSA	CANADIAN STANDARD ASSOCIATION 178, Rexdale Boulevard, Rexdale, Ontario, CANADA M9W IR
BS	BRITISH STANDARDS British Standard Institution, 101, Pentonvile Road, N-19-ND-UK
DIN	DEUTSCHES INSTITUTE FIIR NOR Gurggrafenstrasse 5-10 Post Fach 1107 D-1000, Berlin – 30
INDIAN ELECTRICITY RULES 1956, REGULATION FOR	KITAB MAHAL Baba Kharak Singh Marg,

1.1.4 PRINCIPAL PARAMETERS

1.1.5 Electrical System Date:

a)	System voltage (kV rms)	400/220/132
b)	Max. voltage (kV rms)	420/245/145
c)	Lightning impulse withstand voltage (dry & wet) (kVp)	1550/1050/650
d)	Power frequency withstand voltage (wet) (KV rms)	630/395/275
e)	Short circuit level (KA for 1 sec.	40/40/31.5

1.1.6 Line data /

1.1.7 Conductor

a)	Name	ACSR Zebra	ACSR Moose	ACSR Panther
b)	Strength & wire dia			
i)	Aluminium	54/3.18	54/3.53	30/3.00
ii)	Steel	7/3.18	7/3.53	7/3.0
c)	Conductors per phase 1) 400 KV 2)220 KV 3)132 KV	Single	Double	Single
d)	Spacing between the conductors of same phase (sub-conductor spacing) (mm)	----	As per standard	----
e)	Inter-phase spacing (mm)	8,400	8,400	6800
f)	Configuration			

i)	Single circuit	Delta	Delta	Delta
ii)	Double circuit	Vertical	Vertical	Vertical
g)	Nominal Aluminium area (mm^2)	420	528.5	212.1
h)	Section area of Aluminium (mm^2)	428.90	597	261.5
i)	Total sectional area (mm^2)	484.50	597	262
j)	Calculated resistance at 20 c (Max.) ohm/km per conductor	0.06915	0.05552	0.140
k)	Approx. calculated breaking load (KN)(Minimum)	130.32	161.2	89.67
l)	Modulus of elasticity (GN/M^2)	69	69	82
m)	Co-efficient of linear exp. Per degree cent.	$19.3X10^{-6}$	$19.3X10^{-6}$	$17.8X10^{-6}$
n)	Mass of zinc in gms/sqm	…… 275……		
o)	Overall diameter (mm)	28.62	31.77	21.00
p)	Weight (kg/km)	1621	2004	974
q)	Minimum ultimate tensile strength (KN)	130.32	161.2	89.67
r)	Conductor tension at 32˚ C without external load			
i)	Initial unloaded tension	……..35%……		
ii)	Final unloaded tension	……25%…….		

1.1.8 Galvanized Steel Ground Wire

a)	Size (no. of strands/strand dia)	7/3.15 for 132 and 220 KV, and 7/3.66 for 400 KV
b)	Overall diameter (mm)	9.45(7/3.15) and 10.98(7/3.66)

c)	Standard weight (Kg/km)	432(7/3.15) and 583(7/3.66)
d)	Location of ground wire	One continuous ground wire Wire to run horizontally on the top of the towers for 132 and 220 KV and two ground wire for 400 KV lines.
e)	Tensile load in each ground wire (to be furnished by the Bidder)	
i)	At min. temp. of 5˚ C and in still air (kgs)	
ii)	At every day temp. of 32˚ C and still air (kgs)	
iii)	At 5˚ C and 2/3rd of full wind (kgs)	

1.1.8.1 Towers

a)	Span lengths in metres	ACSR Zebra	ACSR Moose	ACSR Panther
i)	Ruling design span	300	300	250
b)	Wind load (kg/sqm) on conductor	52	52	52
c)	Shielding angle with vertical	20˚	20˚	20˚
d)	Towers to be designed for heavy wind zone	V-zone	V-zone	v-zone

1.1.8.2 Insulator Strings(Disc)(Antifog type)

Sl. No.	Particulars	Single Suspension string	Double suspension string	Single Tension string	Double Tension string
1.	No. of standard Discs (nos)				
	1) 400 KV	1X25	2X25	1X25	2X25
	2) 220 kV	1X15	2X15	1X15	2X15
	3) 132 Kv	1X10	2X10	1X10	2X10
2.	Size of Disc (400kv/220kV/132 kv)	280x145/ 255X145/ 255X145	280x145/ 255X145/ 255X145	305x170/ 305x170/ 280x145	305x170/305x170/280x145
3.	Electromechanical strength (KN) (400 KV/220 kV/132	120/90/90	120/90/90	160/160/120	160/160/120

KV)

4.0 GENERAL TECHNICAL REQUIREMENTS

4.1 Tower Design – General

The employer is looking for a structurally safe design of transmission line towers to be installed on EHV lines keeping the loadings and line parameters detailed in this specification and in compliance with IS: 802 (Part-1/Sec-1)-1995, IS: 802(Part-1/Sec-2)-1992.

The Bidder may offer economical designs with rational sections or offer towers of recent design, proven in service and accepted by other reputed Central and State Sector Utilities and by OPTCL (Previously OSEB) confirming to this technical specification.

The technical particulars for vibration analysis and damping design of the system are as follows:

FOR 400kV LINES.

SL. No.	Description	Technical Particulars
1.	Configuration	Double Circuit Twin ACSR Moose 54/7//3.53 mm, conductor bundle per phase in horizontal formation and all three phases of each circuit in vertical configuration on each side of tower.
2.	Span length in meters	
	(i) Ruling design span	400 meters
	(ii) Maximum span	1100 meters
	(iii) Minimum span	100 meters
3.	Tensile load in each sub-conductor for ruling span	Wind Zone : 5 (50 m/s).
	a) At temperature of 5 deg-C and still air	3267 Kgf.
	b) At temperature of 5 deg.C and 36% full wind	4646 Kgf.
	c) At temperature of 32 deg.C and full wind	7805 Kgf.
4.	Armour rods used	Standard preformed armour rods/AGS
5.	Maximum permissible	+/- 150 micro strains

dynamic strain

FOR 220 kV and 132 kV LINES

SL.NO.	Description	Technical Particulars	
		220kV **ACSR ZEBRA** 54/7/ 3.18mm	132kV **ACSR PANTHER** 30/7/3.0mm
1.	Configuration	Double Circuit Single ACSR conductor per phase in vertical formation	Double Circuit Single ACSR conductor per phase in vertical formation
2.	Span length in metres		
	(I) Ruling design span	350 metres	300 metres
	(ii) Maximum span	1100 metres	1000 metres
	(iii) Minimum span	100 metres	100 metres
3.	Tensile load in each conductor for ruling span	Wind Zone:5 (50 m/s.)	Wind Zone:5 (50 m/s.)
	a) At temperature of 5 deg.C and still air	2919 Kgf.	1791Kgf.
	b) At temperature of 5 deg.C and 36% full wind	4090 Kgf.	2735Kgf.
	c) At temperature of 32 deg-C and full wind	6551 Kgf.	4469 Kgf.
4.	Armour rods used	Standard performed performed armour rods/AGS	Standard armour rods/AGS
5.	Maximum permissible dynamic strain	± 150 micro-strains	± 150 micro-strains

4.0 **DETAILS OF SOLID CORE LONG ROD INSULATORS**:

5.1 The insulator shall consist of standard-discs for a three-phase 50 Hz effectively earthed 220 KV transmission system heavily polluted atmosphere. The insulator shall be ball and socket type.

5.1 The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanically strength and mechanical strength of insulator string alongwith hardware shall be as follows:

Sl. No.	Type of string.	Size of long rod insulator (mm)/(Unit) 132/220 KV	Minimum creepage distance (mm) 132/220 KV	No.of unit 132/220 KV)	Electromechanical strength of insulator (KN) 132/220 KV)
1.	Single suspension	200X 1305 /210X2030	4000 / 6125	'1/2	90 KN
2.	Double suspension	-do-	-do-	'2/4	90 KN
3.	Single tension.	205 X 1450 / 215X2550	4300/7130	'1/2	120 KN/160 KN
4.	Double Tension.	-do-	-do-	'2/4	120 KN/160 KN

5.0 **SPECIFICATION DRAWINGS**:

6.1 A list of specification drawings in respect of the long rod insulators indicated above is given at Annexure-II. These specification drawings are attached herewith 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 shall be distinct and separate from these specification drawings.

6.0 **GENERAL TECHNICAL REQUIREMENT**:

7.1 **PORCELAIN**:

The porcelain used in the manufacture of the shell shall be ivory white, nonporous of high dielectric, mechanical and thermal strength free from internal stress blisters and thermal strength from internal stresses blisters, laminations, voids, foreign matter. Imperfections or other defects, which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid alkalis, and zinc of dust. The manufacturing shall be by the wet process and impervious character obtained by through vetrification.

7.2 **PORCELAIN GLAZE**:

Surfaces to come in contact with cement shall be made rough by stand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

7.3 METAL PARTS:

7.3.1 Cap and Ball pins:

Twin Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip g galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile

steel, drop forged and heat malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity with minimum of 6 dips. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

7.3.2 **SECURITY CLIPS**:

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

7.4 **FILLER MATERIAL**:

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

7.0 **MATERIAL DESIGN AND WORKMANSHIP**:

8.1 **GENERAL**:

i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials 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 voltage

8.2 **INSULATOR SHELL**:

The design of the insulator shell 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 temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

8.3 **METAL PARTS**:

a) The twin ball pin and cap shall be designed to transmit the mechanical stresses 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 insulator or 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.

b) 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 parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any macroscopically visible cracks, insulations and voids.

8.4 **GALVANIZING**:

All ferrous parts shall be hot dip galvanized six times in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 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.

8.4.1 **CEMENTING**:

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

8.5 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 sore adding after installation to prevent complete withdrawal from the socket. The locking device shall be 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 when placed in position and under no circumstances shall it allow separation of insulator units and fitting 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk 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 position shall not be less than 50 N (5 Kgs.) or more than 500N (50 Kgs.)

8.6 **BALL AND SOCKET DESIGNATION**:

The dimensions of the balls and sockets for 80 KN long rod insulators shall be of 16mm and for 120 KN shall be of 20mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-III).

8.7 DIMENSIONAL TOLERANCE OF INSULATORS DISCS

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ISS.

Bundle spacer (only for 400kV lines)

Armour grip bundle spacers shall be used to maintain the spacing of 450 mm 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 offer shall include placement charts recommending the number of spacers per phase per span and the sub span lengths to be maintained between the spacers while installing on the twin bundle conductors.

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.

The placement chart shall be provided for spans ranging from 100m to 1100m. The number of spacers recommended for a nominal ruling span of 400m shall however be not-less than six.

The Bidder shall also furnish all the relevant technical documents in support of their placement charts along with the Bid.

Jumpers at tension points shall also be fitted with spacers so as to limit the length of free conductor to 3.65 m and to maintain the sub conductor spacing of 450 mm. Bidder shall quote for rigid spacer for jumper. It shall meet all the requirements of spacer used in line except for its vibration performance. Spacers requiring retaining rods shall not be quoted for jumpers. For slack span also rigid spacers shall be used with maximum spacing of 30 metres.

The spacer offered by the Bidder shall satisfy the following requirements:

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

For spacers requiring preformed retaining rods, the retaining rods shall be designed for the specified conductor size. The rods shall be made of high strength special aluminium alloy of type 6061 or equivalent aluminium alloy having minimum tensile strength of 35 kg/sqmm. The ends of retaining rods shall 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 rods shall be applied on each clamp to hold the clamp in position. The minimum diameter of the rods shall 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 shall be forged from aluminium alloy of type 6061 or equivalent aluminium alloy having minimum tensile strength of 35 kg/sqmm. 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. The clamp grooves shall be in uniform contact with the conductor over the entire clamping surface, except for rounded edges. The groove of the clamp body and clamp cap shall be smooth and free of projections, grit or other material, which may cause damage to the conductor when the clamp is installed. For the spacers 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 5kN. 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. No rubbing, other than that of the conductor clamp hinges or clamp swing bolts shall take place between any parts of the spacer. Joints incorporating a flexible medium shall be such that there is no relative slip between them.

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 shall not damage or chafe the conductor in any way which might affect its mechanical and fatigue strength or corona performance. The clamping system shall be designed to compensate for any reduction in diameter of conductor due to creep. The spacer assembly shall not have any projections, cuts, abrasions or chattering parts which might cause corona or RIV. The spacer tube shall be made of aluminium alloy of type 6061 or equivalent aluminium alloy. If fasteners of ferrous material are used, they shall conform to and be galvanised conforming to relevant Indian Standards. The spacers involving ferrous fasteners shall not have magnetic power loss more than one watt at 600 amps., 50 Hz alternating current per subconductor. Elastomer, if used, shall be resistant to the effects of temperature up to 85 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 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 and reinstallation without any damage. The spacer assembly shall be capable of being installed and removed from the energised line by means of hot line techniques.

Spacer damper (only for 400kV lines)

As an alternative to vibration dampers and bundle spacers combination, suitable spacer dampers for twin bundle AAAC 61/3.45 conductor may be offered. The spacer damper covered by this Specification shall be designed to maintain the bundle spacing of 450mm under all normal operating conditions and to effectively control aeolian vibrations as well as subspan oscillations to nominal conductor spacing after release of any external extra-ordinary load.

The spacer damper shall restore the normal subconductor spacing due to displacement by wind, electromagnetic and electrostatic forces including the specified short circuit level without permanent deformation or damage either to bundle conductors or to spacer damper itself.

The design offered shall be presented as a system consisting of a recommended number of spacer dampers together with their spacing schedule for spans ranging from 100m to 1100 m.

Under the operating conditions specified, the spacer damper system shall adequately control Aeolian vibrations throughout the life of the transmission line in order to prevent damage to conductor at suspension clamps, dead end clamps and at the spacer clamps.

The spacer damper system shall also control the sub span oscillations in order to prevent conductor damage due to chafing and due to severe bending stresses at the spacer damper clamps as well as suspension and dead end clamps and to avoid wear to spacer damper components.

The spacer damper shall consist of a rigid central body called the frame, linked to the conductors by two articulated arms terminated by suitable clamping system. The dynamic characteristics of the articulations shall be maintained for the whole life of the transmission line.

The clamping system shall be designed to provide firm but gentle and permanent grip while protecting the conductor against local static or dynamic stresses expected during normal operating conditions. The clamping system shall be designed to compensate for any reduction of conductor diameter due to creep.

The clamp of the spacer damper, when installed, shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation. The slip strength of the clamp shall be maintained between 2.5kN to 5kN. The tightening torque for the bolts, if applicable, shall be specified by the manufacturer to achieve the above slip strength.

Bolted type clamps shall allow installation without removal of the bolts or the clamps from clamp body. Locking mechanism shall be suitable to prevent bolt loosening. Clamp locking devices using small loose components shall not be accepted.

Bolts and nuts shall be of mild steel, stainless steel, or high strength aluminium alloy in accordance with the design of the spacer damper.

Where elastomer surfaced clamps are used, the elastomer elements shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061 or equivalent aluminium alloy having minimum tensile strength of 35 kg/sqmm. The insert shall be moulded on the insert surface. The insert shall be duly heat treated and aged to retain its consistent characteristics during service. The grain flow of the forged insert shall be in the direction of the maximum tension and compression loads experienced.

If clamps involving preformed rods are used, these rods shall be designed for specific conductor size. They shall be made of high strength aluminium alloy of type 6061 or equivalent aluminium alloy having a minimum tensile strength of 35 kg/sqmm. The rods shall be ball ended. The rods shall be heat treated and aged to achieve specified mechanical properties and to retain the same during service.

The spacer damper body shall be cast/forged from suitable high strength corrosion resistant aluminium alloy. The aluminium alloy shall be chosen in relation with the process used. However a combination of aluminium alloy and steel shall also be accepted.

The rubber components like damping elements involved in the design shall be made with rubber compound selected specifically for that particular application. The Bidder shall submit a complete list of physical and mechanical properties of the elastomer used. This list shall make reference to all applicable ASTM or other Internationally recognised standards.

The rubber compounds used shall have good resistance to the effects of temperature up to 85 deg.C and to ultra violet radiation, ozone and other atmospheric contaminants. The rubber shall have good wear and fatigue resistance and shall be electrically semi-conductive.

The spacer damper involving ferrous material shall not have magnetic power loss more than one watt at 600 amps., 50 Hz alternating current per sub conductor.

The spacer damper assembly shall have electrical continuity. The electrical resistance between the subconductors across the assembly in case of spacer damper involving elastomer surfaced clamps shall be suitably selected by the manufacturer to ensure satisfactory electrical performance and avoid deterioration of elastomer under service conditions.

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

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

The Bidder shall recommend the spacing between spacer dampers on the line which shall ensure the most satisfactory fatigue performance of the line as specified. The scheme shall indicate the number of spacer dampers per phase per span and the sub-span lengths to be maintained between spacer dampers when installed on the twin bundle conductors.

The number of spacer dampers and their spacing shall be provided for spans ranging from 100 to 1100m. The number of spacer dampers for a nominal ruling span of 400 m shall be not less than six.

No sub-span shall be greater than 70m and no end sub-span shall be longer than 40 metres.

The proposed scheme shall be such that the spacer dampers be unequally distributed along the span to achieve sufficient detuning of adjacent sub-spans for oscillations of sub-span mode and to ensure bundle stability for wind speeds up to 30 kms/hr (8.33 m./sec.).

The Bidder shall furnish all the relevant technical documents in support of the staggering scheme recommended for the spacer damper.

The Bidder in the latter case shall forward documentation of proto type tests conducted and acceptance given by the user authorities as also performance report for such towers in service.

Vibration dampers

All the requirements for vibration damper suitable for line conductors, shall also be applicable for galvanised steel earthwires (7/3.66mm. for 400kV and 7/3.15mm. for 220kV/132kV lines). Minimum one damper on each side per earth wire at suspension point and two dampers on each side at tension point shall be used for ruling design span. Bidders may offer damping systems involving a greater number of dampers for ruling design span; however, suitable price compensation shall be considered for evaluation.

The vibration analysis of the system, with and without dampers, dynamic characteristic of the damper as detailed shall be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the system are as follows :

For 400kV Lines

Sl. No.	Description	Technical Particulars
1.	Configuration	Two galvanised steel earthwires in horizontal configuration
2.	Span length in meters	
	Ruling design span	400 meters
	Maximum span	1100 meters
	Minimum span	1 00 meters
3.	Tensile load in each earthwire for ruling span (50m/s) Wind Zone : 5	
	a) At temperature of 5^{o} C and still air	1368 Kgf
	b) At temperature of 5^{o} C and 36% full wind	2056 Kgf
	c) At temperature of 32^{o} C and full wind	3593 Kgf
4.	Maximum permissible dynamic strain	+/- 150 micro strains

For 132kV and 220kV Lines

Sl. No.	Description	Technical Particulars

1 .	Configuration	One galvanised steel earthwire in horizontal configuration .	
2.	Span length in meters	220 kV Line	132 kV Line
	Ruling design span	350 meters	300 meters
	Maximum span	1100 meters	1000 meters
	Minimum span	100 meters	100 meters
3.	Tensile load in each earthwire for ruling span	Wind Zone:5 (50m/s)	Wind Zone:5 (50m/s)
	a) At temperature of 5 deg.C and still air	1120 Kgf.	1120 Kgf.
	b) At temperature of 5 deg.C and 36% full wind	1667 Kgf.	1606 Kgf.
	c) At temperature of 32 deg.C and full wind	2815 Kgf.	2625 Kgf.
4 .	Maximum permissible dynamic strain	+/- 150 micro strains	+/- 150 micro strains

Flexible copper bond

At suspension and tension towers the earth wire suspension and tension clamps shall be securely bonded to the tower steelwork by means of a multi-strand flexible copper bond wire. The copper bond shall be sufficiently flexible to allow movement of the suspension clamp under all operating conditions and terminated with compression lugs.

The flexible copper bond shall be of nominal 34 sq.mm equivalent copper area and not less than 500 mm in length. It shall consist of 259 wires of 0.417 mm dia. tinned copper conductor. It shall be laid up as seven stranded ropes, each of 37 bunched wires. The tinning shall be as per IS 9567. Two tinned copper connecting lugs shall be press jointed to either ends of the flexible copper cable. One lug shall be suitable for 12 mm, dia. bolt and the other for 16 mm dia. bolt. The complete assembly shall also include one 16 mm dia., 40 mm long mild steel bolt hot dip galvanised with nut and lock washers

Arcing horn

The arcing horn shall be either ball ended rod type or tubular type and shall be formed from galvanised mild steel and of approved types. The arcing horns shall be attached in an approved manner to all suspension and tension insulator sets. The horns shall be attached to the insulator fittings, but not directly to conductor clamps or to the caps of insulator units. The design of the arcing horns shall be such as to reduce, as far as reasonably possible, damage to the line conductors, clamps, insulator strings and arcing horns themselves under all flashover conditions. The

general shape and method of attachment of the live end arcing horn shall also not restrict the replacement of insulators under live line conditions.

The total effective arcing distance shall be 1530mm., 2130mm. and 3050 mm. for 132kV, 220kV and 400kV respectively under nominal dimensions of insulator.

Arcing horns shall be provided on tower and/or line side as indicated on the enclosed string sketches, however, same has been tabulated below for ready reference :

SL.No.	Voltage Level	Types of Strings	Arcing horns to be provided on	Min. Arcing dist. to be maintained(mm)
1.	2.	3.	4.	5.
1.	132kV and 220kV	Single 'I' suspension strings	Line side only	1530(for132kV)& 2130(for 220kV)
1.	2.	3.	4.	5.
2.	-do-	Double suspension strings	Both on line side and tower side	1530(for132kV)& 2130(for 220kV)
3.	-do-	Single tension strings	Line side only	-do-
4.	-do-	Double tension strings	Both on line side and tower side	-do-
5.	400kV	Single 'I' suspension and pilot strings	Tower side (corona/grading rings on line side)	3050
6.	-do-	Double suspension strings	-do-	-do-
7.	-do-	Single tension strings	-do-	-do-
8.	-do-	Double tension strings	-do-	-do-

4.1.1 Transmission Towers

4.1.2 General Description

The towers shall be of the following types:

(b) Double Circuit (A, B, C & D)
(c) Special Towers (River Crossing, Railway Track Crossing, Power Line Crossing etc.)

Types Of Towers

The towers shall normally be of the following standard types, and as stated in Schedule C.

Type of Tower	Deviation Limit	Typical Use

(1)	(2)	(3)
DA/OA/PA	0deg- 2deg	a) To be used as tangent tower with suspension strings. b) Also to be designed for specified broken wire conditions.
DB /0B/PB	0 deg- 15deg	a) Angle towers with tension insulator string b) Also to be designed for unbalanced tension resulting from unequal ruling span of 400m and 200m (for 400kV), of 350m and 250m (for 220kV) and of 300m and 200m (for 132kV)on each side of the tower. c) Also to be designed for uplift forces resulting from an up-lift span of 200m under broken wire conditions. d) Also to be designed for specified broken wire conditions. e) Also to be designed for anti-cascading condition.
DB/OB/PB	0 deg.	f) To be used as section tower.
DC/OC/PC	15 deg-30 deg.	a) Angle tower with tension insulator strings. b) Also to be designed for unbalanced tension resulting from unequal ruling span of 400m and 200m (for 400kV), of 350m and 250m (for 220kV) and of 300m and 200m (for 132kV)on each side of the tower. c) Also to be designed for uplift forces resulting from an up-lift span of 200m under broken wire conditions. d) Also to be designed for specified broken wire conditions.

e) Also to be designed for anti-cascading condition.

DC/OC/PC 0 deg. f) To be used as transposition tower with modifications (only where specified)

DD 30 deg-60 deg a) Angle tower with tension insulator string

b) Also to be designed for the unbalanced tension resulting from unequal ruling span of 400m and 200m (for 400kV), of 350m and 250m (for 220kV) and of 300m and 200m (for 132kV) on each side of the tower.

c) Also to be designed for uplift forces resulting from an uplift span of 300m(for 400kV) and 200m (for 132kV and20kV) under broken wire conditions.

d) Also to be designed for specified broken wire conditions.

e) Dead end with 0 deg to 15 deg deviation on line and 0 deg to 30 deg for sub-station side (slack span side).

DD 0 deg f) Complete dead end.

g) For river crossing anchoring with longer wind span with 0 deg deviation on crossing span side and 0 deg to 30 deg deviation on other sides .

Note: The above towers can also be used for longer span with smaller angle of deviations. (To be decided as per the tower spotting data to be submitted by the Contractor and approved by Project Manager.)

4.1.3 The towers shall be of the self-supporting type, built up of lattice steel sections or members and designed to carry the power conductors with necessary insulators. Ground wires and all fittings under all loading conditions. Outline diagrams of the towers required are to be furnished by the Bidder.

4.1.4 The towers shall be fully galvanized structures built up of structural mild steel sections. All members shall be connected with bolts, nuts and spring washers.

For design of structure weight span limits given in Table 5.1 shall prevail.

TABLE 5.1 (a)
For 132 kV Line

Tower Type	Normal Condition Max. (m)	Min. (m)	Broken Wire Cond Max. (m)	Min. (m)
DA	450	150	270	100
DB, DC & DD	450	0	270	-200

TABLE 5.1 (b)
For 220 kV Line

Tower Type	Normal Condition Max. (m)	Min. (m)	Broken Wire Cond Max. (m)	Min. (m)
DA	525	200	315	100
DB, DC & DD	525	0	315	-200

TABLE 5.1 (c)
For 400 kV Line

Tower Type	Normal Condition Max. (m)	Min. (m)	Broken Wire Con Max. (m)	Min. (m)
DA	600	200	360	100
DB, DC	600	0	360	-200
DD	600	0	360	-300

However, for calculating the tower height, an allowance of 150mm shall be provided, over and above the specified ground clearances, at still air and maximum conductor temperature, to account for any stringing error.

TABLE

Situation	Minimum clearance (metres)		
System voltage (kV):	**132**	**220**	**400**
Normal ground (open country)	6.10	7.015	8.84
* Road crossings, road level	7.00	7.90	9.7
Rail crossings, rail level:	17.9	17.9	19.3
River crossings, bank level			
River crossings, navigable rivers, above highest as specified by the Authority			
flood level;(data to be obtained from Navigation Authority)			
Above trees	4.0	4.6	5.5
Buildings, poles, structures and walls, etc.			
upon which a man may stand : horizontal clearance	4.6	5.5	7.3
Same above : vertical clearance	2.9	3.8	5.6
Power lines	3.1	4.6	6.1

*Any road which is normally maintained by Government and/or other recognised public authority.

4.1.5 Stubs and Superstructures:

(i) The stub shall mean a set of four stub angles fully galvanized from the and shall include cleats, gussets, bolts and nuts, etc. the black portion of the stub being cast in foundation footings. Stub length shall correspond to foundation depth of 3-0 metres from ground level.

(ii) Superstructure shall mean the galvanized tower assembly above the stubs which includes structural members like angle sections, cross arms, ground wire peaks, accessories and fittings such as gusset plates, pack washers, spring, washers, ladders, step bolts, anti climbing devices and such other items which are required for completing the towers in all respect. Steel and zinc required for manufacturing these items will be arranged by the supplier.

(iii) Supply of bolts and nuts and spring washers, hangers/D-shackles for attaching suspension strings and 'U' bolts for attaching ground wire suspension assemblies are included in the supply of tower.

(iv) The following provisions shall apply in connection with the procurement of steel and zinc by the supplier.

(a) The steel used for fabrication of tower parts extensions, templates etc. shall be of mild steel of tested quality as per IS:2062 GRA.

(b) The Bidder shall take into account the fabrication wastage while quoting the rates. The employer will not accept any liability in connection with the wastage of steel during fabrication or otherwise.

(c) The Bidder shall indicate in his offer the sizes of steel sections which are proposed to be used by him in the design of towers.

(d) Substitutions, if any, of steel sections of the tower parts by higher sizes, due to non-availability or otherwise shall be to the supplier's account. The employer will not accept any liability on this account.

(e) The steel shall be procured exclusively from the main steel producers. However, sections not rolled by main producers, can be procured from re-rollers provided.

Re-rolling of structural steel sections is done from billets/ingots of tested quality.

Re-rolled sections are duly tested as per relevant standard.

(f) The zinc used for galvanizing fabricated material shall be of High Grade Electrolytic zinc.

4.1.6 Extensions:

a) The towers shall be designed so as to be suitable for adding 3 metres, 6 metres, 9 metres extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.

b) The Buidder shall have to design leg extensions for all types of towers ranging from minus 3 metres to plus 9 metres at intervals of 1.5 metres and such leg extensions shall be suitable for being fitted to a normal tower as well as a tower with extensions. This is to enable tower spotting in hilly terrain.

4.1.7 Stub setting Templates:

Stub templates shall be designed and supplied by the supplier as per requirement for all types of towers with or without extensions. Stub templates for standard towers and towers with extension shall be fined type. The stub templates shall be painted with anti-corrosive paints.

4.1.8 Fasteners: Bolts, Nuts & Washers

4.1.9 All bolts shall be of property class 5.6 and nuts of property class 5.0 IS: 1367 (Part – 3) 1991 and IS: 6639-1972 shall conform to IS: 12427, they shall be galvanized and shall have hexagonal heads and nuts, the heads being forged out of solid steel rods and shall be truly concentric and square with the shank. The shank shall be perfectly straight.

4.1.10 ully threaded bolts shall not be used, the length of bolts should be such that the threaded portion shall not extend into the place of contact of the members.

4.1.11 ll bolts shall be threaded to take the full depth of the nut and threaded far enough to permit firm gripping of the members, but not any further. It shall be ensured that the threaded portion of each bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit hand tight to the point where the shank of the bolt connects to the head.

4.1.12 lat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be of electro-galvanized steel and of the positive lock type. Their thickness shall be 2.5 mm for 12 mm dia bolts, 3.5 mm for 16 mm dia bolts and 4.5 mm for 20 mm dia bolts.

4.1.13 he Bidder shall furnish bolt schedules giving thickness of members connected, size of bolts and nuts, the length of the shank, the length of the threaded portion of bolts, sizes of bolt holes, thickness of washers and any other special details of this nature.

4.1.14 To obviate bending stress in bolts or to reduce it to a minimum, no bolt shall connect aggregate thickness of more than three (3) times its dia.

4.1.15 he bolt positions in assembled towers shall be as per IS: 5613 (Part-I/Section-I) (Part-II/Section-2)-1985.

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

5.0 Tower Accessories

5.1 Step Bolt Ladders: These bolts shall be of property class 4.6 conform to IS: 6639-1972.

5.1.1 Each tower shall be provided with step bolts on one of the main legs, of not less than 16 mm diameter and 175 mm long, spaced not more than 400 mm apart and extending from about 2.5 metres above the ground level to the top of the tower. Each step bolt shall be provided with two nuts on one end to fasten the bolt security to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN and shall be used as a ladder for climbing.

5.1.2 Anti-climbing devices: This shall conform to IS: 5613 (Part-I/Sec –I), 19085.

Fully galvanized barbed wire type anti-climbing device shall be provided at a height of approximately 3 metres as an anti-climbing measure. Four layers of barbed wires will be provided each inside and outside the tower in horizontal plane, spacing between the layers being 140 to 150 mm. The towers to be designed by the supplier shall have provision to fixed the barbed wire as indicated above. Thus the angle pieces with notches for accommodating barbed wire shall be designed and supplied with the towers along with provision for suitable bolt holes on leg members for fitting bolt holes on leg member for fitting the angles. The scheme of the anti-climbing device shall be submitted along with the tower drawing. Barbed wire shall be included in the scope of bidder.

5.1.3 Insulator strings and ground wire clamp attachments

(a) For the attachment of suspension insulator strings a suitable swinging hanger on the tower shall be provided so as to obtain requisite clearance under extreme swinging conditions and free swinging of the string.

The hanger shall be designed to withstand an ultimate tensile strength of 11.500 kg.

5.1.4 (a)For ground wires at suspension towers suitable ‘U’ Bolts strong enough to withstand the full designed loads shall be provided to accommodate the hook of the ground wire suspension clamps.

(b) At tension towers, horizontal strain plates of suitable dimensions on the underside of each power cross-arm tip and at the top ground wire peak shall be provided for taking the ‘D’ Shackles of the tension insulator strings or ground wire tension clamps, as the case may be. Full details of the attachments shall be submitted by the supplier for the employer’s approval before commencing with mass fabrication.

5.1.5 Phase Plate

Phase plate shall be of mild steel of 16 gauge vitreous enameled at back and front, circular in shape and diameter 75 mm. One set of phase plate shall be consisting of 3 plates red, yellow and blue coloured accordingly to indicate the phase of the

conductor. There shall be one fixing bolt on the plate. This shall conform to IS: 5613 (Part-II/Section01) of latest edition.

5.1.6 Number Plate

The number plate shall be mild steel vitreous enameled at back and front, 200 mmx 150 mm, rectangular shape and inscribed thereon shall be the number of the tower location preceded by letter corresponding to the short name of the line and the type of towers. There shall be two fixing bolts on both end of the plates. The dimension and details of the number plate shall be as per IS: 5613 (Part-II/Section1 & Section-2), 1985.

5.1.7 Danger Plate

These shall be of mild steel vitreous enameled at back and front 250 x 200 mm rectangular shape and inscribed thereon shall be in signal red the work 'DANGER' with its Oriya and Hindi translation and also with the inscription of Bone and Scull and voltage of the line. There shall be two holes on the plates for fixing. This shall conform to IS: 2551 (latest edition).

5.1.8 Details to Tower Fabrication Workmanship

5.1.9 Except where hereinafter modified details of fabrications shall confirm to IS: 802 (Part-II)-1978.

5.1.10 But splices shall generally be used such that the inside cleat angle and outside plates are designed to transmit load. The inside cleat angle shall not be less than half the thickness of the connected heaviest member plus 2 mm. Lap splices may also be used for connecting members of unequal size in such a manner that the inside angle of the lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the members connected through bolts. But as well as lap splices shall be made as above and as close to and above the main panel point as far as possible.

5.1.11 Points shall be so designed so as to avoid eccentricity. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where connections are such that the elimination of the gusset plates would result in eccentric joints then gussets plates and spacer plates may be used in conformity with modern practices. The thickness of the gusset plate, required to transmit stress, shall not be less than that of the thinnest of connected member but not less than 5 mm in any case.

The use of filler in connection shall be avoided as far as possible. The diagonal web members in tension may be connected entirely to the gusset plate where necessary so as to avoid the use of filler and it shall be connected at the point of inter-section by one or more bolts.

5.1.12 The tower structures shall be accurately fabricated to bolt together easily at site without any strain on the bolts.

5.1.13 No angle member shall have the two leg flanges brought together by closing the angle.

5.1.14 The diameter of the hole shall be equal to the diameter of bolt plus 1.5 mm.

5.1.15 The structure shall be designed such that all parts are accessible for inspection and cleaning. Drain holes shall be provided at all points where pockets of depressions are likely to hold water.

5.1.16 All similar parts shall be made strictly interchangeable. All steel sections before any work is done on them, shall be carefully leveled, straightened and made true to detailed drawings by methods which shall not injure the materials so that when assembled, the different matching surfaces are in close contact throughout. No rough edges shall be permitted any where in the structure.

5.1.17 Drilling and Punching

(a) Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

(b) Holes for bolts shall be drilled of punched with a jig but drilled holes are preferred. The following maximum tolerance of accuracy of punched holes is permissible.

(i) Holes must be perfectly circular and no tolerance in this respect is permissible.

(ii) The maximum allowable difference in diameter of the holes on the two sides of plates or angle is 0.8 mm i.e. the allowable taper in punched holes should not exceed 0.8 mm on diameter.

(iii) Holes must be square with the plates or angles and have their walls parallel.

© All burrs left by drills or punches shall be removed completely. When the tower members be truly opposite to each other. Drilling or reaming to enlarge defective holes is not permitted.

5.1.18 Erection Mark:

Each individual member shall have an erection mark conforming to the component number given to it in the fabrication drawings. This mark shall be done with marking dies of 16 mm size before galvanizing and shall be legible after galvanising.

The erection mark shall be A-BB-CC-DDD where

A Employer code assigned to the supplier (Alphabet).

BB Supplier’s Mark (Numerical)

CC Tower type (Alphabet)

DDD Number mark to be assigned by Supplier (numerical).

5.1.19.1 Galvanizing

The super structure of all towers and stubs upto 150 mm below plinth level (Top of concrete pedestal) shall be galvanized. Galvanizing of tower members and stub shall be in conformity with IS: 4759-1984 and shall be done after all fabrication work has been completed except that the nuts may be tapped or return after galvanizing. Threads of bolts and nuts after galvanizing shall have a neat fit and shall be such that they can be turned with fingers throughout the length of the threads of bolts and they shall be capable of developing the full strength of the bolts. Spring washers shall be electro-galvanized as per Grade – 4 of IS: 1573 – 1986. Galvanizing for fasteners shall conform to IS: 1367 (Part-XIII) – 1978.

5.1.19.2 Quantities and Weights

5.1.20 The quantities stated in Annexure – I are only provisional. Final quantities will be informed by the employer to the supplier on completion of detailed survey. However, bids will be evaluated based on quantities indicated in the Annexure – I.

5.1.21 The employer reserves the right to order for the final quantities at the rates quoted in the bid, which shall be valid throughout the pendency of the contract.

5.1.21.1 The unit weight of each type of tower stubs, super structure and extension be furnished by the Bidder. The weight of tower shall mean the weight of tower calculated by using the black section(ungalvanized) weight of steel members including stubs, of the sizes indicated in the approved fabrication drawings and bills of materials, without taking into consideration the reduction in weights due to holes, notches, cuts, etc. but taking into consideration the weight of special fittings.

5.1.21.2 Tower designs Superstructure

5.1.21.3 Wind Pressure

The wind pressure on towers, power conductors and earth wire shall be as per IS: 802 (Part-I/Sec-I) – 1995.

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5.1.21.4 Design Temperatures

The following temperature range for the power conductor and ground wires shall be adopted for the line design confirming to IS: 802 (Part –I/Sec – I) – 1995.

i) Minimum temperature 50˚C.

ii) Every day temperature 32˚C

iii) Maximum temperature of:

a)	Conductor	75˚C for ACSR Moose/Zebra/Panther 90˚C for AAAC (Moose equivalent)
b)	Ground wire exposed to Sun.	53˚C

5.1.21.5 Factors of Safety & Span details

a) Factory of safety.

The factor of safety based on crippling strength of struts and elastic limit of tension members shall not be less than 2(two) under normal condition and 1.5 (one and a half) under broken wire conditions for all the members of the towers and their cross arms.

b) Normal Span

The normal span of the line shall be 300 metres for 400 KV and 220 kV and 250 meters for 132 kV.

c) Wind and weight spans

The wind and weight spans to be adopted in the design of the structures shall be as follows:

i) Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. In case of towers located on an perfectly horizontal terrain, this shall be the normal span. For design purposes the wind on conductor shall be calculated on at least 1.1 times the normal.

ii) Weight Span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower.

All C and D type towers shall be designed for uplift spans (minimum) weight spans in the following table also. These are applicable both for pointed and square cross arms.

For details of cross arms and towers, the span limits given below shall prevail.

WEIGHT SPANS

Tower Type	400/220 KV				132KV			
	Normal Condition		Broken wire condition		Normal Condition		Broken wire condition	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
A & B	525	100	300	100	320	100	250	100
C & D	600	100	300	100	320	100	250	100

5.1.21.6 Conductor and Ground wire Configuration

For single circuit towers the three phases shall be Delta formation. One number of ACSR conductor shall be used for each phase. One galvanized steel wire shall be used as ground wire. The ground wire shall be continuous and shall be provided above the conductors at suitable elevation to offer effective shielding and safe clearances. For double circuit towers the phases shall be in vertical formation with phase to phase horizontal spacing of not less than 8.4 meters and vertical 4.9 meters for 220 kV.

5.1.21.7Loads on Towers

i) Transverse Loads:

Transverse load due to wind on towers conductors and under broken wire earthwire shall be calculated in accordance with IS: 802(Part-I/Sec-I)-1995.

ii) Longitudinal Loads due to wind on towers conductors and shield shall be calculated as per IS: 802 (Part-I/Sec-I)-1995.

iii) Vertical Loads:

The vertical load due to conductors and ground wire shall also include 150 kg. As weight of a Lineman with tools. These loads are in addition to the vertical loads due to insulator fittings and the dead weight of the structure. The weight of a Lineman with tool should not be considered in minimum vertical load calculation. An additional erection load of 3.5 KN shall also be considered for the design of the tower. The stringing procedure shall ensure that the above vertical loads are not exceeded. For calculating vertical loads the following insulator weights may be considered.

	400/220/132 KV
Each single suspension insulator string	160 kg
Each double suspension insulator string	320 kg
Each double tension insulator string	420 kg
Pilot string for 60˚ tower	160 kg

iv) Broken Wire condition

a) Suspension Tower Type A/DA

Breaking of any one power conductor in one phase only, resulting in instanceous unbalance tension of 50% of conductor tension at 32˚C without wind or breaking of one earthwire resulting in an unbalance tension equal to the maximum tension of the ground wire whichever is more stringent is to be considered for design along with appropriate impact factor.

b) Tower Type B & C

Breakage of two phases on the same side and on the same span or breakage of any one phase and any one ground wire on the same span whichever combination is more stringent along with appropriate impact factor for a particular member.

c) Tower Type D/DD

Breakage of all the three phases on the same side and on the same span or breakage of two phases and any one ground wire on the same span, whichever combination is more stringent along with appropriate impact factor for a particular member. Cross arms for angle tower shall be of equal length for both sides.

v) Design Load

Employer's requirement for design longitudinal and transverse loads shall confirm to IS: 802(Part-I/Sec-I)-1995.

The Bidder shall furnish the details of design loads proposed to be adopted in the tower design in accordance with this specification.

The design criteria and other special requirements as stipulated for special towers shall be applicable for river crossing/special towers.

5.1.21.8Tower Steel Sections:

i) Steel sections of tested quality in conformity with IS: 2062 GRA are to be used in towers, extensions and stub setting templates. No individual members shall be longer than 6000 mm.

For designing of towers only rationalized steel sections shall be used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section at no extra cost. However, design approval for such substitution shall be obtained from the employer.

ii) Thickness of Members

The minimum thickness of angle sections used ion the design of towers, shall be kept not less than the following values:

a) Main corner leg members excluding the ground wire peak and main cross arm 6 mm.

b) For all other main members 5 mm.

c) Redundant members 4 mm.

iii) Bolt Arrangement

The minimum bolt spacing and rolled edge distance and sheared edge distances of sections from the centers of the bolt holes shall be provided as furnished in Table-1.

Dia of Bolts (mm)	Hole Dia (mm)	Min. bolt Spacing (mm)	Min. rolled Distance (mm)	Min. Sheared Edge distance (mm)
12	13.5	30	16	19
16	17.5	40	20	23
20	21.5	50	25	27

Bolts sizes mentioned above shall only be used. The minimum width of flanges without bolt holes shall be 30 mm.

For the purpose of calculating stress and bearing stress for bolts refer clause 14.4 and 14.5 of IS: 802 (Part-I/Sec-2)-1992.

iv) Allowable Stress:

Structural steel angle section manufactured according to the latest ISL: 808(Part-V & VI) and tested according to the latest edition of IS:2062 and having its yield strength not less than 255 N/mm. sq. shall be used in the fabrication of tower members.

v) Axial Stress in tension:

The estimated tensile stress in various members multiplied by the appropriate factors of safety shall not exceed the value given by the formula specified in Clause 9.2.1 of IS:802(Part-I/Sec-2)-1992.

vi) Axial Stress in Compression

The estimated compressive stress in various members multiplied by the appropriate factors of safety shall not exceed the value given by the formula specified in Clause 9.2.1 of IS:802(Part-I/Sec-2)-1992.

vii) Slenderness ratio:

Slenderness ratio for members shall be computed in accordance with IS:802(Part-I/Sec-2)-1992. Slenderness ratio for compression and tension members shall not exceed the values specified therein. The following maximum limits of the slenderness ratio shall be adopted i.e. the ratio of unsupported length of the section in any place to the appropriate radius of gyration.

a)	For main corner leg member including the corner members of earth wire peak and the lower corner members of the arms…	150
b)	For other members having calculated stresses….	200
c)	For redundant members….	250
d)	For members having tensile stress only….	375

viii) Erection Stress

Where erection stresses combined with other permissible co-existent stresses could produce a working stress in any member appreciably above the specified working stress, then additional materials shall be added to the member or such other provision made so as to bring the working stress within the specified limit. For the purpose of this clause the specified working stress shall be the ultimate stress divided by the factor of safety of 2.0.

ix) Design calculation and Drawings

The following design calculations and drawings are required to be furnished to the employer.

a) Along with the Bid:

Detailed design calculations and drawing for each type of tower.

b) On award of Contract

The supplier shall submit design of tower extension, stub templates and loading/rigging arrangement of tower testing to enable the employer to make preliminary check regarding structural stability of tower tests.

Upon successful testing of tower and subsequent approval of designs, drawings and bill of materials, the supplier shall furnish Photostat copies of the following in 6(six) copies to the employer for necessary distribution along with one copy of reproducible print.

a) Detailed design calculations along with drawings of towers and foundations.

b) Detailed structural drawings indicating section size, length of member. Sizes of plate along with hole to hole distances, joint details etc.

c) Bill of materials indicating cutting and bending details against each member.

d) Shop drawings showing all details relevant to fabrication.

e) All drawings for the tower accessories.

The supplier is required to submit four copies of the drawings with Photostat copies mentioned above for approval by the employer while submitting the designs, structural drawings. Bill of materials and any other drawings pertaining to the subject transmission line. The supplier shall clearly indicate in each drawing the project code number, if any, specification no.;, name of transmission line, letter reference no. and date on which the submissions are made. The said procedure is to be followed while submitting the distribution copies.

5.1.21.9 Statutory Electrical Clearances:

i) Ground Clearances:

The minimum ground clearance from the bottom conductor shall not be less than 7.00 metres for 220 kV at the maximum sag conditions i.e. at maximum temperature and in still air. However, to achieve the above clearance the height of the tower shall be increased in the following manner:

a) An allowance of 4% of the maximum sag shall be provided to account for errors in stringing.

b) Conductor creep shall be compensated by over tensioning the conductor for a temperature of 26˚C lower than the stringing temperature.

In case of rail track crossings the minimum height above rail level of the lowest portion of any conductor under conditions of maximum sag, in accordance with the regulations for Electrical Crossing of Railway Tracks are given in Table – 5.

TABLE – 5

	Type of work	Inside stn. Limits(mm)	Outside stn. Limits(mm)
a)	For unelectrified track and tracks electrified on 1500 V.DC		
	i) For metre/narrow gauge	10,00017,600	
	ii) For broad gauge	11,200	8,800
b)	Tracks electrified on 25 kV AC for metre, narrow and broad gauge	15,300	13,300

Minimum clearance between the subject power line and any other power line crossing shall not be less than 7000 mm.

ii) Live Metal Clearance:

The minimum live metal clearance to be provided between the live parts and steel work of superstructure shall be as given in IS:5613 (Part-2/Sec-I).

The Bidder may adopt separate cross arm design and length for 'D' type towers under dead end conditions provided adequate live metal clearance is available with at least 15˚ angle and also provided that all the other specified conditions of this specifications are fulfilled. In case pilot insulator strings are proposed to be used, the angle of swing to be considered shall be minimum of 15˚.

In computing live metal clearances, the dimensions of suspension and tension string shall be taken as given in drawings attached herewith. The design of the towers shall be such that it should satisfy all the above conditions when clearances are measured from any live point of the insulator strings.

iii) Angle Shielding

The angle shielding, defined as the angle formed by the line joining the center lines of the ground wire and outer conductor in still air, at tower supports, to the vertical line through the center line of the ground wire shall not be more than 30˚. The drop of the ground wire clamp which is employer supplied item should be considered while calculating the minimum angle of protection. For estimating the minimum angle of protection the drop of ground wire suspension clamp along with U-bolt may be taken as 150 mm.

iv) Mid Span Clearance

The minimum vertical span clearance between any of the earthwire and the nearest power conductor under all temperatures and in still air condition in the normal ruling span shall be 8.10 metres for 220 kV. Further the tensions of the earthwires and power conductors, shall be so co-ordinated that the sag of earthwires shall be at least 10% less than that of the power conductors under all temperatures and loading conditions.

5.1.21.10 Packing

Angle sections shall be wire bundled, cleat angles, gusset plates, blackets, filler plates, hanger and similar other loose items shall be netted and bolted together in multiples or securely wired together through holes.
Bolts, nuts, washers and other attachments shall be packed in double gunny bags, accurately tagged, in accordance with the contents.

The packings shall be properly done to avoid losses/damages during transit. Each bundle or package shall be appropriately marked.

5.1.21.11 Special Towers:

i) Special towers are to be used for major river crossing requiring very long spans. These towers shall form part of the Bidder's scope.

Unit rates for design, fabrication, galvanizing, testing and supply for such towers shall be quoted in the appropriate schedule of Volume IB.

Anchoring of major river crossing towers, shall be with 'D' or DD type towers.

All the requirements as meant for standard towers shall apply for such special towers except those noted in the following clauses.

ii) Shielding Angle:

The shielding angle shall not be greater than 30˚.

iii) Clearances:

The minimum clearance of lowest point of power conductor from the highest flood level in navigable rivers for crossing towers shall be obtained from the navigation authority.

The minimum electrical clearances between live parts and tower body and cross arm member shall be the same as for normal towers.

iv) Stub Location:

The approximate height of foundation on which stub for river cross towers are to be set, over the highest flood level of the river shall be fixed only after employer's approval.

v) Angle of Deviation

The minimum angle of deviation to be considered for special towers is 2˚ and all live material clearances are to be computed considering double suspension insulator strings as per drawing enclosed.

vi) Factors of Safety:

Towers:

The minimum factors of safety for towers shall be:

a) Under normal conditions 2.0
b) Under broken wire conditions 1.;5

vii) Conductor and Earth wire:

The minimum factor of safety for conductors and ground wire shall be 2.5 maximum tension corresponding to $2/3^{rd}$ full wind pressure at minimum temperature or full wind pressure at the mean annual temperature such that the initial unloaded tension at the mean annual temperature do not exceed 30% of the ultimate strength of conductor and ground wire respectively.

viii) Wind Loads:

a) The procedure for wind load calculation on conductor and ground wire shall be the same as for normal structures.

b) The wind pressure values on tower shall be based on IS:802(Part-I/Sec-I)-1995.

ix) Longitudinal Loads:

a) The longitudinal loads due to power conductors and earth wires for suspension towers shall be nil under normal conditions and 100% of the maximum tension of bundled conductors or earth wire under broken wire conditions.

b) Under normal conditions, unbalanced longitudinal pull due to difference in tension in ruling span for river crossing towers on one side and span of the line on the other wise shall also be considered for the design of anchor towers.

5.1.22 TESTS

5.1.23 General

a) All standard tests including quality control tests in accordance with IS:802(Part-III)-1978 shall be carried out.

b) A galvanized tower of each type complete with 6 metres extension shall be subjected to design and destruction test. The tower shall be tested with nuts and bolts of the same make and type which are proposed to be used on the line. The supplier shall submit to the employer for approval, a detailed programme and proposal for testing the towers showing the method of carrying out the tests and the manner of applying the loads. The supplier on receipt of such approval shall intimate the employer about carrying out of the tests at least 30 days in advance of the scheduled date of tests during which time the employer will arrange to depute his representatives to witness the tests. Six copies of the test reports thereof shall be submitted to the employer for approval.

c) In case of premature failure, the tower shall be retested and steel already used in the earlier test shall not be used again. The supplier shall provide facilities to the employer for inspection of materials during manufacturing stage and also during testing of the same.

d) No part of any tower subject to test shall be allowed to be used in the work. The prices to be quoted for such type tests shall be after allowing rebate for the scrap value of the tested tower which is to be retained by the supplier

e) The supplier shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully undergone the tests. In case any deviation is detected the supplier shall replace such defective towers free of cost of the employer. All expenditure incurred in erection, to and fro transportation, any other expenditure or losses incurred on this account shall be fully borne by the supplier.; No extension in delivery time shall be allowed on this account. The employer, however, reserves the right to waive off the testing of the towers, provided the supplier had earlier successfully tested, erected and commissioned similar towers and certificates for such tests carried out earlier are furnished duly certified by the employer and are found acceptable.

f) Each type of tower to be tested shall be a full scale prototype galvanized tower and shall be erected vertically on rigid foundation with the stub protruding above ground level as provided in the design/drawing between ground level and concrete level.

g) The suspension tower to be tested shall be with hanger and 'U' Bolt as per approved design/drawings. The tension tower to be tested shall similarly be with the strain plate as per approved design/drawings.

h) In case of any premature failure even during waiting period, the tower shall be retested with rectified members. However, if the failures are major in nature and considerable portion of tower is to be re-erected then in such cases all the tests which have been carried out earlier are to be reconducted to the entire satisfaction of the employer.

i) The sequence of testing shall be at the discretion of the employer.

5.1.23.1Test for Galvanization

Galvanization of the members of the tower shall withstand tests as per IS:2633.

5.1.24 INSPECTION

5.1.24.9 The supplier shall keep the employer informed well in advance of the commencement of manufacture, progress of manufacture thereof and fabrication of various tower parts at various stages. So that arrangements could be made for inspection by the employer.

5.1.24.10 The acceptance of any batch of items shall in no way relieve the supplier of any his responsibilities for meeting all the requirements and intent of this specification and shall not prevent subsequent rejection if any item of that batch is later found defective.

5.1.24.11 The employer or his authorized representatives shall have free access at all reasonable time to all parts of the supplier's works connected with the fabrication of the material covered under the contract for satisfying themselves that the fabrication is being done in accordance with the provisions of this specification.

5.1.24.12 Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.

5.1.24.13 Should any member of the structure be found not to comply with the approved design, it shall be liable for rejection. No member once rejected shall be resubmitted for inspection except in cases where the employer or his authorized representative considers that the defects can be rectified.

5.1.24.14 Defects which occur during fabrication shall be made good with the consent of and according to the procedure to be laid down by the employer.

5.1.24.15 All gauges and templates necessary to satisfy the employer for conducting tests shall be made available at the test site by the supplier.

5.1.24.16 The correct grade and quality of steel shall be used by the supplier. To ascertain the quality of steel the employer may at his discretion get the material tested at an approved laboratory.

5.1.25 SCHEDULE OF REQUIREMENTS

5.1.25.1 The schedule of requirements of different types of towers is indicated in Volume-III. The quantities indicated therein are tentative and based on preliminary survey conducted by the employer. The exact quantity will be informed to the supplier on completion of detailed survey.

5.1.25.2 The time frame for executing the work is also indicated in this schedule. The supplier has to match the supply and delivery of stubs, tower-parts etc. to complete the work within the time schedule desired by the employer.

5.1.25.3 The supplier shall, as far as possible, dispatch the tower material as completed towers in order to enable erection of complete tower structures at site. Payment for the initial dispatches, to the extent of 30% of the total ordered quantity will be released on the basis of weight (i.e. Metric tones of steel supplied). Beyond this limit, however, payment will be released only for material supplied to complete towers.

5.1.26 SCUEDUALE OF PRICES

5.1.26.1 The prices for supply of materials shall be furnished in the relevant schedule in the manner specified in Volume-III.

5.1.27 GENERAL TECHNICAL REQUIREMENTS

Particulars	Design details	- foundation
Line voltage	-	400/220132 kV
No. of circuits	-	Double/Double/Double

a) Properties of soil for bidding purpose only

Sl. No.	Details	Soft Loose	Mud	Hard Soil	Soft Rock	Hard Rock
1.	Angle of repose of soil(in degree)	30	15	0	0	0
2.	Ultimate bearing strength of earth (T/M^2)	10	5	20.0	50.0	125.0

b) Properties of concrete

All concrete shall be RCC with ratio(1:1.5:3).

c) Factor of safety for foundation against over turning due to up-lift and thrust.

i) Normal condition 2.2

ii) Broken wire condition 1.65

d) Concrete Mixture

i) pad 1:3:6

ii) Pyramid or stepped part of foundation 1:1:5:3

iii) Chimney 1:1:5:3

e) Minimum thickness of chimney 300 m

f) Minimum thickness of concrete over stub
Dry soil 100 mm
Wet & WBC 150 mm

g) Minimum length of stub 2000 mm
in concrete.

h) Distance above ground level of 450 mm
Tower stub and super structure

5.1.28 .Foundation General Description

5.1.29 Design, construction and other relevant drawings shall be furnished by the tower designer for all types of towers (including special towers) for different kinds of soil as detailed below. According to the locations foundations for towers shall be normally of the following types:

a) Soft/Loose Soil
b) Mud
c) Hard/Dense soil
d) Hard/Disintegrated rock

5.1.30 For rock foundations the holes in rocks shall be made in an approved manner so as to eliminate the possibility of serious cracking of the rock. The concrete block shall be properly secured to rock base by adequate no. of anchor bolts and further secured by concrete lodge section by the sides.

TECHNICAL SPECIFICATION

ERECTION OF

400/220/132 KV D.C. TRANSMISSION LINES

CONSTRUCTION OF TOWER FOUNDATION AND ERECTION OF TOWER

1.0 ERECTION OF TOWER AND TOWER FOUNDATION

1.1 SCHEDULE OF ERECTION PROGRAMME

After due approval of the detailed and check survey, the contractor shall submit to the employer a complete detailed schedule of erection programme with a Bar-Chart for construction of the lines indicating therein the target date of completion.

1.1.1 DRAWINGS FOR TOWER AND FOUNDATIONS

The same shall be supplied by the contractor.

1.1.2 TAKING OVER

Tower and tower accessories received at site stores are to be stored item-wise and mark-wise to facilitate joint inspection of the materials (with reference to packing list and detailed order).

If the materials/equipment or any part thereof is damaged or lost during the transit, the replacement of such materials shall be effected by the contractor timely so as to maintain programme of work. However, the line under erection shall be taken over by the purchaser only when the entire line is completed in all respect and made ready for commissioning at rated voltage. Partly erected line will not be taken over.

Taking over of the line shall be in no way relieve the contractor from his responsibility for satisfactory operation of the erected line in terms of the guarantee clause of the specification.

1.1.3 MATERIALS HANDLING AND INSURANCE

The contractor shall deliver all equi9pment/materials against this contract to his site stores under cover of Transit Insurance to be taken in his name. Cost of such insurance is to be borne by the contractor.

Cost of transportation of materials from contractor’s store to the site of work shall be borne by the contractor irrespective of made of transportation and site condition.

The contractor has to bear the cost of premiums for all materials, tower accessories, total erection cost of the line including cement, torsteal for foundation.

It will be the responsibility of the contractor to report to the concerned Police Station about all incidents of thefts and lodge, pursue and settle all claims with Insurance Company in case of damage/loss due to theft, pilferage, flood and fire etc. and the employer of the work shall be kept informed promptly in writing about all such incidents. The loss, if any, on this account shall be recoverable from the contractor if the claims are not lodged and properly pursued in time or if the claims are not settled by the insurance company due to lapses on the part of the contractor. The contractor shall have to replenish promptly damaged, stolen tower members and accessories conductors, earth wire, hardwares etc. and repair/re-erect the damaged lines, free of cost to the employer so

as to maintain the programme of work. The employer will not be responsible in any way for such loss of materials.

1.1.4 EXCAVATION FOR FOUNDATION PITS, DE-WATERING AND SHORING SETS

The contractor shall execute the open excavation job in the foundation pits in all type of soil including latterite and or bounder mixed soil as detailed abelow including removing, spreading and/or stacking the excess spils (as directed by the employer). The item includes the necessary trimming of the sides, leveling, dressing and ramming (as necessary) the bottom of the pits including bailing out water, dewatering by manual and/or mechanical means by emplying water pumps including removing of slushes from foundation pits and nominal open plank shoring with vertical poling boards placed at suitable intervals as directed with required runners, struts, battens for framing as required complete. While quoting the unit rate for foundation as per the activity schedule, the contractor shall include cost of design, all cost of labour, materials, tools, plants, incidentals for earth excavation, dewatering, cement, water, sand, coarse and find aggregates, steel reinforcement, steel angles, forms, mixing, finishing, protection and curing of concrete, back-filling with carried earth, if necessary, disposal of surplus, spoils, stub setting and template. The contractor shall also include in the quoted unit rate for foundation, all charges/costs for preparing the pit marking and foundation layout drawing, grounding of towers including supply of pipe/concrete pipe, earthing, measurement of ground resistance before often growing etc.

1.1.5 CEMENT CONCRETE :

A) Materials

All materials whether to be consumed in the work or used temporarily shall conform to relevant IS specification, unless stated otherwise, and shall be of the best approved quality.

B) Cement

Cement to be used in the work under the contract shall generally conform to IS:269/455-1989. Cement bags shall be stored by the contractor in a water tight well ventilated store sheds on raised wooden platform/dunnage (raised at least 150 mm above ground level) in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter. Sub-standard or partly set cement shall not be used and shall be removed from the site by the contractor at his cost on receipt of approval from the Engineer.

C) Coarse Aggregates Stone chips or stone ballast

D) Reinforcement : Different size of reinforcement(MS ROD-FE-500) as per latest IS.

Remarks: All foundation of tower shall be of RCC: M20 Grade(1:1.5:3) nominal mix

General Technical Particulars
C. 1 - Span Lengths

		132kV	220kV	400kV
Normal span	m	300	350	400
Tower design spans:				
Wind spans:				
Suspension towers	m	300	350	400
Tension towers	m	300	350	400
Maximum weight spans:				
Suspension towers	m	450	525	600
Tension towers	m	450	525	600
Minimum weight spans:				
Suspension towers	m	100	100	100
Tension towers (uplift net)	m	-200	-200	-200 (for DB&DC) -300 (forDD)

C . 2 - Line Conductor (132 kV Construction)

Complete line conductor:		
Actual area (total) per single conductor	mm^2	288.3
Number of conductors per phase		ONE
Horizontal distance between conductor centres of one phase	mm	-
Each single conductor:		
Equivalent to ACSR conductor of code name		ACSR PANTHER
IEC STANDARD No INDIAN STANDARD No		IEC 1089 IS 398 (Pt 4) 1994
Material of conductor		AlumIminium
Number and diameter of wires: Aluminium	No./mm	30/3.0
Total area of conductor	mm^2	261.5
Overall diameter of stranded conductor	mm	21
Mass of conductor per kilometre	kg	974
Ultimate strength of conductor	Newton	89670
Assumed equivalent modulus of elasticity of conductor	N/mm^2	81580
Assumed equivalent coefficient of linear expansion of conductor	per °C	17.8×10^{-6}
Maximum length of conductor supplied on one drum	km	2.4+/-5%

C . 3 - Line Conductor (220 kV Construction)

Complete line conductor:		
Actual area (total) per single conductor	mm^2	484.5
Number of conductors per phase		ONE
Horizontal distance between conductor centres of one phase	mm	-
Each single conductor:		
Equivalent to ACSR conductor of code name		ACSR ZEBRA
IEC STANDARD No INDIAN STANDARD No		IEC 1089 IS 398 (Pt 4) 1994
Material of conductor		Aluminium
Number and diameter of wires: Aluminium	No./mm	54/3.18
Total area of conductor	mm^2	428.9
Overall diameter of stranded conductor	mm	28.62
Mass of conductor per kilometre	kg	1621
Ultimate strength of conductor	Newton	130320
Assumed equivalent modulus of elasticity of conductor	N/mm^2	81580
Assumed equivalent coefficient of linear expansion of conductor	per °C	19.3×10^{-6}
Maximum length of conductor supplied on one drum	km	1.8 +/- 5%

C . 4 - Line Conductor (400 kV Construction)

Complete line conductor:		
Actual area (total) per single conductor	mm^2	597.00
Number of conductors per phase		TWO

Horizontal distance between conductor centres of one phase	mm	450
Each single conductor: Equivalent to ACSR conductor of code name		ACSR MOOSE
IEC STANDARD No INDIAN STANDARD No		IEC 1089 IS 398 (Pt 4) 1994
Material of conductor		Aluminium
Number and diameter of wires: Aluminium alloy	No./mm	54/3.53
Total area of conductor	mm^2	597
Overall diameter of stranded conductor	mm	31.77
Mass of conductor per kilometre	kg	2004
Ultimate strength of conductor	Newton	161200
Assumed equivalent modulus of elasticity of conductor	N/mm^2	68600
Assumed equivalent coefficient of linear expansion of conductor	per °C	19.3×10^{-6}
Maximum length of conductor supplied on one drum	km	1.8 +/- 5%

****ALL THE CONDUCTORS ARE ACSR CONDUCTORS HAVING 7 STRANDS OF GI STEEL WIRE.**

C . 5 - Earth Wire (132 kV And 220 kV Constructions)

		GSW
Complete earth conductor:		
Appropriate Indian Standard No		398(Part-2)
Appropriate British Standard No		183
Material of conductor		galvanised steel
Number and diameter of wires	No./mm	7/3.15
Overall diameter of conductor	mm	9.45
Mass of conductor per kilometre	kg	428
Ultimate strength of conductor	Newton	56000
Lay length	mm	160 +/- 15
Direction of the lay of the outer layer		Right hand
Chemical composition of the steel wire	%	
Carbon		not more than 0.55
Manganese		0.4 to 0.9
Phosphorous		not more than 0.04
Sulphur		not more than 0.04
Silicon		0.15 to 0.35
Purity of Zinc for galvanising	%	99.95
Galvanising after stranding		
a) Minimum weight of Zinc coating per sq. m. of the uncoated wire surface	gms	240
b) Minimum no. of one minute dips that the galvanised wire can withstand in Standard Preece Test		3 and 1/2
Maximum length of conductor on drum #	km	4 +/- 5%
D.C. resistance at 20 ^{o}C	ohms/km	3.375

C . 6 - Earth Wire (400 kV Construction)

	GSW
Complete earth conductor:	

Appropriate Indian Standard No		398(Part-2)
Appropriate British Standard No		183
Material of conductor		galvanised steel
Number and diameter of wires	No./mm	7/3.66
Overall diameter of conductor	mm	10.98
Mass of conductor per kilometre	kg	583
Ultimate strength of conductor	Newton	68400
Lay length	mm	160 +/- 15
Direction of the lay of the outer layer		Right hand
Chemical composition of the steel wire	%	
Carbon		not more than 0.55
Manganese		0.4 to 0.9
Phosphorous		not more than 0.04
Sulphur		not more than 0.04
Silicon		0.15 to 0.35
Purity of Zinc for galvanising	%	99.95
Galvanising after stranding		
a) Minimum weight of Zinc coating per sq. m. of the uncoated wire surface	gms	240
b) Minimum no. of one minute dips that the galvanised wire can withstand in Standard Preece Test		3 and 1/2
Maximum length of conductor on drum #	km	4 +/- 5%
D.C. resistance of the complete earthwire at $20^{O}C$	ohms/km	2.5

C.14 * - Disc Insulator Units (Anti-Fog Type)

		70kN	90kN	120kN	160kN
Size and designation of the ball pin shank	mm	16	16	20	20
Diameter of the disc	mm	280/305	280/305	280/305	280/305
Tolerance on the diameter	+/-mm	13/15	13/15	13/15	13/15

Ball to ball spacing between disc	mm	145	145	145	170
Tolerance on ball to ball spacing	+/-mm	4	4	4	5
Minimum creepage distance of a single disc **	mm	430	430	430	475
Steepness of the impulse voltage which the disc unit can withstand in Steep Wave Front Test	kV per micro sec.	2500	2500	2500	2500
Purity of Zinc used for galvanising	%	99.95	99.95	99.95	99.95
Purity of Zinc used for sleeve	%	99.7	99.7	99.7	99.7
No. of dips in Standard Preece Test		6	6	6	6
1) Cap socket		6	6	6	6
2) Ball pin					

***The parameters specified are for disc insulator unit only. For the Bids offering composite insulator units, the parameters may be suitably selected by the Bidder so as to meet the overall requirements of the respective strings and same shall be guaranteed at Schedules 13A and 14A of the Technical Data Requirement Schedules, Section X.**

**** The minimum creepage distance of single composite insulator unit shall be such that it matches with the total creepage distance of the respective strings with disc insulator units.**

C . 15 - Insulator Strings (Suspension Sets For 132 kV Lines)

	Single "I" Suspension Strings	Double "I" Suspension Strings	Pilot Suspension Strings
Power frequency kV(rms) withstand voltage of the string with arcing horns and corona control rings / grading rings under wet conditions	275	275	275
Impulse withstand voltage (peak) under dry conditions			

1) Positive 2) Negative	Kv kV	650 650	650 650	650 650
Minimum corona extinction voltage under dry conditions	kV(rms)	105	105	105
Radio interference voltage under dry conditions at 1MHz, at 105kV	Micro Volts	not more than 1000	not more than 1000	not more than 1000
Mechanical strength of the complete insulator string along with all hardware fittings	kN	70	2x70	70
Maximum voltage (in percentage) across any disc in the complete insulator string under phase to earth voltage *	%	20	20	20
Number of insulator units in each string **		9	2x9	9
Purity of Zinc used for galvanising	%	99.95	99.95	99.95
Minimum No. of one minute dips the ferrous parts can withstand in Standard Preece Test	No.	6	6	6

*** Voltage distribution criteria is not applicable for strings with composite insulator units.**
**** It is preferrable to have single piece composite insulator unit for each limb of the string. In case, more than one units are used per limb, same shall be indicated by the Contractor.**

C . 16 - Insulator Strings (Tension Sets For 132 kV Lines)

		Single Tension Strings	Double Tension Strings
Power frequency withstand voltage of the string with arcing horns and corona control rings / grading rings under wet conditions	kV(rms)	275	275
Impulse withstand voltage (peak) under dry conditions			

1) Positive 2) Negative	kV kV	650 650	650 650
Minimum corona extinction voltage under dry conditions	kV(rms)	105	105
Radio interference voltage under dry conditions at 1MHz, at 105kV	Micro Volts	not more than 1000	not more than 1000
Mechanical strength of the complete insulator string along with all hardware fittings	kN	90	2x90
Maximum voltage (in percentage) across any disc in the complete insulator string under phase to earth voltage *****	%	22	22
Number of insulator units in each string ******		10	2x10
Purity of Zinc used for galvanising	%	99.95	99.95
Minimum No. of one minute dips the ferrous parts can withstand in Standard Preece Test	No.	6	6

*** Voltage distribution criteria is not applicable for strings with composite insulator units.**
**** It is preferrable to have single piece composite insulator unit for each limb of the string. In case, more than one units are used per limb, same shall be indicated by the Contractor.**

C . 17 - Insulator Strings (Suspension Sets For 220 kV Lines)

		Single "I" Suspension Strings	Double "I" Suspension Strings	Pilot Suspension Strings
Power frequency withstand voltage of the string with arcing horns and corona control rings / grading rings under wet conditions	kV(rms)	460	460	460
Impulse withstand voltage (peak) under dry conditions				

1) Positive 2) Negative	kV kV	1050 1050	1050 1050	1050 1050
Minimum corona extinction voltage under dry conditions	kV(rms)	154	154	154
Radio interference voltage under dry conditions at 1MHz, at 154kV	Micro Volts	not more than 1000	not more than 1000	not more than 1000
Mechanical strength of the complete insulator string along with all hardware fittings	kN	70	2x70	70
Maximum voltage (in percentage) across any disc in the complete insulator string under phase to earth voltage *****	%	13	13	13
Number of insulator units in each string******		14	2x14	14
Purity of Zinc used for galvanising	%	99.95	99.95	99.95
Minimum No. of one minute dips the ferrous parts can withstand in Standard Preece Test	No.	6	6	6

*** Voltage distribution criteria is not applicable for strings with composite insulator units.**
**** It is preferrable to have single piece composite insulator unit for each limb of the string. In case, more than one units are used per limb, same shall be indicated by the Contractor.**

C . 18 - Insulator Strings (Tension Sets For 220 kV Lines)

		Single Tension Strings	Double Tension Strings
Power frequency withstand voltage of the string with arcing horns and corona control rings / grading rings under wet conditions	kV(rms)	460	460
Impulse withstand voltage (peak) under dry conditions 1) Positive	kV	1050	1050

2) Negative	kV	1050	1050
Minimum corona extinction voltage under dry conditions	kV(rms)	154	154
Radio interference voltage under dry conditions at 1MHz, at 105kV	Micro Volts	not more than 1000	not more than 1000
Mechanical strength of the complete insulator string along with all hardware fittings	kN	120	2x120
Maximum voltage (in percentage) across any disc in the complete insulator string under phase to earth voltage *****	%	14	14
Number of insulator units in each string ******		15	2x15
Purity of Zinc used for galvanising	%	99.95	99.95
Minimum No. of one minute dips the ferrous parts can withstand in Standard Preece Test	No.	6	6

*** Voltage distribution criteria is not applicable for strings with composite insulator units.**
**** It is preferrable to have single piece composite insulator unit for each limb of the string. In case, more than one units are used per limb, same shall be indicated by the Contractor.**

C . 19 - Insulator Strings (Suspension Sets For 400 kV Lines)

		Single "I" Suspension Strings	Pilot Suspension Strings
Power frequency withstand voltage of the string with arcing horns and corona control rings / grading rings under wet conditions	kV(rms)	680	680
Switching surge withstand voltage (peak) under wet conditions			
1) Positive	kV	1050	1050
2) Negative	kV	1050	1050
Impulse withstand voltage (peak) under dry conditions			

1) Positive 2) Negative	kV kV	1550 1550	1550 1550
Minimum corona extinction voltage under dry conditions	kV(rms)	320	320
Radio interference voltage under dry conditions at 1MHz, at 305kV	Micro Volts	not more than 1000	not more than 1000
Mechanical strength of the complete insulator string along with all hardware fittings	kN	120	120
Maximum voltage (in percentage) across any disc in the complete insulator string under phase to earth voltage *****	%	9	9
Number of insulator units in each string ******		23	23
Purity of Zinc used for galvanising	%	99.95	99.95
Minimum No. of one minute dips the ferrous parts can withstand in Standard Preece Test	No.	6	6

*** Voltage distribution criteria is not applicable for strings with composite insulator units.**
**** It is preferrable to have single piece composite insulator unit for each limb of the string. In case, more than one units are used per limb, same shall be indicated by the Contractor.**

C . 20 - Insulator Strings (Tension Sets For 400 kV Lines)

		SingleTension Strings (Low Duty)	Double Tension Strings
Power frequency withstand voltage of the string with arcing horns and corona control rings / grading rings under wet conditions	kV(rms)	680	680
Switching surge withstand voltage (peak) under wet conditions			
1) Positive	kV	1050	1050
2) Negative	kV	1050	1050
Impulse withstand voltage (peak) under dry conditions			
1) Positive	kV	1550	1550
2) Negative	kV	1550	1550

Minimum corona extinction voltage under dry conditions	kV(rms)	320	320
Radio interference voltage under dry conditions at 1MHz, at 305kV	Micro Volts	not more than 1000	not more than 1000
Mechanical strength of the complete insulator string along with all hardware fittings	kN	120	2x160
Maximum voltage (in percentage) across any disc in the complete insulator string under phase to earth voltage *****	%	10	10
Number of insulator units in each string ******		24	2x23
Purity of Zinc used for galvanising	%	99.95	99.95
Minimum No. of one minute dips the ferrous parts can withstand in Standard Preece Test	No.	6	6

*** Voltage distribution criteria is not applicable for strings with composite insulator units.**
**** It is preferrable to have single piece composite insulator unit for each limb of the string. In case, more than one units are used per limb, same shall be indicated by the Contractor.**

C . 21 - Tower Design Particulars (132 kV Construction)

Minimum clearance between live metal and tower steelwork:		
i.with suspension insulator set swing 0°	mm	1530
with suspension insulator set swing 15°	mm	1530
with suspension insulator set swing 30°	mm	1370
with suspension insulator set swing 45°	mm	1220
with suspension insulator set swing 60°	mm	1070
ii.with jumper loop swing 0°	mm	1530
with jumper loop swing 10°	mm	1530
with jumper loop swing 20°	mm	1070

with jumper loop swing 30°	mm	1070
with jumper loop swing 40°	mm	-
Insulator suspension set, unobstructed transverse swing angle from vertical	degrees	0 - 60
Earth conductor suspension clamps, unobstructed transverse swing angle from vertical	degrees	0 - 50
Earth conductor maximum shielding angle from vertical at tower attachment point over outer line conductors	degrees	30

C . 22 - Tower Design Particulars (220 kV Construction)

Minimum clearance between live metal and tower steelwork:		
i. with suspension insulator set swing 0°	mm	2130
with suspension insulator set swing 15°	mm	1980
with suspension insulator set swing 30°	mm	1830
with suspension insulator set swing 45°	mm	1675
with suspension insulator set swing 60°	mm	-
ii. with jumper loop swing 0°	mm	2130
with jumper loop swing 10°	mm	1675
with jumper loop swing 20°	mm	1675

with jumper loop swing 30°	mm	-
with jumper loop swing 40°	mm	-
Insulator suspension set, unobstructed transverse swing angle from vertical	degrees	0 - 45
Earth conductor suspension clamps, unobstructed transverse swing angle from vertical	degrees	0 - 50
Earth conductor maximum shielding angle from vertical at tower attachment point over outer line conductors	degrees	30

C . 23 - Tower Design Particulars (400 kV Construction)

Minimum clearance between live metal and tower steelwork:		
i. with suspension insulator set swing 0°	mm	3050
with suspension insulator set swing 15°	mm	3050
with suspension insulator set swing 30°	mm	1860
with suspension insulator set swing 45°	mm	-
with suspension insulator set swing 60°	mm	-
ii. with jumper loop swing 0°	mm	3050
with jumper loop swing 10°	mm	3050
with jumper loop swing 20°	mm	3050
with jumper loop swing 30°	mm	1860
with jumper loop swing 40°	mm	1860
Insulator suspension set, unobstructed transverse swing angle from vertical	degrees	0 - 30
Earth conductor suspension clamps, unobstructed transverse swing angle from vertical	degrees	0 - 50
Earth conductor maximum shielding angle from vertical at tower attachment point over outer line conductors	degrees	20

C . 25 - Particulars Of Double Circuit Towers (132 kV Construction)

Type Of Tower		DA	DB	DC	DD
Type of insulator sets		Suspension	Tension	Tension	Tension
Maximum angle of deviation	degree	0 - 2	0 - 15	15 - 30	30 - 60
Normal span length	m	300	300	300	300
Minimum ground clearance of line conductor at 85°C, normal ground	m	6.42	6.42	6.42	6.42
Minimum height of earth conductors above upper line conductor at mid-span	m	6.1	6.1	6.1	6.1
Vertical spacing between line conductors at tower (minimum)	m	3.9	3.9	3.9	3.9
Minimum Clearance between conductors of one circuit and tower climbing leg of the other circuit.	m	4.5	4.5	4.5	4.5

C . 26 - Particulars Of Double Circuit Towers (220 kV Construction)

Type Of Tower		DA	DB	DC	DD
Type of insulator sets		Suspension	Tension	Tension	Tension
Maximum angle of deviation	degree	0 - 2	0 - 15	15 - 30	30 - 60
Normal span length	m	350	350	350	350
Minimum ground clearance of line conductor at 85 °C, normal ground	m	7.23	7.23	7.23	7.23
Minimum height of earth conductors above upper line conductor at mid-span	m	8.5	8.5	8.5	8.5
Vertical spacing between line conductors at tower (minimum)	m	4.9	4.9	4.9	4.9
Minimum Clearance between conductors of one circuit and tower climbing leg of the other circuit.	m	5.5	5.5	5.5	5.5

C . 27 - Particulars Of Double Circuit Towers (400 kV Construction)

Type Of Tower		DA	DB	DC	DD
Type of insulator sets		Suspension	Tension	Tension	Tension
Maximum angle of deviation	degree	0 - 2	0 - 15	15 - 30	30 - 60
Normal span length	m	400	400	400	400
Minimum ground clearance of line conductor at 85 °C, normal ground	m	8.84	8.84	8.84	8.84
Minimum height of earth conductors above upper line conductor at mid-span	m	9.0	9.0	9.0	9.0
Vertical spacing between line conductors at tower (minimum) .	m	8.0	8.0	8.0	8.0
Minimum Clearance between conductors of one circuit and tower climbing leg of the other circuit.	m	6.5	6.5	6.5	6.5

C . 28 - Foundation Design Particulars

Assumed density of Plain Cement Concrete (PCC) for foundation in dry soil	kg/m^3	2240
Assumed density of Plain Cement Concrete (PCC) for foundation in presence of sub-soil water	kg/m^3	1240
Assumed density of Re-inforced Cement Concrete (RCC) for foundation in dry soil	kg/m^3	2400
Assumed density of Re-inforced Cement Concrete (RCC) for foundation in presence of sub-soil water	kg/m^3	1400
28 day concrete cube strength (characteristic strength for M-20 concrete)	N/mm^2	20
28 day concrete cube strength (characteristic strength for M-15 concrete)	N/mm^2	15
Minimum proportion of stub load to be allowed for in the design of stub cleats	%	100
Density of all type of soils :		
1) under dry conditions	kg/m^3	1440
2) in presence of surface water	kg/m^3	1440
3) in presence of sub-soil water	kg/m^3	840
Ultimate bearing capacity of the soil :		
1) normal soil under dry condition	kN/m^2	214
2) normal soil in presence of surface as well as sub-soil water	kN/m^2	107
3) wet black cotton soil	kN/m^2	107
4) fissured rock (both for dry and wet)	kN/m^2	400
5) hard rock	kN/m^2	750
Angle of repose for :		
1) dry soil	Degree	30
2) wet soil due to presence of surface/ sub-soil water	Degree	15
3) wet black cotton soil	Degree	0
4) dry fissured rock	Degree	20
5) wet fissured rock	Degree	10
Ultimate bond between steel and concrete	kN/m^2	0.147

Note : All the soil parameters furnished above are subject to verification by actual soil investigations. The Contractor shall be required to carry-out field test for each type of foundation, as per the quoted rates in Price Schedules, to prove the design parameters considered.

The foundation classification criteria shall be as given below, depending upon type of soil and sub-soil water level / presence of surface water :

Normal Dry : To be used for locations where normal dry cohesive or non-cohesive soils are met without encountering sub-soil water table within the depth of foundation.

Wet : To be used for locations,

a) where sub-soil water is met at 1.5 m. or more below the ground level;

b) which are in surface water for long periods with water penetration not exceeding one metre below the ground level e.g. , the paddy field.

Partially Submerged : To be used for the locations where sub-soil water table is met between 0.75 to 1.5 m. below the ground level;

Fully Submerged : To be used for locations where sub-soil water table is met at less than 0.75 m. below the ground level;

Black Cotton Type : To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement. For designing the foundation for such locations, the soil is to be considered as fully submerged.

Fissured Rock : To be used at locations where decomposed or fissured rock, hard gravel, kankar, lime-stone, laterite or any other soil of similar nature is met. Under-cut type foundation is to be used for such locations.

In case of fissured rock locations where water table is met at 1.5 m. or more below ground level, wet type fissured rock foundations shall be adopted.

Hard Rock : To be used for the locations where chiselling, drilling or blasting is required for excavation . For these locations rock anchoring is to be provided to resist the uplift forces.

PILE FOUNDATION-

a) **SCOPE-** The work involved is to take up the pile foundation work of including stub setting of special type tower. The detailed survey, soil investigation and the design has to be done bidder and the design is to be approved by OPTCL, which shall be strictly followed by the contractor. The contractor shall cast the foundation including stub setting as per the design, the schedule of quantities enclosed and direction of engineer in charge.

b) 1. The pile foundation shall be of RCC, Cast-in-situ bored piles as per IS:2911 . Pile boring shall be done using Rotary Hydraulic Rigs. Two stage flushing of pile bore shall be ensured by airlift technique duly approved by the Employer

2. Minimum diameters of piles shall be 450/500mm (for under reamed piles)/ 600 mm (for bored cast in situ piles).

3. Only straight shaft piles shall be used. Minimum cast length of pile above cutoff level shall be 1.0 m.

4. The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, locations of initial test piles etc.) for Engineer's approval.

5. The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

6. Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical		
Lateral	:	Minimum of 2 Nos. in each mode
Uplift		

7. The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test (initial test) the method of loading shall be cyclic as per IS:2911 (relevant part).

8. Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter

9. Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :
   (i) Vertical : 0.5% of the total number of piles provided.
   (ii) Lateral : 0.5% of the total number of piles provided.

10. The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.
11. In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.
12. Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

13. The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge.
14. Low Strain Pile Integrity test shall be conducted on all test piles and job piles. This test shall be used to identify the routine load test and not intended to replace the use of static load test. This test is limited to assess the imperfection of the pile shaft and shall be undertaken by an independent specialist agency. The test equipment shall be of TNO or PDI make or equivalent. The process shall confirm to ASTM.

15. Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.
16. The following shall be adhered to **PILE FOUNDATION**:

i) The pile foundation shall be of under reamed piles as per IS: 2911 part III or bored cast in situ piles as per IS 2911 part I sec2

ii) The minimum diameter of pile shall be 500 mm in case of under reamed piles and 600 mm in case of bored cast in situ piles.

iii) Under reamed piles shall be adopted only in case of clay black cotton soil or medium dense sandy soil is encountered. Design of under reamed shall be done strictly as per IS 2911 part III.

iv) The bidder shall furnish design of piles (in terms of rated capacity, length, diameter, termination criteria to locate the founding level for construction of pile in terms of measurable parameter, reinforcement for job as well as test piles, locations of initial test piles etc.) for Engineer's approval.

v) The piling work shall be carried out in accordance with IS:2911 (Relevant part) and accepted construction methodology. The construction methodology shall be submitted by the Contractor for Engineer's approval.

vi) Number of initial load tests to be performed for each diameter and rated capacity of pile shall be subject to minimum as under.

Vertical	
Lateral	Minimum of 2 Nos. in each mode.
Uplift	

vii) The initial pile load test shall be conducted with test load upto three times the estimated pile capacity. In case of compression test (initial test) the method of loading shall be cyclic as per IS:2911 (part IV).

viii) Load test shall be conducted at pile cut of level (COL). If the water table is above the COL the test pit shall be kept dry through out the test period by suitable de-watering methods. Alternatively the vertical load test may be conducted at a level higher than COL. In such a case, an annular space shall be created to remove the effect of skin friction above COL by providing an outer casing of suitable diameter larger than the pile diameter.

ix) Number of routine pile load tests to be performed for each diameter/allowable capacity of pile shall be as under :

i) Vertical : 0.5% of the total number of piles provided.

ii) Lateral : 0.5% of the total number of piles provided.

x) The routine tests on piles shall be conducted upto test load of one and half times the allowable pile capacity. Piles for routine load tests shall be approved by the Employer.

xi) In case, routine pile load test shows that the pile has not achieved the desired capacity or pile(s) have been rejected due to any other reason, then the Contractor shall install additional pile(s) as required and the pile cap design shall accordingly be reviewed and modified, if required.

xii) Testing of piles and interpretation of pile load test results shall be carried out as per IS:2911 (Part-4). Contractor shall ensure that all the measuring equipment and instruments are properly calibrated at a reputed laboratory / institute prior to their use. Settlement / movement of the pile top shall be made by Linear Variable Differential Transducers (LVDT) having a least count of 0.01mm.

xiii) The test load on initial test piles shall be applied by means of reaction from anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge.

xiv) Contribution of frictional resistance of filled up soil if any, shall not be considered for computation of frictional resistance of piles.

a) MATERIALS- Contractor shall supply cement, steel rod and stubs and all other materials required. All coarse aggregates, fine aggregates are to be of very good quality and to be approved by the engineer in charge.

b) Watch and Ward- The cost of watch and ward, site store, making of Islanding/platform for the pile boring, stabilization of bore hole and all other activities incidental to successful construction of the pile foundation are to be included in the cost of the tender and no additional cost shall be paid separately on any additional component.

The cement, steel shall be supplied to the contractor at the nearest store and the contractor shall have to receive the same at designated stores and transport to site at his own cost.

The piling shall be done in presence of the engineer in charge and due certification to be done at the spot only.

Standard followed and to be followed-

Indian Standards(IS)	Title	International and Internationally Recognize Standard/Code
IS:1080-1990	Codes of Practice for Design and Construction of Simple Spread Foundations	
IS: 1498-1992	Classification and Identification of Soils for General Engineering Purposes.	ASTM D 2487/ ASTM D 2488
IS: 1892-1992	Code of Practice For Design and Construction of Foundation in Soils : General Requirements.	
IS: 2131-1992	Method of Standard Penetration Soils	ASTM D 1586
IS: 2132-1992	Code of Practice For Thin Walled Sampling of Soils	ASTM D 1587
IS: 2720-1992	Method of Test For Soils (Relevant Parts.	ASTM D 420
IS: 2809-1991	Glossary of Terms And symbols Relating to Soil Engineering	ASTM D 653

Indian Standards(IS)	Title	International and Internationally

		Recognize Standard/Code
IS: 2911-1980	Code of Practice For Design and Construction of Pile Foundations (Relevant Parts).	
IS: 3025	Methods of Sampling And Testing (Physical And Chemical) for Water used in industry.	
IS: 3043-1991	Code or Practice for Indexing and Storage Of Drill Cores.	
IS: 4091-1987	Code of Practice for Design and Construction Of Foundations for Transmission Line Towers and Poles.	
IS: 4434-1992	Code of Practice for in-situ Vane Shear Test for Soils.	ASTM D 2573/ ASTM D 4648
IS: 4453-1992	Code of Practice for Exploration by Pits, Trenches, Drifts and Shafts.	
IS: 4464-1990	Code of Practice for Presentation of Drilling Information and core Description in Foundation Investigation	
IS: 4968 - (Part-II) – 1992	Method for Subsurface sounding for soils, dynamic method using cone and Bentonite slurry	
IS: 5313-1989	Guide for Core Drilling Observations.	

Indian Standards(IS)	Title	International and Internationally Recognize Standard/Code
IS:6403-1990	Code of Practice for	

	Diamond Core Drilling for Site Investigation for River Valley Projects.	
IS: 6935-1989	Method of Determination of water level in a Bore Hole.	
IS: 7422-1990	Symbols and Abbreviations for use in Geological Maps Sections and subsurface Exploratory Logs (Relevant Parts).	
IS:8009 (Part-I)-1993	Code of Practice for Calculation of Settlements of Foundations (Shallow Foundations subjected to symmetrical Vertical Loads).	
IS:8764-1991	Method of Determination of Point Load Strength Index of Rocks.	
IS: 9179-1991	Method of Determination of Unconfined compressive Strength of Rock Materials.	ASTM D 2938
IS: 9179-1991	Method of Preparation of Rock Specimen for Laboratory Testing.	ASTM D 4543
IS: 9259-1992	Specification for Liquid Limit apparatus.	ASTM D 4318
IS: 9640-1992	Specification for Split Spoon Sampler	ASTM D 1586
IS: 10050-1992	Method of Determination of Slake Durability Index of Rocks.	ASTM D 4644
IS: 11315- (Part-II)-1991	Description of Discontinuities in Rock Mass-Core Recovery	

TESTS

Tests as indicated in this specification and as may be requested by the Owner, shall be conducted. There tests shall include but may not be limited to the following :

a) **Tests of undisturbed and disturbed samples**

- Visual and engineering classification;
- Sleeve analysis and hydrometric analysis;

- Liquid, plastic and shrinkage limits;
- Specific gravity;
- Chemical analysis
- Swell pressure and free swell index determination
- Proctor compaction test.

b) Tests of undisturbed samples:

- Bulk density and moisture content;
- Relative density (for sand),
- Unconfined compression test;
- Box shear test (for sand);
- Tri-axial shear tests (depending on the type of soil and field conditions on undisturbed or remoulded samples):

i) Unconsolidated untrained;

ii) Consolidated drained test;

- Consolidation.

c) **Tests on rock samples**

- Visual classification:
- Moisture content, porosity and density:
- Specific gravity;
- Hardness
- Stake durability;
- Unconfined compression test (both saturated and at in-situ water content;
- Point load strength index;
- Deformability test (both saturated and dry samples)

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

CONDUCTOR, AL TUBE G.I GROUND WIRE, INSULATORS, HARDWARE, CLAMPS & CONNECTORS

CONDUCTORS

S E C T I O N - I

TECHNICAL SPECIFICATION OF ACSR "MOOSE","ZEBRA",
AND " PANTHER" CONDUCTORS

1. **SCOPE :-**

1.1. This specification provides for the manufacture, testing, supply and delivery at destination of the steel cored aluminum conductors as per Appendix-I attached.

2. **STANDARDS :-**

2.1 The conductors shall comply in all respects to the clauses of this specification as indicated below & with the Indian Standard Specification, International standards with latest amendments. Some of the standards are :-

i) IS 398 - Specification for Aluminium Conductors for overhead transmission purposes,

IS 398, Part-II-Aluminium conductors for overhead Transmission purpose - Specification

ii) IS 1521, 1972 - Method of tensile testing of steel

iii) IS 1778 -1989 – Reel & drums for bare conductors.

iv) IEC - 1098

3. **MATERIALS :-**

3.1 The material offered shall be of best quality and workmanship. The steel Cored Aluminum conductor strands will consist of hard-drawn aluminum wire manufactured from 99.5% pure electrolytic aluminum rods of E.C. Grade. The steel wire shall be made from materials produced either by the acid or basic open hearth process or by electric process. No steel wire drawn from pressmen process shall be used. The steel wire shall not contain sulphur or phosphorus exceeding 0.05 percent, and the total of sulphur and phosphorus shall not exceed 0.085 percent.

3.2 The steel wires shall be evenly and uniformly coated with zinc complying with Indian Standard 4826-1979 specification for galvanized coatings on round steel wires. The uniformity of zinc coating and the weight of coating shall be in accordance with Appendix-II. The coating on the galvanized steel wires may be applied by the hot process or the electrolytic process.

4. **SIZES :-**

4.1 The size of steel-cored Aluminum Conductors shall be as given in Appendix-I. The resistance and weights shall be in accordance with the values given in the same appendix.

5. **TOLERANCES :-**

5.1 The following tolerances shall be permitted on standard diameter of aluminum wires.

Tolerance on standard diameter of aluminum wire $\pm$ 1 percent. wires.

Note : - The cross-section of any wire shall not depart from circularity by more than an amount corresponding to a tolerance of 2 percent on the standard diameter.

5.2 A tolerance of + 2 percent shall be permitted on the standard diameter of the galvanized steel wires. The variation from the approximate weights shall not be more than plus or minus 5 percent.

6. **MECHANICAL PROPERTIES : -**

6.1 The value of the final modules of elasticity for steel cored aluminum conductor in the average of values obtained from actual stress strain tests. The co-efficient of linear expansion for steel Cored Aluminum Conductors has been calculated on the basis of co-efficient of linear expansion of 23.0 x 10-6 per degree centigrade of aluminum and 11.5 x 10-6 per degree centigrade for steel and represent only the average values. These values shall however, be given by the bidder under the guaranteed technical particulars.

7. **SURFACE CONDITIONS :-**

7.1 The wires shall be smooth and free from inequalities, spills and splits. The surface conductor shall be free from points, sharp-edges, abrasions or other departures from smoothness or uniformity of surface contour that would increase radio interference and corona losses. When subjected to tension up to 50% of the ultimate strength of the conductor, the surface shall not depart from its cylindrical form nor any part of the component, parts or strands, move relative to each other in such a way as to get out of place and disturb the longitudinal smoothness of the conductor.

8. **JOINTS IN WIRES : -**

8.1 Aluminium wires : No joints shall be permitted in the aluminium wires in the outermost layer of the ACSR conductor. Joints in the inner layers are permitted, in addition to those made in the base rod or wire before final drawing, but no two such joints shall be less than 15 meter. apart in the complete stranded conductor. Such joints shall be made by cold pressure butt-welding.

Joints are not permitted in the outermost layer of the conductor in order to ensure a smooth conductor finish and reduce radio interference levels and corona losses on the extra high voltage lines.

8.2 Galvanized steel wires : - There shall be no joints except those in the base rod or wire before final drawing, in steel wires forming the core of the steel-reinforced aluminum conductor.

Joints have not been permitted in the steel wires after final drawing in order to avoid reduction in the breaking strength of the conductor that may occur as a result of failure of the joints.

9. **STRANDING :-**

9.1 The wires used in construction of a stranded conductor shall before stranding, satisfy all requirements of IS-398/ (part-II)1976 with latest amendments. For steel-cored aluminum conductors the lay ratio of the different layers shall be within the limits given under Appendix-I.

9.2 For all, constructions, each alternate layer shall be stranded in opposite directions. The wires in each layer shall be evenly and closely stranded round the under laying wire or wires. The final layer of wires shall have a right hand lay.

10. **PACKING AND MARKING : -**

10.1 The conductor shall be wound in non-returnable reels or drums conforming to Indian Standard 1978-1961 specification for Reels and Drums for Bare Wire, or any other authoritative standard and marked with the following : -

a)	Trade name, if any	b)	Contract/Award letter Number
c)	Name of manufacturer	d)	Name & Address of Consignee
e)	Drum Number	f)	Length of conductor
g)	Size of conductor	h)	Gross Weight of drum with conductor
i)	Weight of empty drum **with lagging.**	j)	Net and gross of conductor.
k)	Arrow marking of un-winding		

10.2 The reel shall be of such construction as to assure delivery of conductor in the field from displacement and damage and should be able to withstand all stresses due to handling and the

stringing operations so that conductor surface is not dented, scratched or damaged in any way during manufacture, transport and erection. The conductor shall be properly lagged on the drums and the method of lagging to be employed may be clearly stated in the tender. It should be stocked to suit the reel and held in place by steel strapping. Lagging shall not be nailed or bolted in place.

10.3 The conductor drum should be suitable for wheel mounting. Before reeling, the card-board or other suitable material shall be secured to the drum and inside flanges of the drums. After reeling the conductor, the exposed surfaces should be wrapped with suitable soft material to prevent the conductor from dirt and grit. Any space between the drum lagging and conductor should be suitably filled with soft filler material compactly packed. The conductor drum shall be made as per the relevant IS.

11. **LENGTHS : -**

11.1 The conductor shall be supplied in the standard lengths **as below** with a permitted variation of 5%. Not less than 90% of the total quantity of the conductor shall be supplied in the standard lengths. Thus the quantity of the conductor in lengths shorter than standard ones shall not exceed 10% of the total quantity to be supplied. Further no single conductor lengths in respect of such 10% (Maximum supply) in random lengths, shall be shorter than 50% of the standard lengths.

Type of conductor	Length per drum.
MOOSE ACSR	1.1 K.M
ZEBRA ACSR	1.1 K.M.
PANTHOR ACSR	2.2 K.M.

12. TESTS AND TEST CERTIFICATES :-

The following type tests ,(& any other tests if purchaser decides to do), shall be conducted on the conductor at any Govt. approved laboratory or CPRI, in presence of the representatives of OPTCL, on the samples collected and sealed by the representative of OPTCL from the manufactured & offered drums of conductor at random at free of cost to OPTCL or firm may quote their test charges which will be taken in to account during bid price evaluation. If test charges will not be quoted by the firm, it will be treated as nil during bid price evaluation & firm have to do the type tests at free of cost to OPTCL. **Also the tenderer shall furnish valid type test reports, the tests are as per the IS 398 (part-2) conducted in any govt. approved laboratory or CPRI within last 5 years, from the date of opening of the bid (Techno-commercial) document, without which their bids will not be considered for evaluation.**

12.1 Individual wire and finished steel cored Aluminum Conductor shall be subjected to before dispatch from the works, to the tests as per the provision of the Indian standard Specification 398 (Part-II-1976) with the latest amendments & as per the tests indicated in this specification below.

12.2 Samples for individual wires for test shall be taken before stranding form not less than 10 percent of the spiels in the case of aluminum wire and ten percent of the wire coils in the case of steel wires. If samples are taken after stranding, they shall be obtained by cutting 5 meters from the outer end of the finished conductor from not more than 10 percent of the finished reels.

12.3 The mechanical tests shall be carried out on single wires only.

12.4 The Tensile test shall apply to wires of all diameters forming part of steel cored aluminum conductors. If it is not possible to test the component wires before stranding the test may be made on wires taken from stranded conductors. The tensile strength of any of the wires shall not be less than the minimum values given in Appendix-II.

12.5 A suitable tensile testing machine shall be used the accuracy of which can easily be checked and the machine adjusted if necessary. The test sample before being placed in the

machine, shall be straightened, if necessary in such a way as to cause the minimum alteration in its physical properties.

The load shall be applied gradually and rate of separation of the Jaws of the testing machine shall not be greater than 10cm/min. and less than 2.5cm/min.

TYPE TESTS

12.6 **Wrapping Test : -**

12.6.1 Samples of aluminium wires shall be wrapped round a wire of its own diameter to form a close helix of eight turns. Six turns shall then be unwrapped and again clearly wrapped in the same direction as before. The wire shall not break.

12.6.2 Samples of steel wires shall be closely wrapped eight times round a mandrel of diameter equal to four times the wire diameter. Six turns shall then be unwrapped and again closely wrapped in the same direction as before. The wire shall not break.

12.7 **Galvanizing Test : -**

12.7.1 The uniformity of zinc coating and the weight of coating shall be as given in Appendix-II and shall be determined according to Indian Standard Specification 4826-1979. with latest amendments.

12.7.2 This test shall be made whenever practicable, on wires before stranding and before the specimen has been bent, straightened or tested in any other way.

12.8 **Ductility Test : -**

This test shall be made on galvanized steel wires only by any of the proceedings given in 12.8.1 and 12.8.2.

12.8.1 **Torsion Test : -** One specimen cut from each of the sample shall be gripped at its ends in two vices, one of which shall be free to move longitudinally during the test. A small tensile bond not exceeding 2% of the breaking load of the wire, shall be applied to the sample during testing. The specimen shall be twisted by consisting one of the vices to revolve until fracture occurs and the number of twists shall be indicated by a counter or other suitable device. The rate of twisting shall not exceed 60 rev/min.

When tested before stranding, the number of complete twists before fracture occurs shall not be less than 18 on a length equal to 100 times the diameter of the wire. The fracture shall show a smooth surface at right angles, to the axis of the wire.

When tested after stranding, the number of complete twists before fracture occurs shall be not less than 16 on a length equal to 100 times the diameter of the wire. The fracture shall show a smooth surface at right angles to the axis of the wire.

12.8.2 **Elongation Test : -** The elongation of one specimen cut from each of the samples shall be determined. The specimen shall be straightened by hand and on original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied as described in 12.5 and the elongation shall be measured after the fractured ends fitted together. If the fracture occurs outside the gauge marks, or within 25mm of either mark and the required elogation is not obtained, the test shall be disregarded and another test made. When tested before stranding, the elongation shall be not less than 4 percent. When tested after stranding, the elongation shall be not less than 3.5 percent.

12.9 Surface Condition Test

A sample of the finished conductor having a minimum recommended length of 5 meters with compression type dead end clamps compressed on both ends in such a manner as to permit the conductor to take its normal straight line shape, shall be subject to a tension of 50% of the UTS of the conductor. The surface shall not depart from its cylindrical shape nor shall the strands move relative to each other so as to get out of place of disturb the longitudinal smoothness of

conductor. The measured diameter at any place shall be not less than the sum of the minimum specified diameters of the individual aluminum and steel strands.

12.10 **Ultimate Strength (UTS) Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to specified 50% of UTS and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to the minimum UTS specified in Appendix-I and held for one minute. The applied load shall then be increased until the failing load is reached and the value recorded.

12.11 **Corona Extinction Voltage Test**

One sample of conductor of 5m length shall be strung. In case of twin conductor, two samples shall be arranged with the actual sub-conductor spacing between them. This sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 KV (rms) for 400 KV and 176 KV (rms) for 220 KV system line to ground under dry condition. There shall be no evidence of corona on any part of sample when all possible sources of corona are photographed in a darkened room. The test shall be conducted without corona control rings. The voltage shall be corrected for standard atmospheric conditions.

12.12 **Radio Interference Voltage Test**

Under the conditions as specified in 12.11 above, the conductor samples shall have a radio interference voltage level below 1500 microvolts at one MHZ when subjected to 50HZ AC voltage of 1.1 times maximum line to ground voltage under dry condition. This test may be carried out with corona control rings and arcing horns.

12.13 **D.C. Resistance Test on Stranded Conductor**

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20 degree centigrade as per clause No.12.8 of IS : 398 (part V). The resistance corrected at 20 degree centigrade shall conform to the requirements of this specification.

12.14 **Stress-Strain Test**

12.14 (i)This test is contemplated only to collect the creep data of the conductor from the supplier. A sample of conductor of minimum 10 metres length shall be suitably compressed with dead end clamps.

12.14 (ii)**Test Set-up**

12.14 (ii) (a) The test sample shall be supported in a trough over its full length and the trough adjusted so that the conductor will not be lifted by more than 10 mm under tension. This shall be ascertained by actual measurement.

12.14 (ii) (b) The distance between the clamp and the sleeve mouth shall be monitored with callipers during the test to ensure that, after the test, it does not change by more than 1 mm +/- 0.1mm from the value before the test.

12.14 (iii) (c) The conductor strain shall be evaluated from the measured displacements at the two ends of the gauge length of the sample. The gauge reference targets shall be attached to the clamps which lock the steel and aluminum wires together. Target plates may be used with dial gauges or displacement transducers and care shall be taken to position the plates perpendicular to the conductor. Twisting the conductor, lifting it and moving it from side-to-side by the maximum amounts expected during the test should introduce no more than 0.3mm error in the reading.

12.14 (iii)Test Loads for Complete Conductor

The loading conditions for repeated stress-strain tests for complete conductor shall be as follows :

12.14 (iii) (a) 1 KN load shall be applied initially to straighten the conductor. The load shall be removed after straightening and then the strain gauges are to be set at zero at zero tension.

12.14 (iii) (b) For non-continuous stress-strain data, the strain reading at 1 KN intervals at lower tensions and 5KN intervals above 30% of UTS shall be recorded.

12.14 (iii) (c) The sample shall be reloaded to 50% of UTS and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes during the hold period. The load shall be released after the hold period.

12.14 (iii) (d) Reloading up to 70% of UTS shall be done and held for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45, and 60 minutes and then the load shall be released.

12.14 (iii) (e) Reloading up to 85% of UTS shall be done and hold for 1 hour. Readings are to be noted after 5, 10, 15, 30, 45 and 60 minutes and then the load shall be released.

12.14 (iii) (f) Tension shall be applied again and shall be increased uniformly until the actual breaking strength is reached. Simultaneous readings of tension and elongation shall be recorded up to 90 % of UTS at the intervals described under Clause 12.14 (iii) (e).

12.14 (iv)**Test Loads for Steel core Only.**

The loading conditions for repeated stress-strain tests for the steel core of ACSR shall be as follows :

12.14 (iv) (a) The test shall consist of successive application of load applied in a manner similar to that for the complete conductor at 30%, 50%, 70% and 85% of UTS.

12.14 (iv) (b) The steel core shall be loaded until the elongation at the beginning of each hold period corresponds to that obtained on the complete conductor at 30%, 50%, 70% and 85% of UTS respectively.

12.14 (v)Stress Strain Curves

The design stress-strain curve shall be obtained by drawing a smooth curve through the 0.5 and 1 hour points at 30%, 50%, and 70% of UTS loadings. The presence of any aluminum slack that can be related to any observed extrusion entering the span from the compression dead ends shall be removed from the lower ends of the design curves. Both the laboratory and design stress-strain curves shall be submitted to the purchaser along with test results. The stress-strain data obtained during the test shall be corrected to the standard temperature i.e. 20 degree centigrade.

12.15 Chemical Analysis of Zinc

Samples taken from the Zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

12.16 Chemical Analysis of Aluminum and Steel

Samples taken from the Aluminum ingots/ coils/ strands shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in this specification.

ROUTINE/ACCEPTANCE TESTS

12.17 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this specification. Drum dimensions should confirm to **IS: 1778**.The flange diameter, traverse width, barrel diameter and flange thickness are to be as per relevant standard.

12.18 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conforms to the requirements of this specification.

12.19 Dimensional Check of Steel and Aluminum Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

12.20 **Check for Lay-ratios of various Layers**

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification.

12.21 **Breaking load test on welded Aluminum strand & Individual wires**

Two Aluminum wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual strand guaranteed by the supplier.

12.22 Ductility Test

12.23 wrapping test

12.24 Resistance test

12.25 Galvanising Test

13. **RETEST AND REJECTION : -**

13.1 Each coil or spool selected for testing shall be tested for compliance with the requirements of Indian Standard Specification 398 (part-II) 1976 with latest amendment if any selected coil or spool not fulfill any of the test requirements, that particular coil or spool shall be withdrawn. In respect of each failure, two test pieces shall be selected from two different coils in the lot and subjected to the test under which the failure occurred. If either of the two retest pieces fails to pass that test, the lot concerned shall be rejected.

If samples are taken for test after stranding and if any selected reel fails in the retest, the manufacturer may test each and every reel and submit them for further inspection. All rejected materials shall be suitably marked and segregated.

14. **GUARANTEED TECHNICAL PARTICULARS : -**

The bidder shall fill in the guaranteed technical particulars in the Performa at Appendix-IV and submit the same with his tender, without which bid will not be considered.

15. **SAG TENSION CHARTS AND SAG TEMPLATES : -**

The contractor shall supply each six copies of sag tension charts and sag templates in respect of each type of the steel core aluminum conductor. The Contractor shall also supply sag template in celluloid which shall be subject to the approval by the purchaser and without involving any extra charges. The design data of the lines on which these conductors will be used are given in **Appendix-III.**

A P P E N D I X - I

	ACSR CONDUCTOR:	MOOSE	ZEBRA
1.	Size of conductor:	54/7/3.53 mm	54/7/3.18 mm
2.	Stranding and wire diameter		
	Aluminum	54/3.53 mm	54/3.18 mm
	Steel	7/3.53 mm	7/3.18 mm
3.	Sectional area of Aluminum (in $mm^{2)}$	528.50	428.90
4.	Approximate total mass (in Kgs/KM)	2004	1622
5.	Calculated resistance at 20°C Max.: (in Ohms/Km.)	0.05552	0.06868
6.	Calculated breaking load of: composite conductor (in KN) (U.T.S.) (Min)	161.20 KN	130.32 KN.
7.	Lay Rating :-		
	Steel core	Max – 18	Max- 28
		Min - 16	Min-13
	Aluminium Layers		
	12 Wire Layer	Max – 14	Max-17
	(Innermost Layer)	Min – 12	Min - 10
	18 Wire Layer	Max -13	Max - 16
	(Lay immediately beneath outside Layer)	Min – 11	Min - 10
	24 wire layer (outside layer)	Max -12	Max - 14
		Min -10	Min - 10
8.	Modulus of elasticity (in Kg / mm^2):	6860	8158
		0.7036×10^6 Kg x CM^2 (69 GN per Sq. meter)	
9.	Co-efficient of linear expansion of conductor per degree centigrade.	----------19.3×10^{-6} ----------	
10.	Standard area of Cross Section in Sq. mm of conductor.	597.0 mm^2	484.5 mm^2
11.	Diameter of complete conductor in	31.77 mm	28.62 mm

A P P E N D I X - II

Solid Steel and Aluminum Wires used in Steel cored

Aluminum Conductors

		ZEBRA		MOOSE	
1.	Diameter	Steel	Aluminum	Steel	Aluminium
	Standard (in mm)	3.18	3.18	3.53	3.53
	Maximum (in mm)	3.24	3.21	3.60	3.55
	Minimum (in mm)	3.12	3.15	3.46	3.51
2.	Cross Sectional Area of nominal Diameter Wire (in mm^2)	7.942	7.942	9.791	9.791
3.	Weight (in Kg/KM)	61.95	21.47		
4.	Minimum tensile strength:	As per relevant ISS			
5.	Minimum breaking load before stranding (in KN)	10.43	1.29	12.86	1.57
6.	Minimum breaking load: after stranding (in KN)	9.91	1.23	12.22	1.49
7.	Zinc coating of steel strands				
	Number and duration: of dips	3 (1 Min. dip)		3 dips of 1min	
	Minimum Weight of : Coating (in gm/ $m^{2)}$ (A s per IS-4826 –1979)	260		260	
8.	Maximum resistance at: Aluminum strands (in Ohms / KM)	3.626	2.974	2.921	20°C of
9.	Minim Purity of aluminum rod:	----------99.5 %----------			

A P P E N D I X – III

	ACSR CONDUCTOR:	ZEBRA	MOOSE
1.	Conductor	---------Steel cored Aluminum-----	
	(a) Copper equivalent: mm^2		
	(b) Stranding (in mm)	54/7/3.18	54/7/3.53
2.	Normal Span.	320 Meters	
	Wind Span.	320 Meters	
	Weight Span.		
	(a) Max.	500 Meters	
	(b) Min.	50 Meters	
3.	Wind Pressure on full project area.	52 Kgf per M^2	
4.	Temperature		
	(a) Minimum	5 ° C	
	(b) Maximum	67 ° C	
	(c) Every day	32°C	
5.	Factors of safety : Minimum		
	(i) Every day temperature and no wind.	4.00	
	(ii) Minimum temperature and 2/3 maximum wind :	2.00	
	(iii) Every day Temperature and full wind	2.00	
	This is as per Indian Electricity Rules, 1956.		
6.	Relative Humidity.		
	Maximum.	100 Percent	
	Minimum.	60 Percent	
7.	Isoceramic level.	100/Years	
8.	Number of rainy days per year.	100 days	
9.	Average rainfall per year	1150 mm. approx.	
10.	Altitude.	Less than 350 Metres.	

Technical parameters

Sl. No.	Description		ACSR MOOSE
1	Stranding and wire diameter		54Al /3.53 mm+7 Steel/3.53 mm
2	Number of Strands		
	Steel centre		1
	1st Steel Layer		6
	1st Aluminium Layer		12
	2nd Aluminium Layer		18
	3rd Aluminium Layer		24
3	Sectional area of aluminium		528.5 mm^2
4	Total sectional area		597.00 mm^2
5	Overall diameter		31.77 mm
6	Approximate weight		2004 kg/km
7	Calculated DC resistance at 20 °C		0.05596 Ω/km
8	Minimum UTS		161.2 kN
9	The details of aluminium strand are as follows:		
	Minimum breaking load of strand before stranding		1.57 kN
	Minimum breaking load of strand after stranding		1.49 kN
	Maximum DC resistance of strand at 20 °C		2.921Ω/km
10	The details of steel strand are as follows		
	Minimum breaking load of strand before stranding		12.86 kN
	Minimum breaking load of strand after stranding		12.22 kN
11	Minimum number of twist to be with stood in torsion test when tested on a gauge length of 100 times diameter of wire		18 - before stranding 16 - after stranding
12	Tolerances		
12a	Diameter of aluminium strands	Standard	3.53 mm
		Maximum	3.55 mm
		Minimum	3.51 mm
	Diameter of steel strands	Standard	3.53 mm
		Maximum	3.60 mm
		Minimum	3.46 mm
13	Lay ratio of Conductor		
13a	Steel - 6 wire layer	Maximum	18
		Minimum	16
13b	Aluminium - 12 wire layer	Maximum	14
		Minimum	12
13c	Aluminium - 18 wire layer	Maximum	13
		Minimum	11
13d	Aluminium - 24 wire layer	Maximum	12
		Minimum	11
14	Materials composition		
14a	Aluminium		99.5% with copper content less than 0.4%
14b	Steel	Carbon	0.50 to 0.85 %

	Manganese	0.50 to 1.10 %
	Phosphorous	not more than 0.035 %
	Sulphur	not more than 0.045 %
	Silicon	0.10 to 0.35 %
14c	Zinc for galvanising	electrolytic high grade zinc of 99.95% purity conforming to IS 209-1979.

A P P E N D I X – **PANTHER**

1.	Size of conductor	30/7/3.00 mm
2.	Stranding and wire diameter	
	Aluminum	30/3.00 mm
	Steel	7/3.00 mm
3.	Sectional Area of Aluminum	212.10 mm^2
4.	Approximate total mass	974 Kgs/KM
5.	Calculated resistance at 20° C Max.	0.139 Ohm/KM
6.	Calculated breaking load of composite conductor (U.T.S) (Min)	89.67 KN
7.	Lay Ratio :-	
	Steel Core	Max - 28 Min - 13
	Aluminum Layers	
	12 Wire layer (Layer below outside layer)	Max - 16 Min - 10
	18 Wire layer (Outside Layer)	Max - 14 Min - 10
8.	Modulus of elasticity	0.815 x 10^6Kg/CM^2 (80GN/M^2)
9.	Co-efficient of Linear expansion of conductor.	17.8 x 10^{-6} / °C
10.	Standard area of cross Section in sq. mm of conductor	261.50 Sq. mm
11.	Diameter of complete conductor in mm	21 mm

A P P E N D I X - II

PANTHER

Solid Steel and Aluminium Wires used in Steel cored Aluminium Conductors

1.	Diameter	Steel	Aluminum
	Standard	3.00 mm	3.00 mm
	Maximum	3.06 mm	3.03 mm
	Minimum	2.94 mm	2.97 mm
2.	Cross Sectional Area of nominal Diameter Wire	7.069 mm^2	7.069 mm^2
3.	Weight	55.13 Kg/KM	19.11Kg/Km
4.	Minimum tensile strength	134Kg/mm^2	16.87Kg/mm^2
5.	Minimum breaking load before stranding	9.29 KN	1.17 KN
6.	Minimum breaking load after stranding	8.83 KN	1.11 KN
7.	Zinc coating of steel strands		
	No and duration of dips	3 (1 Min. dip)	
	Minimum Weight of coating	As per IS 4826-1979	
8.	Maximum resistance at 20°C of Aluminum strands		4.079 Ohms/KM
9.	Purity of aluminum rod		99.5%

A P P E N D I X - III

PANTHER

1.	Conductor	Steel cored Aluminum
	(a) Copper equivalent	130 mm^2
	(b) Stranding	30/7/3.00 mm
2.	Normal Span.	320 Meters
	Wind Span.	320 Meters
	Weight Span.	
	(a) Max.	500 Meters
	(b) Min.	50 Meters
3.	Wind Pressure on full projected area.	52 Kgf per M^2
4.	Temperature	
	(a) Minimum	5 °C
	(b) Maximum	67°C
	(c) Every day	32°C
5.	Factors of safety : Minimum	
	(i) Every day temperature and no wind.	4.00
	(ii) Minimum temperature and 2/3 maximum wind :	2.00
	(iii) Every day Temperature and full wind	2.00
	This is as per Indian Electricity Rules, 1956.	
6.	Relative Humidity.	
	Maximum.	100 Percent
	Minimum.	60 Percent
7.	Isoceramic level	100/years
8.	Number of rainy days per year.	100 days
9.	Average rainfall per year	1150 mm. approx.
10.	Altitude.	Less than 350 Meters

G.I EARTH WIRE

SECTION – II

S.NO.	DESCRIPTION
1.	SCOPE
2.	STANDARDS
3.	MATERIALS
4.	SIZE AND CONSTRUCTION
5.	LENGTH OF JOINING
6.	TESTS AND TEST CERTIFICATES
7.	PACKING AND MARKING
8.	SAG AND TENSION CHARTS AND SAG TEMPLATE
9.	OVERHEAD EARTH CONDUCTORS

TECHNICAL SPECIFICATION FOR G.I. GROUND WIRE.

(7/3.15 mm and 7/3.66mm)

1. **SCOPE** :

1.1 This specification provides for the manufacture, testing before despatch, supply and delivery of Ground wire for the purpose of earthing and protection of power transmission line, as per the particulars given in Appendix-I attached. The ground wire shall consist of standard galvanized steel wire.

2. **STANDARDS** :

2.1 The ground wire shall comply in all respect with the Indian Standard (IS) 2141-1979

3. **MATERIALS** :

3.1 The material offered shall be of best quality and workmanship. The steel wires (Strands) shall be manufactured from steel produced by any suitable process. The steel wire shall not contain sulphur and phosphorous exceeding 0.040 percent each as per IS : 2141-1971.

3.2 The steel wires shall be evenly and uniformity quoted with zinc complying with IS: 209-1965 specification for zinc (Retired). Only virgin zinc shall be used and reclaimed zinc is not permitted. The virgin zinc shall be of zn 99.95 percent quality.

3.3 The content of carbon shall not be more than 0.55 percent, manganese and silicon contents shall be 0.40 to 0.90 and 0.15 to 0.35 respectively.

4. **SIZE AND CONSTRUCTION** :

4.1 The size of ground wire shall be as given in Appendix-I. The physical properties have been given in the same Appendix. The lay of the strands shall be of lengths as given in the Appendices. The wires shall be so stranded together that when any evenly distributed pulls applied at the end of the completed strands each wire will take on equal share of the pull.

5. **LENGTH OF JOINING**:

5.1 The ground wire may be supplied in the standard length as per manufacturers standard practice and such length will be specifically indicated in the tender. However random length of ground wire upto a maximum of 10 (Ten) percent may be allowed.

5.2 The length of strand which may be supplied without joints in the individual wires comprising it depends on the length of wire which may be carried by the bobbin in a normal stranding machine. The normal lengths of strand which shall be supplied without joints in individual wires, excluding welds made in the rod before drawing shall be as given in Appendix – I.

5.3 Each coil shall be warranted to contain no weld joints or splice ether than in the rod before it is drawn and those permitted in 5.3 above. The wire shall be circular and shall be free from scale or irregularities, imperfections, flow spite and other defects. The zinc coating shall be smooth even and bright.

6. **TESTS AND TEST CERTIFICATES**:

6.1 Ground wire shall be subjected to the tests as specified in the IS:2141-1979 before despatch.

6.2 Al the coils of the galvanized strand shall be of the same grade, diameter and construction manufactured under similar condition shall be grounded to constitute one lot.

6.3 Samples from each lot shall be tested for ascertaining the conformity to the requirements of the ground wire specified herein. The coils selected shall be tested for length of the lay and joints. The lot shall be declared conforming to the requirements of these characteristics if all the coils are found satisfactory. One test specimen from each wire of the strand shall be drawn, from every selected coil and subjected to tensil tests, ductility test and coating test. One specimen of the completed strand from each coil shall be subjected to tensil strength. The lot shall be declared conforming to the requirements of these characteristics if the entire best specimen satisfy the relevant requirements.

6.4 **Chemical Analysis** : One sample shall be drawn from the lot for chemical analysis. Unless otherwise agreed to between the purchase and supplier the chemical analysis shall be carried out.

6.5 **Tensile Test** : The wire when tested in accordance with IS : 1521-1960 shall have minimum tensile strength specified in the Appendix – I. The tensile strength of the finished strand shall not be less than 95% of the aggregate of the single wires.

6.6 **Ductility test** : The wire shall be subjected to wrapping test in accordance with IS : 1755-1961. When wrapped eight times round its own diameter and on being subsequently straightened the wire shall not break or split.

6.7 **Coating test** : The uniformity of zinc coating shall be tested as per IS: 2633-1964. The wire shall withstand the number of dips specified in Appendix – I.

6.8 Three copies of manufacturers test certificate shall be submitted by the contractor to the purchaser for approval immediately after such tests have been conducted on the strands and the wire.

6.9 The purchaser reserves the right to inspect the material at Manufacturer's works before despatch.

7. **PACKING AND MARKING** :

7.1 The ground wire shall be supplied in non-returnable reals or drums of non-perishable or treated wood conforming to IS: 1778-1991 specification for Reals and Drums for Bare wire. Each coil shall be provided with a level fixed firmly on the inner part of the coil, bearing the following information.

(a) Trade name, if any.
(b) Name of manufacturer
(c) Type of wire, size and length of wire.
(d) Not weight of the wire.
(e) Total weight, and
(f) Number of lengths on the real or drum unless otherwise agreed to between the purchaser and the supplier, the stranded wire shall be supplied in 50 Kg. coil.

8. **SAG AND TENSION CHARTS AND SAG TEMPLATE** :

8.1 The successful tenderer shall be required to submit six copies of sag templates and strings charts for different temperatures and spans, One set of charts shall be ink on tracing cloth. The design date of the lines on which the ground wire will be used are given in Appendix – II

A P P E N D I X – I

TECHNICAL SPECIFICATION OF GROUND WIRE

(i)	Material	:	Steel
(ii)	Purity of material	:	Sulphur and phosphorous contents not exceeding 0.040 percent each. Carbon content not exceeding 0.55 percent. Total silicon contents shall be 0.15 to 0.35 and Manganese contents shall be 0.40 to 0.90 respectively.
(iii)	Standing and wire diameter	:	7/3.15 mm
(iv)	Weight	:	428 Kg / Km.
(v)	Single wire before stranding		
	Diameter of wire	:	3.15 mm
	Tolerance	:	+ 0.060 mm - 0.030 mm
	Minimum elongation in 100 mm.	:	4 mm.
	Minimum breaking strength	:	857 kg.
	Minimum tensile strength	:	85.7 kgf / mm2
(vi)	**Stranded wire length of lay**		
	Maximum	:	175 mm
	Minimum	:	145 mm
	Minimum breaking load	:	5810 kg
	Over all diameter	:	9.45 mm
	Modulus of elasticity	:	1.938 x 106 Kg/Cm2
	Co-efficient of linear expansion	:	11.50 x 10^{-6} per deg. C.
	D.C. resistance at 20^0C	:	3.375 Ohms/Km.
(vii)	**Zinc coating** :		
	Number of one minute dips	:	Three
	Number of half-minute dips	:	One
	Quality of zinc	:	Zn 98 IS:209/1966
	Weight of coating on wire process of galvanising	:	275 g/m^2
	Process of galvanising	:	Hot-dip.
(viii)	Joints	:	There shall be no joint in any of the wires constituting the ground wire.
(ix)	**Lengths** -		
	Standard length	:	1500 metres.
	Tolerance on standard length	:	$\pm$ 5 percent
	Random lengths	:	Not more than 5 percent of the lengths ordered.
(x)	**Tests** : -	:	A sample of the finished ground wire when tested in tensile testing machine shall not fail at a stress less than 100% of UTS value of the ground wire. The length of the test sample shall be not less than 5 meters.
	Type tests Ultimate tensile strength test.		
	Electrical Tests	:	As per BS : 182/1972 and BS :

			3229/1960
	Routine Tests	:	As per clause No. 6 of IS: 2141 1968. In addition to these tests, the weight and adherence of Zinc coating tests shall be conducted as per clause 4 and 5 of IS : 4826/1968.
(xi)	Test Reports	:	Three copies of manufacturer test certificates shall be submitted by the Contracts to the purchaser for approve immediately after such test have been conducted on the galvanised steel strand and the wire.

9. Overhead earth conductors

General(7/3.66mm)

Where earth conductors are erected to provide the specified degree of lightning protection, they shall consist of stranded galvanised steel and shall comply with IEC 888 and IEC 1089 in so far as it applies to steel wires.

Galvanising shall comply with the requirements of IS 2141.

The arrangement of earth conductors shall be such that failure of a single conductor cannot predictably result in a fall across both bus bars in a duplicate bus bar substation.

Technical parameters

SI No.	Parameter		Value
1	Stranding and wire diameter		7/3.66mm
2	Number of strands		1/6
3	Total sectional area		73.65 mm^2
4	Overall diameter		10.98mm
5	Approximate weight		583 kg/km
6	Calculated DC resistance at 20C		2.5 ohms/m
7	Minimum ultimate tensile strength		68.4kN
8	Direction of outer lay		Right hand
9	Tolerances		
9a	Diameter	standard	3.66mm
		maximum	3.75mm
		minimum	3.57mm
9b	Lay length	standard	181mm
		maximum	198mm
		minimum	165mm
10	Steel composition	Carbon	≤ 0.55%
		Manganese	0.4 to 0.9%
		Phosphorous	≤ 0.04%
		Sulphur	≤ 0.04%
		Silicon	0.1 to 0.35%
11	Zinc for galvanising		Electrolytic high grade zinc of 99.95% purity to *209 1979*

Table for Technical parameters for earth wires

INSULATORS
SECTION-III

S.NO.	DESCRIPTION
1.	SCOPE
2.	STANDARDS
3.	PRINCIPAL PARAMETERS
4.	GENERAL TECHNICAL REQUIREMENTS
5.	DETAILS OF SOLID CORE ROD INSULATORS
6.	SPECIFICATION DRAWINGS
7.	GENERAL TECHNICAL REQUIREMENTS
8.	MATERIAL DESIGN AND WORKMANSHIP
9.	TESTS (FOR DISC INSULATORS)
10	INSPECTION
11.	QUALITY ASSURANCE PLAN
12.	TEST DETAILS

INSULATORS

TECHNICAL SPECIFICATION FOR DISC INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORK

1.0 SCOPE.

1.1 This specification provides for design, manufacture, engineering, inspection and testing before despatch packing and delivery FOR (destination) for Indian manufacturers of disc. Insulators as per technical requirements furnished in this specification.

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

1.2 Following is the list of documents constituting this package.

(i) Technical specification.

(ii) Technical data sheet.

(iii) Drawings of insulators

(ii)

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.

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.

2.0 **STANDARDS**:

2.1 Except as modified in this specification, the disc insulators shall conform to the following Indian Standards, which shall mean latest revisions and amendments. 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 274 IEC 383
4.	IS: 2071 Part-(I) Part-(II) Part-(III)	Method of High Voltage Testing.	
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: 120
	Part – III	Locking devices.	IEC: 372
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: 305
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 437 NEMA Publication No.107/1964 CISPR
14.	IS: 8269	Methods for switching impulse test on HV insulators.	IEC: 506
15.		Thermal mechanical performance test and mechanical performance test on string insulator units.	IEC: 575
16	IEC	Long Rod Insulators	IEC-433

2.2 The standards mentioned above are available from:

Reference.	Abbreviation.	Name & Address:
BS		British Standards, British Standards Institution, 101, Pentonvile Road, N-19 ND,U
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, ORISSA
ISO		International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej-12 DK-2900 Helleprup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44th. Street New York, NY 10017 USA

3.0 **PRINCIPAL PARAMETERS.**

3.1 DETAILS OF DISC INSULATORS:

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 OPTCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type, radio interference 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.

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
3.1.3 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 /220/400 KV	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 Tension	280x145	430	1x10/1x15	120 KN Antifog Disc Insulator
6	Double Tension	-do-	-do-	2x10/2x15	120 KN Antifog Disc Insulator
7	Single Tension	305x170	475	1x10/1x15/1x25	160 KN Antifog Disc Insulator
8	Double Tension	-do-	-do-	2x10/2x15/2x25	160 KN Antifog Disc Insulator
5	Single Suspension	280x145	430	1x10/1x15/1X25	120 KN Antifog Disc Insulator
6	Double Suspension	-do-	-do-	2x10/2x15/2X25	120 KN Antifog Disc Insulator

3.2 **SPECIFICATION DRAWINGS**:
3.2.1 The specification in respect of the disc insulators are described.These specification 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.

4.0 GENERAL TECHNICAL REQUIREMENTS:
4.1 Porcelain:
The porcelain used in the manufacture of the shells shall be ivory white nonporous of high dielectric, mechanical and thermal strength, free from internal stresses blisters, laminations, voids, forgone matter imperfections or other defects which might render it in any way unusable for insulator shells. Porcelain shall remain unaffected by climatic conditions ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through vetrification.

The insulator shall be made of highest grade, dense, homogeneous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points foreign particles and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

4.1.1 Porcelain glaze:

Surface to come in contact with cement shall be made rough by stand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be down. The Glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body through out the working temperature range.

4.2 METAL PARTS:

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.

4.2.2 **Security Clips**:

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

4.3 **FILTER 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.

4.4 **MATERIALS DESIGN AND WORKMANSHIP**:

4.4.1 **GENERAL**:

(II) 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.

(III) 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.

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.

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.

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 99.5 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.

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.

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.).

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.

4.5 **BALL AND SOCKET DESIGNATION**:

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

4.6 **DIMENSIONAL TOLERANCE OF INSULATOR DISCS**:

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

4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

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

(a)

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

(C) 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 inslator-kN	70	90	120	160
6	Materials of shell	Porcelain	Porcelain	Porcelain	Porcelain
	Electrical value				
7.					
7.1	Power frequency Withstand voltage disc (a) Dry-kV (rms) (b) Wet-kV (rms)	 80 45	 80 45	 85 50	 90 50
7.2	Power frequency flash over voltage single-disc (a) Dry-kV (rms) (b) Wet-kV (rms)	 85 50	 85 50	 90 55	 95 55
7.3	Impulse withstand voltage 1.2/50 micro second 1.Positive –kV(peak) 2.Negative –kV (peak)	 125 125	 125 125	 130 130	 135 135
7.4	Impulse Flashover voltage 1.2/50 micro second 1.Positive –kV(peak) 2.Negative –kV (peak)	 135 130	 135 130	 140 135	 145 140

*** Tolerance as per relevant IS (Latest edition).**

4.7 **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.

4.8 **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.

4.9 **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.

4.10 **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.

4.11 INSULATOR STRINGS:

4.11.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/22 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.

4.11.2 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 3.12

4.12 STRING CHARACTERISTICS:

4.12.1 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 sting (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%

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

4.12.3 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.

5.0 DETAILS OF SOLID CORE LONG ROD INSULATORS:

5.1 The insulator shall consist of standard-discs for a three-phase 50 Hz effectively earthed 132 KV transmission system heavily polluted atmosphere. The insulator shall be ball and socket type.

5.2 The size of long rod 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:

Sl. No.	Type of string.	Size of long rod insulator (mm)/(Unit) 132/220 KV	Minimum creepage distance (mm) 132/220 KV	No.of unit 132/220 KV)	Electromechanical strength of insulator (KN) 132/220 KV)
1.	Single suspension	200X 1305 /210X2030	4000 / 6125	'1/2	90 KN
2.	Double suspension	-do-	-do-	'2/4	90 KN
3.	Single tension.	205 X 1450 / 215X2550	4300/7130	'1/2	120 KN/160 KN
4.	Double Tension.	-do-	-do-	'2/4	120 KN/160 KN

6.0 **SPECIFICATION DRAWINGS**:

6.1 The specification in respect of the long rod insulators indicated above is given at Annexure-II. These 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 shall be in line with the specification.

7.0 **GENERAL TECHNICAL REQUIREMENT**:

7.1 **PORCELAIN**:

The porcelain used in the manufacture of the shell shall be ivory white, nonporous of high dielectric, mechanical and thermal strength free from internal stress blisters and thermal strength from internal stresses blisters, laminations, voids, foreign matter. Imperfections or other defects, which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid alkalis, and zinc of dust. The manufacturing shall be by the wet process and impervious character obtained by through vetrification.

7.2 **PORCELAIN GLAZE**:

Surfaces to come in contact with cement shall be made rough by stand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze

shall remain under compression on the porcelain body throughout the working temperature range.

7.3 METAL PARTS:

7.3.1 Cap and Ball pins:

Twin Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip g galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity with minimum of 6 dips. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

7.3.2 **SECURITY CLIPS**:

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

7.4 **FILLER MATERIAL**:

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

8.0 **MATERIAL DESIGN AND WORKMANSHIP**:

8.1 **GENERAL**:

i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials 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 voltage

8.2 **INSULATOR SHELL**:

The design of the insulator shell 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 temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity and temperature.

8.3 **METAL PARTS**:

i) The twin ball pin and cap shall be designed to transmit the mechanical stresses 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 insulator or 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 parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any macroscopically visible cracks, insulations and voids.

8.4 **GALVANIZING**:

All ferrous parts shall be hot dip galvanized six times in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 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.

8.4.1 **CEMENTING**:

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

8.5 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 sore adding after installation to prevent complete withdrawal from the socket. The locking device shall be 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 when placed in position and under no circumstances shall it allow separation of insulator units and fitting 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk 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 position shall not be less than 50 N (5 Kgs.) or more than 500N (50 Kgs.)

8.6 **BALL AND SOCKET DESIGNATION**:

The dimensions of the balls and sockets for 80 KN long rod insulators shall be of 16mm and for 120 KN shall be of 20mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-III).

8.7 DIMENSIONAL TOLERANCE OF INSULATORS DISCS

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ISS.

9.0 **TESTS (FOR DISC INSULATORS**) :

9,1 The following tests shall be carried out on the insulator string and disc insulators.

9.2 **TYPE TEST**:

This shall mean those tests, which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall be conducted on a representative number of samples prior to commencement of commercial production. The Bidder shall indicate his schedule for carrying out these tests.

9.3 **ACCEPTANCE**:

This shall mean these tests, which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

9.4 **ROUTINE TESTS**:

This shall mean those tests, which are to be carried out on each insulator to check the requirements, which are likely to vary during production.

9.5 **TESTS DURING MANUFACTURE**:

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

9.6 **TEST VALUE**:

For all type and acceptance tests the acceptance values shall be the value guaranteed by the bidder in the guaranteed technical particulars of the acceptance value specified in this specification of the relevant standard whichever is more stringent for that particular test.

9.7 **TEST PROCEDURE AND SAMPLING NORMS**:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and normal according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms land procedure for the same shall be as specified in Annexure-IV attached hereto as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

9.8 **TYPE TESTS**:

The following type test shall be conducted on a suitable number of individual unit components, materials or complete strings.

9.8.1 On the complete insulator string with hardware fittings.

a)	Power frequency voltage withstand test with corona control rings and under wet condition.	: BS:137(Part-I)
b)	Switching surge voltage withstand test under wet condition (400 only)	:
c)	Impulse voltage withstand test under dry condition.	: IEC: 383
d)	Impulse voltage flashover test under dry condition.	:
e)	Voltage distribution test.	:
f)	Corona & RIV test under dry condition.	: As per this specification.
g)	Mechanical strength test.	: As per this specification.
h)	Vibration.	:

9.8.2 On Insulators:

a)	Verification of dimensions.	: IS: 731
b)	Thermal mechanical performance test:	: IEC:575
c)	Power frequency voltage withstand and flashover (I) dry (ii) wet.	: BS: 173
d)	Impulse voltage withstand flashover test (dry)	: IEC: 383
e)	Visible discharge test (dry)	: IS:731
f)	RIV test (dry)	: IS:8263

9.8.3 All the type tests given under clause No.6.8.1 above shall be conducted on single suspension and Double Tension insulator string alongwith hardware fittings.

9.9 ACCEPTANCE TESTS:

9.9.1 For insulator:

a) Visual examination	: IS:731
b) Verification of dimensions.	: IS:731
c) Temperature cycle test.	: IS:731
d) Galvanizing test.	: IS:731

e) Mechanical performance test. : IEC:575
f) Test on locking device for ball and socket coupling. : IEC:372
g) Eccentricity test. : As per this specification.
h) Electro-mechanical strength test. :
i) Puncture test. : IS:731
j) Porosity test. : IS:731

9.10 ROUTINE TESTS:

9.10.1 For insulators:

a) Visual inspection. : IS:731
b) Mechanical routine test. :
c) Electrical routine test. : IEC:383

9.11 TEST DURING MANUFACTURE:

On all components as applicable.

a) Chemical analysis of zinc used for galvanizing. :
b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings. :
c) Chemical analysis, hardness test and magnetic particle inspection for forgings. : As per this specification.
d) Hydraulic Internal Pressure tests on shell. :
e) Crack detection test for metal parts. :

9.12 **ADDITIONAL TEST**:

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/ laboratory or at any other recognized laboratory/ research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

9.13 **CO-ORDINATION FOR TESTING**:

For insulator strings, the supplier shall arrange to conduct testing of their disc insulators with the hardware fittings to be supplied to the purchaser by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc insulator with the hardware fittings.

NOTE:

In respect of electrical tests on a complete string consisting of insulators and hardware guarantee of values of responsibility of testing shall be with hardware manufacturer of RIV corona and voltage distribution test and with insulator manufacturer for all other tests.

9.14 **TEST CHARGES AND TEST SCHEDULE**:

9.14.1 **TYPE TEST**:

The insulator offered shall be fully type tested as per this specification. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory. The bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than five years. The purchaser reserves the right to demand repetition of some or all type tests in the presence of purchasers' carrying representative. For this purpose the bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type already type tested and the design/type offered against this

specification, purchaser reserves the right to demand repetition of tests without any extra cost.

9.14.2 **ACCEPTANCE AND ROUTINE TEST**:

All acceptance and routine tests as stipulated herein shall be carried out by the supplier in the presence of purchaser's representative.

9.14.3 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

9.14.4 For type tests involving tests on a complete insulator string with hardware fittings, the purchaser will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.

9.14.5 In case of failure of the complete string in any type tests, the supplier whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the purchaser as to the items that has caused the failure in any of the type tests shall be final and binding.

10. **INSPECTION**:

10.1 i. Purchaser and its representative shall at all times be entitled to have access to the works and to all places of manufacturer where insulators are manufactured and the supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

ii. The supplier shall keep the purchaser informed in advance of the time of starting and of progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.

iii. No material shall be dispatched from its point of manufacture unless the materials has been satisfactorily inspected and tested.

iv. The acceptance of any quantity of insulators shall in no way relieve the supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

10.2 **IDENTIFICATION MARKING**:

10.2.1 Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by 'KN' to facilitate easy identification and proper use.

10.2.2 The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

11. **QUALITY ASSURANCE PLAN**:

11.1 The bidder hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection.

i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw materials in presence of bidder's representative, copies of test certificates.

ii. Informations and copies of test certificates as in (i) above in respect of bought out materials.

iii. List of manufacturing facilities available.
iv. Level of automation achieved and lists of area where manual processing exists.
v. List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such tests and inspection.
vi. Special features provided in the equipment to make it maintenance free.
vii. List of testing equipping available with the bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

11.2 The supplier shall within 30 days of placement of order submit the following information to the owner.
i) List of raw material and the names of sub-suppliers selected from those furnished alongwith the offer.

POST INSULATORS.
Post insulator shall conform in general to IS 2544, IEC 168 and IEC 815.

3.1 constructional features
Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright and be designed to with stand any shocks to which they may bed subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.
Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might after the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.
The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC 815 for the specified pollution level.
When operated at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.
The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS 2633, and IS 4579. The zinc used for galvanizing shall be grade Zn 99.95 as per IS 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky while deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions. Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.
Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

12. TEST DETAILS.

1. **VOLTAGE DISTRIBUTION TEST**:

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage and proportionate correction be applied as to give a total of 100% distribution. The voltage across any disc. Not exceed the values given in clause 4-12.1

2. **CORONA EXTINCTION VOLTAGE TEST (DRY)**:

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than the value specified at clause 4.12.1 (iv) under dry condition. There shall be no evidence of corona on any part of the sample when all possible sources of corona are photographed in a darkened room.

3. **RIV TEST (DRY):**

Under the conditions as specified in (2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 500 micro volts at one MHz when subjected to 50 Hz AC voltage of 1.1 times maximum time to ground voltage under dry condition. The test procedure shall be in accordance with IS: 8263.

4. The complete insulator string along with its hardware fitting excluding arcing horn corona controlling/grading ring and suspension assembly/dead end assembly shall be subject to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased already rate to 68% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand,. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing loads reached and the value recorded.

5. **VIBRATION TEST:**

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspensions string a load equal to 600 Kg. shall be applied along with the axis of the suspensions string by means of turn buckle. The insulators string along with hardware fittings and two sub conductors throughout the duration of the test vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulator string (more than 10Hz) by means of vibration inducing equipment. The amplitude of vibration at the antipode point nearest to the string shall be measured and the same shall not be less than 120.4 being the frequency of vibration. The insulator strings shall be vibrated for five million cycles then rotated by 90 deg and again vibrated for 5 million cycles without any failure, after the test, the disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware fittings shall be examined to fatigue fatter and mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test. The disc insulators shall be subjected to the following tests as per relevant standards.

	Test.	Percentage of disc To be tested.
a)	Temperature cycle test followed by	60
	Mechanical performance test.	40

b) Puncture test (for porcelain insulator only)

6. **CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING**.

Samples taken from the zinc ingot shall be chemically analysed as per IS: 209. The purity of zinc shall not be less than 99.95%.

7. **TEST FOR FORGINGS**:

The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

1. **TEST ON CASTING**:

The chemical analysis mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

2. **HYDRAULIC INTERNAL PRESSURE TEST ON SHELLS**:

The test shall be earned out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the suppliers and purchaser in Quality Assurance Programme.

3. **THERMAL MECHANICAL PERFORMANCE TEST**:

The thermal mechanical performance test shall be carried out on minimum 15 number of disc insulators units as per the procedure given in IEC 575. The performance of the insulator unit shall be determined by the same standard.

4. **ECCENTRICITY TEST**:

The insulator shall be vertically mounted on a future using dummy pin and socket. A vertical scale with horizontal slider shall be used for the axial run out. The pointer shall be positioned in contact with the bottom of the outermost petticoat of the disc. The disc insulators shall be rotated with reference to the fixture and the slider shall be allowed to move up and down on the scale but always maintaining contact with the bottom of the outer most petticoats. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

Similarly using a horizontal scale with veridical slider the radial run out shall be measured. The slider shall be positioned on the scale to establish contact with the circumstance of the disc insulator and disc insulator rotated on its future always maintaining the contact. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

5. **CRACK DETECTION TEST**:

Crack detection test shall be carried out on each ball and pin before assembly of disc unit. The supplier shall maintain complete record of having conducted such tests on each and every piece of ball pin The bidder shall furnish full details of the equipment available with him for crack test and also indicate the test procedure in detail.

6. Tubular bus conductors:

General

Aluminium used shall be grade 63401 WP conforming to IS 5082. The tube shall be seamless and shall be manufactured by either of the following processes:

- Hot extrusion process through die and mandrel (Hollow billet process). Heat treatment shall be carried out after hot extrusion of tube.
- Bridge extrusion process and then cold drawn. Heat treatment shall be carried out after cold drawing of tube.

Constructional features

For outside diameter (OD) and thickness of the tube there shall be no minus tolerance, other requirements being as per IS 2678 and IS 2673.

The aluminium tube shall be supplied in suitable cut length to minimise wastage.

Technical parameters

Sl No.	Size	4" IPS (EH type)	3"IPS (EH type)	4.5"IPS (EH type)
1	Outer diameter (mm)	114.20	88..9	120.0
2	Thickness (mm) :	8.51	7.62	12.0
3	Cross-sectional area (sq.mm) :	2825.61	2373.63	4071.5
4	Weight (kg/m) :	7.7	6.44	10.993
5	Chemical composition			
	i) Cu	0.05 max	0.05 max	0.05 max
	ii) Mg	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9
	iii) Si	0.3 to 0.7	0.3 to 0.7	0.3 to 0.7
	iv) Fe	0.5 max	0.5 max	0.5 max
	v) Mn	0.03 max	0.03 max	0.03 max
	vi) Al	Remainder	Remainder	Remainder
6	Minimum ultimate Tensile strength Kg/Sq mm	20.5	20.5	20.5
7	Temp co-eff of resistance	0.00364 per Deg C		
8	Minimum electrical conductivity at 20 deg C	55% of IACS		
9	Modulus of Elasticity	6700 Kg/sq mm		

7. Post insulators:

Post insulators shall conform in general to IS 2544, IEC 168 and IEC 815.

Constructional features

Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright and be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.

The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC 815 for the specified pollution level.

When operating at normal rated voltage there shall be no electric discharge between conductor and insulators, which would cause corrosion or injury to conductors, or insulators by the formation of substance produced by chemical action.
The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS 2633, and IS 4579. The zinc used for galvanising shall be grade Zn 99.95 as per IS 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.
Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the bevelled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.
Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

Services to be performed by the equipment being furnished

The equipment shall be able to withstand forces due to wind load on the equipment and approach conductor and due to short circuit, all forces considered together.
The Contractor shall submit detailed calculations proving the satisfactory performance of the equipment under short circuit conditions to meet the layout requirements.

Technical Parameters

SI No.	Parameter	400kV	245kV	132kV	33klV
1	Type	Confirming to IEC 273 (solid core)			
2	Voltage class (kV)	420	245	145	36
3	Dry and wet one minute withstand voltage (kVrms)	630	460	235	70
4	Dry lightning impulse withstand voltage (kVp)	± 1550	± 1050	± 650	± 250
5	Wet switching surge withstand voltage (kVp)	± 1175	NA	NA	NA
6	Max. RIV at corona extinction voltage (microvolts)	500	500	500	NA
7	Corona extinction voltage (kVrms)	320 (min)	156 (min)	105	
9	Total minimum cantilever strength (kg)	not< 800	not< 800	not< 600	not< 600
10	Minimum torsional moment	As per IEC 273			
11	Total height of insulator (mm)	3650	2300	1100	325
12	PCD (mm) top/bottom	127/300	127/254	127/254	76/76
13	No. of bolts top/bottom	4/8	4/8	4/8	4/8
14	Diameter of bolt holes (mm) top/bottom	M16/18	M16/18	M16/18	M16/18
15	Pollution level as per IEC 815	Heavy	Heavy	Heavy	Heavy
16	Minimum total creepage distance (mm)	10500	6125	3625	900

If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Supplier.

8. Spacers

General

Spacers shall conform to IS 10162. Spacers are to be located at a suitable spacing to limit the short circuit forces and also to avoid snapping of sub conductors during short circuit conditions.

Constructional features

No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.
Spacer design shall be made to take care of fixing and removing during installation and maintenance.
The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

SECTION-IV HARDWARES

S.NO.	DESCRIPTION
1.	SCOPE
2.	STANDARDS
3.	MATERIALS AND DESIGN
4.	GALVANISING
5.	ACCESSORIES FOR CONDUCTOR AND GROUND WIRE
6.	VIBRATION DAMPER FOR ACSR PANTHER, ZEBRA, MOOSE AND GROUND WIRE
7.	REPAIR SLEEVE FOR ACSR PANTHR, ZEBRA, MOOSE AND GROUND WIRE
8.	SUSPENSION CLAMPS : FOR GROUND WIRE
9.	TENSION CLAMPS (DEAD AND ASSEMBLY) FOR GROUND WIRE
10.	BONDING PIECES
11.	INSULATORS HARDWARE
12.	CLAMP
13.	TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS

TECHNICAL SPECIFICATION FOR HARDWARE FITTINGS.

SUITABLE FOR GALVANISED STEEL STRANDED GROUNDWIRE (7/3.15mm and 7/3.66 mm) ACCESSORIES AND POWER CONDUCTOR ACSR PANTHER ,ACSR ZEBRA AND MOOSE.

1.0 SCOPE

This Specification covers design (if required), manufacture, testing at manufacturer's Works, supply and delivery of GSS), power conductor and ground wire accessories, insulator and hardware fittings for string insulators suitable for use in 220 and 132 KV Over-head transmission lines and sub- stations of OPTCL. The hard wares to be supplied shall be as per approved drawings of OPTCL. Any change there of shall be with due permission of Sr. G.M (CPC).The firm shall submit his drawings for approval of OPTCL and only after which the manufacturing shall be started.

The materials/equipment offered, shall be complete with all components, which are necessary or usual for the efficient performance and satisfactory maintenance. Such part shall be deemed to be within the scope of contract.

2.0 STANDARDS

The materials covered under this Specification shall comply with the requirement of the latest version of the following standards as amended upto date, except where specified otherwise.

i)	IS;2486 Part-II & III	: Insulator fitting for overhead power lines with a nominal voltage greater than 1,000 volts.
ii)	IS:2121 Part I & II	Conductor & earth wire accessories for overhead power lines.
iii)	IS:9708	Stock Bridge Vibration Dampers on overhead power lines.
iv)	IS:2633	Method of testing of uniformity of coating on zinc coated articles
v)	IS:209	Specification for Zinc.
vi)	BS:916	Specification for Hexagonal bolts and nuts.

3.0 MATERIALS AND DESIGN

Aluminium and aluminium alloys, malleable iron and forget steel, having required mechanical strength, corrosion resistance and mach inability depending on the types of application for which accessories / fittings are needed, shall be employed.

In manufacturer of the accessories / fittings, the composition of the aluminium alloys used shall be made available to Employer if required for verification.

The materials offered shall be of first class quality, workmanship, well finished and approved design. All castings shall be free from blow-holes, flaws, cracks of other defects and shall be smooth, close grained and true forms and dimensions. All machined surfaces should be free, smooth and well finished.

Metal fittings of specified material for conductor and earth wire accessories and string insulator fittings are required to have excellent mechanical properties such as strength, toughness and high resistance against corrosion. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to the minimum.

All bolts, nuts, bolt-heads shall be the white worth's standard thread. Bolt heads and nuts shall be hexagonal. Nuts shall be locked in an approved manner. The treads in nuts and tapped holes shall be cut after galvanising an shall be well fabricated and greased. All other treads shall be cut before galvanising. The bolt treads shall be undercut to take care of increase in diameter due to galvanising.

All nuts shall be made of materials to Clause 4.8 of IS:1367 (latest edition) with regard to its mechanical properties.

The general design conductor and earthe wire accessories and insulator fittings shall be such as to ensure uniformity, high strength, free from corona formation and high resistance against corrosion even in case of high level of atmosphere pollution.
All hooks, eyes, pins, bolts, suspension clamps and other fittings for attaching to the tower or to the line conductor or to the earthwire shall be so designed that the effects of vibration, both on the conductor and the fittings itself, are minimized.
Special attention must be given to ensure smooth finished surface throughout. Adequate bearing area between fittings shall be provided and point or line contacts shall be avoided.
All accessories and hardwares shall be free from cracks, shrinks, slender air holes, burrs or rough edges.
The design of he accessories and hardwares shall be such as to avoid local corona formation or discharge likely to cause interference to tele-transmission signals of any kind.

4.0 GALVANISING :

All ferrous parts of conductor and ground wire accessories and insulator hardwares shall be galvanised in accordance with IS:2629-Recommended Practice for hot dip galvanising of iron and steel or any other equivalent authoritive standards. The weight of zinc coating shall be determined as per method stipulated in IS:2633 for testing weights, thickness and uniformity of coating of hot dip galvanished articles or as per any other equivalent authoritative standards. The zinc used or galvanisation shall conform to grade zn 98 of IS:209. The galvanised parts shall withstand four (4) dips of 1 minute each time while testing uniformity of zinc coating as per IS:2633.

Spring washers shall be elctro galvanised.

5.0 ACCESSORIES FOR CONDUCTOR AND GROUND WIRE, MID SPAN COMPRESSION JOINTS:FOR ACSR- PANTHER ,ZEBRA, MOOSE AND GROUNDWIRE OF 7/3.15 and 7/3.66 mm.

The Mid-Span Joints for conductor and earthwire shall be of compression type. The conductor mid-span joints shall comprise of outer aluminium sleeve of extruded aluminium (99.5% purity) and inner sleeve HDG Steel. All filler plug shall also be provided. The ground wire mid-span joints shall be of HDG steel. The sleeves shall be of circular shape suitable for compression into hexagonal shape.

The compression type mid-span straight joints shall be suitable for making joints in the ACSR "PANTHER,ZEBRA & MOOSE" conductor or in the galvanised steel stranded ground wire.

The joints shall be so designed that when installed no air space is left within the finished joints. The joints shall have the conductivity as specified in relevant Clause.

The joints shall conform to IS:2121 (latest edition) unless specified otherwise. The details of the joints both suitable for ACSR- Panther,Zebra & Moose and ground wire are given in the technical particulars.
The inner and outer diameters and lengths of the offered joints before and after compression shall be clearly shown in the drawings.

6.0 VIBRATION DAMPER FOR ACSR PANTHER,ZEBRA MOOSE AND GROUND WIRE(7/3.15 and 7/3.66 mm)

Vibration Damper having 4 resonance frequency characteristic commonly called 4R Damper shall be offered. The Damper shall eliminate fatigue on the conductor due to vibration and damp out the vibration effectively so that no damage due to vibration is caused to conductor / ground wire / string.

The dampers are proposed to be used at all tension locations and also at suspension locations. One or more dampers are proposed to be used on tension/suspension locations depending upon the span.

Bidder shall also recommend the number of damper required to effectively damp out conductor or ground wire vibration for different values of span lengths and the distance of fixation.

Vibration dampers shall be of approved design. The clamps of the vibration dampers shall be made of aluminium alloy, so designed as to prevent any damage while fixing on the conductor during erection or

in continued operation. The fastening bolts should be approved by the Employer. The spring washers should be elctro galvanised and of minimum 2 mm thickness.

The messenger cable shall be made from high tensile strength steel strands in order to prevent subsequent drop of weight in service.

Clamping bolts shall be provided with self locking nuts as designed to prevent corrosion of the threads. All ferrous parts including the messenger cable shalal be bot dip galvanised. The end of the messenger cable shall be effectively sealed to prevent corrosion.

The vibration dampers and its attachment shall have smooth surface so that no corona occurs on them.

The clamps of the stock bridge vibration dampers shall be so designed that in case of loosening of the bolt or changing free parts of the clamp, it does not allow the damper to disengage from the conductor.

7.0 REPAIR SLEEVE FOR ACSR PANTHER,ZEBRA,MOOSE AND GROUNDWIRE :

Compression type repair sleeves shall be offered to provide reinforcement for conductor with broken or damaged aluminium strands/galvanished steel ground wire broken in damaged steel strands. The repair sleeve shall be designed to make good a conductor of which not more than one-sixth ($1/6^{th}$) of the strands in the outermost layer and damaged or severed. The repair sleeves after compression should present a smooth surface.

8.0 SUSPENSION CLAMPS : FOR GROUND WIRE

Suspension clamps of suitable size are require for holding the galvanised steel stranded ground wire at suspension points. The suspension clamps shall be suspended from the lower hanger or 'D' belt of 16 mm. dia. And should, therefore, be supplied with a suitable attached that would allow the clamps to swing freely both in the transverse and longitudinal direction. The clamps shall be so designed that the effect of vibration both on the groundwire and the fittings itself is minimum.

The clamps shall be manufactured and finished so as to avoid sharp radia of curvature, ridges which might lead to localized pressure and damage the ground wire in service.

The clamps shall be made of heat treat malleable iron one Eye hook made of forced steel. The entire assembly shall be hot dip galvanised.

The clamping surface shall be smooth and formed to support the groundwire on long easy curves to take care or required steel vertical and horizontal angles.

The clamps shall permit the groundwire to slip before the failure of the latter occurs. The leg of U-bolt holding the keeper piece of the clamps shall be kept sufficient long and shall be provided with threads, nuts and locking nuts for fixing the flexible earthing hond between the suspension clamps and tower structures.

9.0 TENSION CLAMPS (DEAD AND ASSEMBLY) FOR GROUND WIRE.

Compression type dead end assembly of G.S.S. ground wire shall be required for use on the tension towers. The dead end assembly shall be supplied with complete jumper terminals, nuts and bolts suitable link pieces between the steel clevis and tower strain plates so as to provide sufficient flexibility not less than that of G.S.S. ground wire and the tensile strength not less than 90% that of the G.S.S. ground wire.

The assemblies shall comprise of compression type dead end clamps and one anchor shackle made of forget steel. The entire assembly shall be hot dip galvanised.

One of bolt holding joint per terminal of dead end assemblies shall be kept sufficiently long and threaded and shall be provided with nuts, washers and locking nuts for fixing the flexible earthing bond between the dead-end clamp and tower structures.

10.0 BONDING PIECES (FLEXIBLE COPPER EARTHING BOND FOR EARTHWIRE 7/3.15 and 7/3.66 mm)

The tenderer shall offer flexible copper earthing bonding pieces for connecting the ground wire suspension and tension clamps and tower legs suitable for earthing.

Each bond piece shall have suitable compression type galvanises steel lug or thimble on either and for making connections to clamp and tower legs. The size, strength, etc. of the bonding piece is given in this Specification.

11.0 INSULATOR HARDWARES

The insulator disc hardwares and string assemblies to be offered by the tenderer shall be suitable to meet the requirement given in the specific technical particulars as detailed hereinafter.

Hardwares for suspension and tension insulator shall be suitable for insulator with normal pin shank diameter of 20 mm. in case of tension string unit and 16mm. for suspension string unit.

Each insulator string shall generally include the following hardware components.

Single Suspension Set.	Double Suspension Set.
a) Ball Hook	**a) Ball Hook.**
b) tower side arcing horn	**b) Socket clevis with R-Type security clip-3 Nos.**
c) Socket Eye with R-Type security clip.	**c) Yoke Plate-2 Nos.**
d) Line side arcing horn.	**d) Tower side arcing horns-2Nos.**
e) Armour grip suspension clamps	**e) Ball clevis – 2 Nos.**
	f) Line side arcing homs-2 Nos.
	g) Clevis Eye.
	h) Armour Grip Suspension Clamp.
Single Tension Set :	Double Tension Set :
a) Anchor Shackle.	**a) Anchor Shackle.**
b) Ball Eye.	**b) Chain Link**
c) Tower side arcing horn.	**c) Yoke Plate – 2 Nos.**
d) Socket Clevis with R-Type security clip.	**d) Tower side arching horn.**
e) Line side arcing horn	**e) Ball Clevis – 2 Nos.**
f) Compression type dead end clamp.	**f) Socket Clevis with R-Type security clip – 2 Nos.**
	g) Line side arcing horns.
	h) Compression type dead end clamps.

12.0 CLAMP

12.1 ARMOUR GRIP SUSPENSION CLAMPS

Armour Grip Suspension Clamp shall consist of 2 neoprene insert, one set of armour rods made of aluminium alloy, two aluminium housing having inner profile matching with the profile of the armour rods page and supporting strap made of aluminium alloy. The A.G. type suspension clamp shall be designed, manufactured and finished as to have a suitable shape without sharp edges at the end and to hold the respective conductor properly. It should, however, have sufficient contact surface to minimise damagedue to fault current. The clamp shall be or Armour Grip Type.

The A.G. type suspension clamp shall permit the conductor to slip before the occurrence of failure of the conductor and shall have sufficient slip strength to resist the conductor tension under broken wire conditions. The clamp shall have slip strength of not less than 15 % of respective conductors.

12.2 TENSION CLAMPS

The Tension Clamps shall be made out of aluminium alloy and of compression type suitable for PANTHER,ZEBRA & MOOSE conductor. The tension clamps shall not permit slipping or damage to failure of the complete conductor or any part thereof at a load less than 90% of the ultimate strength of conductor. The mechanical efficiency of tension / clamps shall not be affected by method of erection

involving come / along or similar clamps or tension stringing operation during or after assembly and erection of tension clamp itself. The tension clamp shall be of a design that will ensure unrestricted flow of current without use of parallel groove clamps.
The clamps shall be as light as possible.

12.3 ARCING HORNS

Each hardware assembly shall have provision for attaching arcing horns of both adjustable and non/adjustable type across the suspension and tension strings or tower side. However each hardware assembly shall be provided with arching horn of fixed type on line side only.

12.4 UNIVERSAL JOINTING COMPOUND

BENDEX-HV' Universal jointing compound which is a chemically inert compound to be used as filler for the compression joints and dead end clamps to be supplied.

13.0 TESTS, TEST CERTIFICATE AND PERFORMANCE REPORTS

The fittings and accessories for the power conductor and G.S.S. ground wire, insulator and hardwares shall be tested in accordance with IS:2121, IS:2486, IS:9708 (For V Dampers), BS:916 for hexagonal bolts and nuts or any other authoritative equivalent standards. Six sets of type and routine test certificates and performance reports are to be submitted by the bidder.
The Employer however, reserves the right to get all the tests performed in accordance with the relevant I.S. Specification as Acceptance Test in presence of Employer-s representatives.
The tenderer shall clearly state the testing facilities available in the laboratory at his Works and his ability to carry out the tests in accordance with this Specification. All the specified tests shall be carried out without any extra cost.

Acceptance Test for power conductor and G.S.S. ground wire accessories.

a) Visual examination
b) Dimensional verification
c) Failing load test
d) Slip strength test (for clamps)
e) Electrical resistance test
f) Resonance frequency test (for vibration dampers)
g) Fatigue test (for vibration dampers)
h) Mass pull off test (for vibration dampers)
i) Galvanising test**.**

13.1 ACCEPTANCE TEST FOR HARDWARES

a) Dimensional verification.
b) Ultimate tensile test.
c) Slip strength test.
d) Electrical resistance test.
e) Heating cycle test
f) Breaking strength of full string assembly.
g) Galvanising test.

13.2 SPECIFIC TECHNICAL REQUIREMENTS FOR CONDUCTOR ACCESSORIES AND INSULATOR HARDWARES

Conductor	Panther/zebra/Moose	GSS ground wire
a) Type	ACSR Panther/zebra/Moose	Ground wire.
b) Material	Aluminium conductor steel reinforced.	Galvanised stranded steel wire.
c) Strand & Wire diameter.	Panther/Zebra/Moose Aluminium 30/3mm Steel 7/3mm,/all.54/3.18mm steel-7/3.18mm,/ all.54/3.53mm steel-7/3.53mm resp.	7/3.15 mm. and 7/3.66 mm
d) Weight per Km.	974/1622 /2004Kg/Km.	426 Kg/Km.and 583Kg/Km
e) Overall diameter	21/28.62/31.7 mm	9.4mm. and 10.98 mm
f) D.C. Resistance at 20 deg. C when corrected to standard weight.	0.13750/0.06915/0.05552 Ohms/KM.	3.375 Ohms/KM
g) Minimum Breaking load/Ultimate tensile strength.	144/13289/16120 Kg	5710 Kg.and 10580 Kg 1393 Kg.
h) Maximum working tension at minimum temperature & 2/3 full wind.	3806/4325 Kg.	
i) Maximum Sag at maximum temperature & no wind.	6120/9240 mm.	5150mm.

DISC Insulator (for suspension & tension Insulator strings) (132 ,220 and 400 KV)

Disc Insulators	Suspension	Tension
a) Type	**Ball & Socket**	**Ball & Socket.**
b) Ball size	**16mm. Alt. B**	**20mm. Alt.**
c) Diameter	**(IS:2486 Pt.II)**	**B/20mm**
d) Spacing	**254/255 mm.**	**(IS:2486 Pt.II)**
e) E.M. strength	**146/145 mm.** **90/120 KN,.**	**255/280 mm** **145/170mm.** **120/160 KN.**

	Single Suspension	Single Tension	Double Suspension	Double Tension
132 KV / 220 KV /400 KV				
String Arrangements :				
a) No. of insulator discs.	**10/14/25**	**10/14/25**	**2x10/2X14 /2X25**	**2x10/2 X14/ 2X25**
b) Length of string assembly (mm)	**1672/2340**	**1851/3003**	**1837/2243**	**2132/30 82**

GENERAL REQUIREMENT FOR POWER CONDUCTOR & GROUND WIRE:

I) ACCESSORIES.

	GENERAL REQUIREMENTS				
	POWER CONDUCTOR AND GROUND WIRE ACCESSORIES				
A)	**MID-SPAN COMPRESSION JOINTS**				
		Suitable for ACSR "Panther'/zebra/Moose		Suitable for G.S.S. groundwire 7/3.15 and 7/3.66 mm.	
	i) Type **ii) Material** **a) Outer sleeve**	**Compression** **Extruded Aluminium**		**Compression** **Extruded aluminium.**	
	b) Inner sleeve	**Steel (galvanised)**		**Steel (Galvanised)**	
		Before Compress-ion	**After Compre-ssion**	**Before Compression**	**After Compressi on**
	iii) Dimension of Compression joint for Aluminium part.	**Outer dia:38mm Inner Dia:23mm. Minimum length : 610mm. Minimum weight 1.2 kg. (approx)**	**Adjacent Size 32 mm. Diagonal Size : 37nn.**		
	iv) Dimension of compression joint for Steel Part	**Outer dia:18mm Inner dia. 9.3 mm Adjacent Size : 15.1mm Minimum Length : 203mm. Minimum weight : 0.28Kg (app.)**	**Adjacent size : 15.1mm. 10mm. Minimum**	**Outer dia.18mm. Inner dia : size : 17.4mm Length 203mm.**	**Adjacent Size : Diagonal**
	v) Minimum failing load.	**95% of ultimate tensile strength of conductor**		**95% of ultimate tensile strength of groundwire**	
	vi) Electrical resistance 20 Deg. C	**75% of measured resistance of the equivalent length of conductor.**			

	vii) Galvanising :		
	a) Ferrous Parts. **b) No.of dips 4 dips for 1 minute withstand.**	**Hot-dip galvanised (HDG)** **4 dips**	**Hot dip galvanised.** **4 dips**
	viii) Minimum Corona formation voltage	**110% of maximum line to ground voltage**	

B) VIBRATION DAMPERS:

(SUITABLE FOR ACSR CONDUCTOR: PANTHER/ZEBRA /MOOSE AND G.S.S. GROUND WIRE 7/3.15 and 7/3.66 mm.

i) Type : 4R Stock Bridge Type
ii) Distance between conductor : 74.5 mm. & axis of the Vibration Damper.
iii) Messenger Cable : 130 Kg/mm sq. quality (19 strands)
iv) Bolt size : 16 mm. (dia.)
v) Slip strength of messenger Cable : 500 Kgs.
vi) Mass pull-of : As per I.S.S.

C) REPAIR SLEEVES:

SUITABLE FOR ACSR PANTHER/ZEBRA/MOOSE CONDUCTOR AND G.S.S. GROUND WIRE.

		Suitable for ACSR panther/Zebra/Moose.	**Suitable for G.S.S. Ground wire.**
i)	**Type**	**Compression**	**Compression.**
ii)	**Material**	**Extruded aluminium.**	**Steel**
iii)	**Min. failing load**	**95% of UTS of conductor.**	**95% of UTS of ground wire.**
iv)	**Length**	**241/279 mm.**	**200 mm (150 mm. min.)**
v)	**Dimension :**		
	a) After compression (i) Adjacent side	**21mm**	**11.5 mm**
	(b) Before Compression		

:	**21mm.**	
(i)Outerdiameter 38/48mm.	**11.5mm.**	
(ii)Innerdiameter 23/40mm		
vii) Electrical Resistance at 20 deg. C	**Not more than 75% of the resistance of equivalent length of conductor.**	
vii) Galvanising :		
a) Ferrous parts		**Hot – dip galvanized**
b) No. of dips for one-minute stand.		**4 dips**

D) SUSPENSION CLAMP:
FOR GROUND WIRE 7/3.15 and 7/3.66 mm

i) Type : Envelop type

ii) Material : Forged Steel / NCL.

iii) Minimum slip strength : 25% of UTS of ground wire.

iv) Dimension :

(a) Overall length : 230mm

(b) Inner dia. (before compression). : 10mm.

(c) Outer diameter (before compression). : 18mm.

(d) After Compression :

Adjacent : 15.1 mm.

Diagonal side : 17.4mm.

(e) Galvanising :

(i) Fwerrous parts. : Hot-dip galvanised.

(ii) No. of dips for one-minute withstand. : 4 dips

E) BONDING PIECES:

a) material : flexible copper bond (37/7/ 0.417 mm. tinned copper flexi-

ble stranded cable).

b) Length : Not less than 750 mm.

c) Bolt size : 16mm x 40 mm.

d) Copper area. : 34 sq.mm.

e) Thickness of long : 6 mm.

f) Material for connecting socket. : Tinned Brass

F) INSULATOR HARDWARES

A) String hardwares :

Material and strength

	Description of item.	Material	UTS
i)	Bolt hook	Forged Steel	11,500 Kgs (90 KN)
ii)	Anchor Shackle	-do-	15,500 Kgs (120 KN)
iii)	Socket Eye Horn Holder.	- do-	11,500 Kgs (90 KN)
iv)	Socket Clevis.	-do-	15,500 Kgs.
v)	Ball Clevis	-do-	15,500 Kgs.
vi)	Clevis Eye	-do-	15,500 Kgs.
vii)	Socket Eye.	-do-	15,500 Kgs.
vii)	Bottom / Top Yoke plate :		
	Double suspension	Mild Steel	11,500 Kgs.
	Double Tension	-do-	15,500 Kgs.
ix)	Arcing Horn	-do-	___
x)	Suspension Clamp.	Aluminium Alloy and Neoprene.	___
xi)	Tension Clamp.	All.Alloy & Steel.	11,500 Kgs.

xii)	**Ball Pin**	**High tensile forged steel (hot-dip galvanised)**	**90% of UTS of conductor.**
xiii)	**Security Clip**	**Brass (R-Type)**	
	Mininum failing load String (KN)	**Single Suspension**	**: 11,500**
		Single Tension	**: 11,500/15,500**
		Double Suspension	**: 11,500**
		Double Tension	**: 11,500/15,500**

II) CLAMPS.

	Single suspension string	**Single tension string**	**Double suspension string**	**Double tension string.**
i) Type	AGS Type	Compression Type	AGS Type	Compression Type
ii) Material	**Aluminium Alloy and neoprene**	Aluminium Alloy and Steel	Aluminium Ally and Neoprene	Aluminium Alloy and Steel
ii) Minimum slip strength	Not less than 15%	90% of UTS of conductor	Not less than 15% of UTS of conductor	90% of UTS of conductor
iv) Minimum failing load (kg)	11,500	90% of UTS of conductor	11,500 90%	Of UTS of conductor

III). Suspension assembly: armour grip clamp.

1. The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminum reinforcements and AGS preformed rod set.

2. Elastomer insert shall be resistant to the effects of temperature up to 85 deg. C, ozone, Ultraviolet radiation 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 preformed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.

3. The AGS preformed rod set shall be as detailed above in general except that the length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavourable stress on the conductor under all operating conditions.

IV) **Fasteners: bolts, nuts & washers.**

1. All bolts and nuts shall conform to IS-6639 – 1972. All bolts and nuts shall be galvanized. All bolts and nuts shall have hexagonal heads, the heads being truly concentric, and square with the shank, which must be perfectly straight.

2. Bolts upto M16 and having length upto ten 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-I to ensure proper bearing.

3. 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.

4. 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 not 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 be tight to the point where shank of the bolt connects to the head.

5. Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS-2016-1967.

6. 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 the bolts and size of holes and any other special details of this nature.

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

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

9. Fasteners of grade higher than 8.8 are not to be used and minimum grade for bolts shall be 5.6.

GENERAL:

1. 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-2629-1985 and shall satisfy the tests mentioned in IS 2633-1986. 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 be guaranteed to withstand at least six successive dips each lasting one minute under the Standard Preece test for galvanizing.

2. 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 of grade Zn 99.95 as per IS 209-1979.

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

4. Socket ends, before galvanizing shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal

contours of socket ends shall be concentric with the axis of the fittings as per IS 2486/IEC-120. 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. All current carrying parts shall be so designed end manufactured that contact resistance is reduced to minimum.

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

Electrical Design:

The normal duty and heavy duty suspension, light duty, normal duty and heavy duty tension insulator sets shall all comply with the technical requirements of schedule C and satisfy the test requirements stated in Section-7.

Mechanical design:

The mechanical strength of the insulators and insulator fittings shall be as stated in Schedule-C

The design shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to the development of defects.

Insulating material shall not engage directly with hard metal. All fixing materials shall be of approved quality, shall be applied in an approved manner and shall not enter into chemical action with the metal parts or cause fracture by expansion in service. Where cement is used as a fixing medium, cement thickness shall be as small and even as possible and proper care shall be taken to correctly centre and locate the individual parts during cementing.

- **Technical Specification for Design, Supply and Testing of Hard ware fittings.**

Type tests:

The following type tests shall be conducted on hardware fittings.

A. **On suspension hardware fittings only.**

(a) Magnetic power loss test.
(b) Clamp slip strength Vs torque
(c) Mechanical strength test.
(d) On one test on elastomer.

B. **On Tension hard ware fittings only.**

Electrical resistance test for Dead end assembly. IS 2486 (Part-I) 1971

(a) Heating cycle test for dead end assembly. -do-

(b) Slip strength test for dead end assembly. IS 2486 (Part-I)

(c) Mechanical strength test.

C. **On both suspension and tension hardware fittings**.

(a) Visual examination. IS-2486 (Part-I) 1971

(b) Verification of dimension. -do-

(c) Galvanizing / electroplating test. -do-

(d) Mechanical strength test of each component
(including corona control ring/grading ring and arcing horn)

(e) Mechanical strength test of welded joint.

(f) Mechanical strength test for corona control ring/
grading ring and arcing horn. BS-3288 (Part-I)

(g) Test on locking device for ball and socket coupling. IEC – 3721984

(h) Chemical analysis, hardness tests, grain size,
inclusion rating and magnetic particle inspection for forging/casting.

D. **On suspension hardware fittings only.**

(a) Clamp slip strength ver as torque test for suspension clamp.

(b) Shore hardness test of elastomer cushion for AG suspension clamp.

(c) Bend test for armour rod set. IS-2121 (Part-I)

(d) Resilience test for armour rod set. -do-

(e) Conductivity test for armour rod set. -do-

E. **On tension hardware fittings only**

	Unit.	37/4.00 mm^2
MID SPAN COMPRESSION JOINTS FOR CONDUCTORS.		
Weight of the joint.	Kg.	1.27
Slipping strength.	KN	129.6
Resistance of the completed joint.	Ohms.	0.000027
Materials of the joints specify alloy type and its aluminum contents.		6201
Before compression dia of sleeve.	mm	
(a) Inner diameter.		31+/-0,5
(b) Outer diameter.		48+/-1.0
Dimensions after compression.	mm	
(a) Corner to corner.		46+/-0.5
(b) Surface to surface.		40+/-0.5

Length of the sleeve.	mm	
(a) Before compression.		500+/-5.0
(b) After compression.		540+/-5.0
Compression pressure.	Tone	100
Whether designed for intermittent or continuous compression.		Continuous compression.
Minimum corona extinction voltage under dry condition.	Kv	154
Radio interference voltage under conditions.	Micro volt.	Below 1000
REPAIR SLEEVE FOR CONDUCTOR		
Weight of the sleeve.	Kgs.	0.63
Before compression dia of sleeve.		
(a) Inner diameter.	mm	31.05
(b) Outer diameter.	mm	48.10
Dimensions after compression.		
(a) Corner to corner.	mm	48.05
(b) Surface to surface.	mm	40.05
Length of sleeve.		
(a) Before compression.	mm	279.50
(b) After compression.	mm	300.50
Compression pressure.	Tone.	100
Minimum corona extinction voltage under dry condition.	Kv.	154
Radio interference voltage under condition.	Microvolt.	Below 1000

(a) Slip strength test for dead end assembly. IS-2121 (Part-I)

All the acceptance tests stated at clause shall also be carried out on composite insulator unit, except the eccentricity test at clause. In addition to these, all the acceptance tests indicated in IEC 1109 shall also be carried out without any extra cost to the employer.

F. For hardware fittings.

(a) Visual examination. IS-2121 (Part-I)

(b) Proof & test.

G. Tests on conductor accessories.

H. Type tests.

I. Mid span compression joint for conductor and earthwire.

(a) Chemical analysis of materials.

(b) Electrical resistance tests. IS-2121 (Part-II) 1981 clause 6.5 & 6.6

(c) Heating cycle test. -do-

(d) Slip strength test. -do-
(e) Corona extinction voltage test (dry)
(f) Radio interference voltage test (dry)

J. Repair sleeve for conductor.
(a) Chemical analysis of materials.

VIBRATION DAMPER FOR CONDUCTOR.

Vibration Damper for AAC 37/4.00 mm	Unit.	
Total weight of the damper.	Kgs.	4.5
		Left. Right.
Weight of each damper mass.	Kgs.	1.6 2.2
Resonance frequencies.		
1. First frequency.	Hz	12+/- 1 18+/- 2
2. Second frequency.	Hz	28+/- 2 36+/- 2
Dimension of each damper mass.	Mm	55 Ox165 60 Ox195
Material of:		
1. Damper miss.		Cast iron hot dip galvanized.
2. Messenger cable.		High tensile galvanized steel wire.
No. of strands in messenger cable strands.		19
Lay ratio of messenger cable strands.		9-11
Min tensile strength of messenger cable.	Kg./ Sq.mm	135
Miss pull-off strength.	KN	5
Clamping forque.	Kg.m	7
Slipping strength of the damper clamp.	KN	
1. Before fatigue test.		2.5
2. After fatigue test.		2.0
Magnetic power loss per vibration damper.	Watts.	1 watt at 500 amps.
Min. corona extinction voltage under dry conditions.	Kv.	154
Radio interference voltage under dry condition 1MHz, at 154 KV.	Microvolt.	Below 1000
Percentage variation in reactance after fatigue test in compassion with that before the fatigue test.	%	20

SECTION – V
CLAMPS AND CONNECTORS

S.NO. DESCRIPTION

(A)TECHNICAL SPECIFICATION FOR CLAMPS & CONNECTORS

1. SCOPE
2 STANDARDS
3. MATERIAL AND WORKMANSHIP
4. RATING
5. EQUIPMENT CONNECTORS
6. TEMPRATURE RISE
7. WEIGHTS
8. INTERCHANGE ABILITY

(B)TECHNICAL SPECIFICATION FOR ACSR BUS-BAR

1. SCOPE
2. MATERIALS
3. MECHANICAL CHARACTERISTICS
4. DIMENSIONAL TOLERANCE
5. CHEMICAL COMPOSITION
6. ELECTRICAL & MECHANICAL CHARACTERISTICS AND CURRENT RATINGS

TECHNICAL SPECIFICATION
CLAMPS AND CONNECTORS

(A) TECHNICAL SPECIFICATION FOR CLAMPS & CONNECTORS

1. SCOPE

This specification covers design, manufacture, assembly, testing at manufacturer's works, supply and delivery at site of all terminal connectors of 220,132 & 33KV equipments (mainly breaker, isolator, CT,PT,CVT,BPI and LA) and all other clamps and dropper connectors required for the switch yard as per approved lay out and system design.

2. STANDARDS

The terminal connectors under this specification shall conform strictly to the requirements of the latest version of the following standards as amended up-to-date, except where specified otherwise.

i)	IS: 5561	Power Connectors.
ii)	IS:617	Aluminium & Aluminium Alloy
iii)	IS: 2629	Recommended Practice for hot dip galvanizing of iron and steel.
iv)	IS: 2633	Method of testing uniformity of coating of zinc coated articles.

The materials conforming to any other authoritative standards which ensure equal or better performance shall also be acceptable. The salient point of these specifications and points of difference between these and the above specifications, shall be clearly brought out in the bid.

3. MATERIAL & WORKMANSHIP

The terminal connectors shall be manufactured from Aluminium Silicon Alloy and conform to designation A6 of IS: 617 (latest edition)

The connectors shall be of best quality and workmanship, well finished and of approved design. Specific materials for clamps and connectors should have high current carrying capacity, high corrosion resistance and be free from corona formation.

All connectors or its components to be connected with ACSR conductor shall be of compression type having aluminium purity not less than 99.5%.

All bus bar clamps shall be made preferably from forged aluminium of purity not less than 99.5%. The thickness and contact surface should be maintained in such a way that the clamp should conform to IS:5561/1970 or any latest revision thereof.

4. RATING

The connector rating shall match with the rating of the respective equipments for the terminal connectors and the connectors for bus bar and dropper should be of the following rating. Minimum thickness at any part of connector shall be 10(ten)mm. Indicative ratings are given below:

	Rating	400/220 / 132 KV
1.	Main bus bar connectors high level and low level (Amps)	3600/2000/2000
2.	High level bus sectionalisation isolator(Amps)	3600/2000/2000
3.	Connectors along the bay (Amps)	3600/2000/2000
4.	Terminal connectors for CB(Amp.)	as per rating of CB
5.	-do- for Isolator(Amps)	as per rating of ISO
6.	-do- for CT	As per CT rating
7.	-do- for PI	As per PI rating
8.	-do- for LA	As per LA rating
9.	-do- for PT	As per PT rating
10.	-do- for CVT	As per CVT rating
11.	-do- for WT	As per WT rating.

5. EQUIPMENT CONNECTORS

Bimetallic connectors shall be used to connect conductors of dissimilar metal. The following bimetallic arrangement shall be preferred.

i) copper clodding of minimum 4 mm. thickness on the aluminium portion of connector coming in contact with the copper palm or stud of the equipment.

ii) alternatively, to provide cold rolled aluminium copper strip between the aluminium portion of the connection, the sheet thickness shall not be less than 2 mm.

Sufficient contact pressure should be maintained at the joint by the provision of the required number of bolts or other fixing arrangements, but the contact pressure should not be so great as to clause relaxation of the joint by cold flow, the joint should be such that the pressure is maintained within this range under all conditions of service, to avoid excessive local pressure, the contact pressure should be evenly distributed by use of pressure plates, washers or suitable saddles of adequate area of thickness should be less than that of an equal length of conductor where measured individually test results showing the milli drop test and resistance should be enclosed with the bid.

All connectors shall be so designed and manufactured as to offer ease of installation as these are to be used in overhead installations, design shall be such that full tightening of nuts and bolts should be possible with the use of double wrench.

The connectors shall be such as to avoid local corona, sound or visible discharge.

6. TEMPRATURE RISE

The temperature rise of connectors when carrying rated current shall not exceed 45˚ C above reference design temperature of 50˚ C.

i) Acceptance Tests
(a) Tensile Test
(b) Temperature rise test
© Temperature rise test

ii) Routine Test
(a) Visual Inspection
(b) Dimensional Check

Type test reports from a recognized laboratory shall have to be submitted.

7. WEIGHTS

Weights of different materials uses in manufacture, such as aluminium, silicon, copper etc. should be clearly indicated in the bid.

8. INTERCHANGE ABILITY

Corresponding parts of similar clamps and connectors shall be made to gauge or jig and shall be interchangeable in every respect.

(B) TECHNICAL SPECIFICATION FOR ACSR BUS-BAR

1. SCOPE

The specification covers design, engineering, manufacture, testing at manufacturer's works, supply and delivery of heavy duty ACSR bus-bar for use in 220 KV and 132 kV sub-station.

2. MATERIALS

The ACSR bus bar shall be drawn by using MOOSE/ZEBRA as per system requirement.
The strung ACSR bus-bar shall be of heavy duty type and design to operate within set temperature limits and to withstand thermal and electromechanical forces developed due to short circuits.

3. MECHANICAL CHARACTERISTICS

The mechanical strength of the strung ACSR bus-bar shall be limited to be maximum allowable tension for specific size of conductor as per ISS.

4. DIMENSIONAL TOLERANCE

Dimensional tolerances shall be as per relevant ISS.

5. CHEMICAL COMPOSITION

The chemical composition for ACSR conductors (MOOSE/ZEBRA) shall be holding good under all operating condition.

6. ELECTRICAL & MECHANICAL CHARACTERISTICS AND CURRENT RATINGS

Electrical and mechanical characteristics and current ratings for ACSR bus-bar shall be same as stipulated for MOOSE/ZEBRA ACSR conductors, the details of which has been specified.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

LINE HARDWARE AND ACCESSORIES FOR 132/220 KV & GROUND WIRE 7/3.15mm

A	HARDWARES	Suspension		Tension
i	Maker's name and Address	ERI-TECH LIMITED		
ii	Size and designation of ball and socket with standard specification to which conforming	16mmB as per IS 2486		20mm as per IS 2486
iii	Material			
a	Anchor shackle	NA		Forged steel Galvanised
b	Chain Link	NA		Forged Steel galvanised
c	Ball hook / Ball Link (HH)	Forged Steel galvanized		Forged Steel galvanised
d	Socket Eye (HH)	Forged Steel galvanized		NA
e	Ball Clevis	Forged Steel galvanized		Forged Steel galvanised
f	Socket Clevis	Forged Steel galvanized		Forged Steel galvanised
g	Yoke Plate	Mild Steel Galvanised		Mild Steel Galvanised
h	Arcing Horn	Mild Steel Galvanised		Mild Steel Galvanised
i	Clamp Suspension	A.G.S. Clamp		NA
j	Dead End/Cross arm strap	NA		NA
k	Dead end clamp(Compression)	NA		Ext. Al. Alloy
iv	Standard specification to which the Hardwares conform	IS 2486, IS: 2004,IS:617, IS-2633, & IS-733		
v	Standard specification to which conforming	IS: 2486		
vi	Galvanising			
a	Ferrous parts	Hot Dip Galvanised		
b	Spring washers	Electro Galvanised		
c	Quality of zinc used	99.5%		
d	Number of dips which the clamp can withstand	4/ 1 minute dips		
vii	Standard to which conforming	IS 2633		
viii	Reference to drawing No.	Drg. Attached		
ix	Minimum failing load in kg	For AAAC & ACSR Panther (132 kv)	For AAAC & ACSR Zebra (220 kv)	For AAAC & ACSR Moose (220 kv/400 KV)
a	For Single Tension Hardwire Fittings	120 kN	160 kN	160 kN
b	For Double Tension Hardwire Fittings	120 kN	160 kN	160 kN
c	For Single Suspension Hardwire Fittings	70 kN	70 kN	90/120 kN
d	For Double Suspension Hardwire Fittings	70 kN	70 kN	120 kN
B.	TENSION CLAMPS	Suitable for Panther, Zebra & Moose (AAAC/ACSR)		
i	Type	Compression type tension clamp		
ii	Material	Ext. Al. Alloy/ Ext. Al.		
iii	Breaking Strength	95% of UTS of Conductor		
iv	Slipping strength	95% of UTS of Conductor		
v	Galvanising			
a	Ferrous parts	Hot Dip Galvanised		
b	Spring washers	Electro Galvanised		
c	Quality of zinc used	99.5%		
d	Number of dips which the clamp can withstand	4/ 1 minute dips		
vi	Standard to which conforming	IS 2633		
vii	Electrical Conductivity			
	a. Results of heating cycle test carried out	T.C. Attached		
	b. Electrical resistance	Not more than 75% of equivalent length of conductor		
viii	Reference to type tests and other tests reports attached	T.C. Attached		
ix	Make of bolts and nuts used	Local Make		

C	SUSPENSION CLAMPS	Panther (AAAC/ACSR)	Zebra (AAAC/ACSR)	Moose (AAAC/ACSR)
i	Type	AGS Type		
ii	Type of material used for retaining rod for AGS assembly giving reference of ISS	Aluminium Alloy 6061/ Equivalent	Aluminium Alloy 6061/ Equivalent	Aluminium Alloy 6061/ Equivalent
iii	minimum tensile strength of retaining rod material	35 kg/mm^2	35 kg/mm^2	35 kg/mm^2
iv	Chemical composition of retaining rod material	As per IS:733	As per IS:733	As per IS:733
v	Electrical conductivity of Armour Rod material (in percentage of the conductivity of IACS i.e. International Annealed Copper Standard	Not less than 40% of IACS	Not less than 40% of IACS	Not less than 40% of IACS
vi	Slipping strength of cushioned suspension assembly	8% to 15% of UTS of Conductor	20 to 29 KN of UTS of Conductor	20 to 29 KN of UTS of Conductor
vii	Breaking strength of suspension Clamp	7000kgf	7000kgf	9000kgf
viii	Physical properties of neoprene cushion			
a	Minimum Tensile Strength	2000 psi	2000 psi	2000 psi
b	Minimum ultimate Elongation	300%	300%	300%
ix	Ageing (guaranteed life of the assembly)	40 years	40 years	40 years
x	Hardness	65 to 80 A	65 to 80 A	65 to 80 A

D	Midspan compressions joints for	Panther		Zebra	
		AAAC	ACSR	AAAC	ACSR
i	Type	Compression Type			
ii	Suitable for	AAAC Panther	ACSR Panther	AAAC Zebra	ACSR Zebra
iii	Materials				
a	Outer Sleeve	Ex. Al. Alloy	Ex. Al.	Ex. Al. Alloy	Ex. Al.
b	Inner Sleeve	N.A.	Galvanised Steel	N.A.	Galvanised Steel
iv	Outer Sleeve				
a	Outer Dia. Before compression (mm)	Ø 38	Ø 38	Ø 48	Ø 48
b	Flat to Flat After compression (mm)	32	32	40	40
v	Length of Outer Sleeve				
a	Before compression (mm)	610	610	711	711
b	After compression (mm)	655	660	760	768
vi	Inner Sleeve				
a	Outer Dia. Before compression (mm)	N.A.	Ø 18	N.A.	Ø 19.2
b	Flat to Flat After compression (mm)	N.A.	15.1	N.A.	16.1
vii	Length of Inner Sleeve				
a	Before compression (mm)	N.A.	203	N.A.	241
b	After compression (mm)	N.A.	230	N.A.	273
viii	Weight of Sleeve				
a	Aluminium (kg)	1.2	1.2	2.032	2.032
b	Galvanised Steel (kg)	N.A.	0.295	N.A.	0.410
ix	Galvanising				
a	Ferrous parts	Hot Dip Galvanised			
b	Spring washers	Electro Galvanized			
c	Quality of zinc used	99.5%			
d	Number of dips which the clamp can withstand	4/ 1 minute dips			
x	Standard to which conforming	IS 2633			
xi	Slipping strength of mid span joint expressed as percentage of UTS of conductor	95%			

xii	Breaking strength of mid span joint expressed as percentage of UTS of conduct	95%			
xiii	Conductivity of Compression joint expressed as percentage of conductivity of cable	100% of equivalent length of conductor			
xiv	Resistance as percentage of measured resistance of equivalent length of conductor	Not more than 75% of equivalent length of conductor			
E	**Repair Sleeve**	**AAAC & ACSR Panther**		**AAAC & ACSR Zebra**	
i	Type	Compression type			
ii	Suitable for	AAAC Panther	ACSR Panther	AAAC Zebra	ACSR Zebra
iii	Outside diameter or length of sleeve				
a	Before compression (mm)	Ø 38	Ø 38	Ø 48	Ø 48
b	After compression Flat to Flat (mm)	32	32	40	40
iv	Length of Sleeve				
a	Before compression (mm)	241	241	279	279
b	After compression (mm)	270	270	310	310
v	Material	Ex. Al.Alloy	Ex. Al.	Ex. Al.Alloy	Ex. Al.
vi	Weight of sleeve in (kg)	0.450	0.453	0.810	0.810
vii	Breaking strength as percentage of UTS of conductor	95%			
viii	Conductivity as percentage of conductivity of conductor	100% of equivalent length of conductor			
ix	Resistance as percentage of measured resistance of equivalent length of conductor	Not more than 75% of equivalent length of conductors			
F	**Vibration Damper**	For AAAC & ACSR ZEBRA			
i	Total weight of the damper (Kg)	4.5 Approx			
		Left		Right	
ii	Weigh of each damper mass (kgs.)	1.6		2.2	
iii	Resonance frequencies				
	1. First frequency (Hz)	12± 1		18± 2	
	2. Second frequency (Hz)	28± 2		36±2	
iv	Dimensions of each damper mass	60 Φ x 195		55 Φ x 165	
v	Material of :				
	1. Damper mass	Cast iron hot dip galvanised.			
	2. Messenger cable.	High tensile galvanised steel wire.			
vi	Galvanising				
a	Ferrous parts	Hot Dip Galvanised			
b	Spring washers	Electro Galvanised			
c	Quality of zinc used	99.5%			
d	Number of dips which the clamp can withstand	4/ 1 minute dips			
vii	Standard to which conforming	IS 2486 and IS 2633			
viii	No of strands in messenger cable strands	19			
ix	Lay ratio of messenger cable strands	9 11			
x	Min tensile strength of messenger cable (kg /sq. mm)	135			
xi	Mass pull - off strength (KN)	5			
xii	Clamping torque (Kg.m)	7			
xiii	Slipping strength of the damper clamp				
	1.Before fatigue test (KN)	2.5			
	2. After fatigue test (KN)	2			

xiv	Magnetic power loss per vibration damper (Watts)	1 watt at 500 amps
xv	Min. corona extinction voltage under dry conditions (KV)	154
xvi	Radio interference voltage under conditions 1 MHZ, AT 154 KV (Microvolt)	Below 1000
xvii	Percentage variation in reactance after fatigue test in comparison with that before the fatigue test (%)	20
G	**Midspan compression joint For 7/3.15mm Galvanised Stranded Steel Wire**	
i	Material	Galvanized Steel
ii	Size	OD 20.2 x Length 230
iii	Suitable for groundwire	Yes (7/3.15)
iv	Weight in kg	0.85
v	Minimum failing load	50 KN
vi	Galvanization	
a	Ferrous parts	Hot Dip Galvanised
b	Spring washers	Electro Galvanised
c	Quality of zinc used	99.5%
d	Number of dips which the clamp can withstand	4 / 1 minute dip
vii	Standard to which conforming	IS 2633
H	**Suspension Clamps For 7/3.15mm Galvanised Stranded Steel Wire**	
i	Materials	Malleable Cast Iron / Galvansied Steel
ii	Size	As per Drawing
iii	Suitable for groundwire	Yes (7/3.15)
iv	Weight in kg	
v	Slip strength	12-17 KN
vi	Minimum failing load	70 KN
vii	Galvanising	
a	Ferrous parts	Hot Dip Galvanised
b	Spring washers	Electro Galvanised
c	Quality of Zinc used	99.5%
d	Number of dips which the clamp can withstand	4/1 minute dips
viii	Standard to which conforming	IS 2486 and IS 2633
I	**Compression type dead end assemblies For 7/3.15mm Galvanised Stranded Steel Wire**	
i	Materials	Forged steel
ii	Size	As per drawing
iii	Suitable for ground wire	Yes (7/3.15)
iv	Weight in kg	3.69
v	Minimum failing load	70 KN
vi	Galvanising	
a	Ferrous parts	Hot Dip Galvanised
b	Spring washers	Electro Galvanized
c	Quality of zinc used	99.5%
d	Number of dips which the clamp can withstand	4/ 1 minute dips
vii	Standard to which conforming	IS 2486 and IS 2633
J	**Flexible copper bond**	
i	Drawings enclosed	Yes

ii	Stranding	37/7/0.417
iii	Cross sectional area (Sq.mm)	75.6
iv	Minimum copper equivalent area (Sq.mm)	34 (each individual wire)
vi	Length of copper cable (mm)	500
vii	Material lugs	Tinned Copper
viii	Bolt Size	
	(i) Diameter (mm)	16
	(ii) Length (mm)	40
ix	Resistance (Ohm)	0.0004 (as per IS:2121)
x	Total weight of flexible copper bond (kg)	0.45 (approx)

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

OPGW CABLE &

OPTIC FIBRE EQUIPMENT

TECHNICAL SPECIFICATION

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1.2 General Information and Scope

1.2.1 The transmission lines where OPGW shall be commissioned, are of 132 kV voltage class or 220 kV voltage class. The bill of quantities for the same is specified in the BPS/ BOQ.

1.2.3 : The quantities of hardware fittings such as tension assembly, suspension assembly, vibration damper, etc required for the stringing of the OPGW are not reflected in the BPS/BOQ. The contractor has to assess the quantities of such hardware fittings required for the OPGW stringing per km as per the tower schedule and profile survey of the transmission line.

1.2.4 : The bidder shall submit along with the Bid the sag-tension chart of the offered OPGW, based on the profile, for verification and approval by the employer.

2. OPGW cabling and associated hardware & fittings

This section describes the functional & technical specifications of OPGW cabling and associated hardware & fittings.

Fibre Optic Cabling

This section defines the requirements for G.652D Dual-window Single mode (DWSM) telecommunications grade fibre optic cable. Bidders shall furnish with their bids, detailed descriptions of the fibres & cable(s) proposed.

All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years. Documentary evidence in support of guaranteed life span of cable & fibre shall be submitted by the Contractor during detailed engineering.

Required Optical Fibre Characteristics

This section describes the characteristics of optical fibre to be provided under this specification.

Physical Characteristics

Dual-Window Single mode (DWSM), G.652D optical fibres shall be provided in the fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 1-1(a).

Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in table 1-1 (a) shall be “guaranteed” fibre attenuation of any & every fibre reel.

The overall optical fibre path attenuation shall not be more than calculated below:

Maximum attenuation @ 1550nm: 0.21 dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

Maximum attenuation @ 1310nm: 0.35dB/km x total km + 0.05 dB/splice x no. of splices + 0.5 dB/connector x no. of connectors

Table 1-1(a)

DWSM Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 μm (± 0.6μm)
Cladding Diameter:	125.0 μm ± 1 μm
Mode field concentricity error	≤ 0.6μm
Cladding non-circularity	≤ 1%
Cable Cut-off Wavelength λ_{cc}	≤□□1260 nm
1550 nm loss performance	As per G.652 D
Proof Test Level	≥ 0.69 Gpa
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.21 dB/km
Chromatic Dispersion;Maximum: **Zero Dispersion Wavelength:** **Zero Dispersion Slope:**	18 ps/(nm x km) @ 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm 1300 to 1324nm 0.092 ps/(nm^{2}xkm) maximum
Polarization mode dispersion coefficient	≤ 0.2 ps/km^½
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60ºC - +85ºC
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (30±1 mm radius Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB

2.1.2 Fibre Optic Cable Construction

Overhead Fibre Optic Cables shall be OPGW (Optical Ground Wire). The OPGW cable is proposed to be installed on the transmission lines of Orissa Power

Transmission Corporation Ltd. (OPTCL). The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service. The OPGW cable to be supplied shall be designed to meet the overall requirements of all the transmission lines. Normally the tower span of the lines shall not exceed 600 m, however, some of the spans may be up to around 1000 m or more. The exact details shall be collected by the Contractor during survey. To meet the overall requirement of all the transmission lines, the contractor may offer more than one design without any additional cost to OPTCL , in case span length of 600 m is found during survey. It may also be noted that some of the transmission lines route may be added during the engineering stage.

Transmission Line Details

The list of transmission lines are indicated in **Annexure-1** . The details required for cable design etc. shall be collected by the Contractor during survey.

Optical Fibre Cable Link Lengths

The estimated optical fibre link lengths are provided in Appendices as transmission line route length. However, the Contractor shall supply & install the optical fibre cable as required based on detailed site survey to be carried out by the Contractor during the project execution. The Contractor shall verify the transmission line route length during the survey and the Contract price shall be adjusted accordingly. For the purpose of payment, the optical fibre link lengths are defined as transmission line route lengths from Gantry at one terminating station to the Gantry in the other terminating station. The actual cable lengths to be delivered shall take into account various factors such as sag, service loops, splicing, working lengths & wastage etc. and no additional payment shall be payable in this regard. The unit rate for FO cable quoted in the Bid price Schedules shall take into account all such factors.

Optical Fibre Identification

Individual optical fibres within a fibre unit and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme. Colouring utilized for colour coding optical fibres shall be integrated into the fibre coating and shall be homogenous. The colour shall not bleed from one fibre to another and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre. If more than the specified number of fibres are included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Each fibre unit shall be individually identifiable utilizing colour coding. Buffer tubes shall be filled with a water-blocking gel.

Optical Fibre Strain & Sag-Tension chart

The fibre optic cable shall be designed and installed such that the optical fibres experience no strain under all loading conditions defined in IS 802. Zero fibre strain condition shall apply even after a 25 year cable creep.

For the purpose of this specification, the following definitions shall apply:

Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is *no fibre strain*.
The *no fibre strain* condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.
The *Cable strain margin* is defined as the maximum cable strain at which there is no fibre strain.
The cable *Maximum Allowable Tension (MAT)* is defined as the maximum tension experienced by the Cable under the worst case loading condition.
The cable *max strain* is defined as the maximum strain experienced by the Cable under the worst case loading condition.
The cable *Every Day Tension (EDT)* is defined as the maximum cable tension on any span under normal conditions.
The *Ultimate /Rated Tensile Strength (UTS/* RTS/ breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.
While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
The sag shall not exceed the earth wire sag in all conditions.
The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS.
The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted along with the bid under various conditions mentioned below:

53° C , no wind and no ice
32° C, no wind and no ice
0°C, no wind and no ice
32° C, full wind and no ice
32° C, 75% full wind and no ice
0° C, 2/3rd / 36% of full wind (IS 802:1977/1995)

The above cases shall be considered for the spans from 100 m to 600 m or higher span length in the range of 50 m spans. Max. vertical sag, max. tension and max sag at 0° C & no wind shall be considered for in line with the design parameter of transmission line. **The typical details are indicated in the Appendices**. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines. In case of any span higher than 600m, suitable OPGW cable meeting sag-tension requirement of transmission line shall also be

provided by the Contractor. The Contractor shall submit the stringing chart for review of OPTCL.

Cable Materials

The materials used for optical fibre cable construction, shall meet the following requirements:

Filling Materials

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC 60794-1-F-5.

The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, **non hygroscopic**, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

Marking, Packaging and Shipping

This section describes the requirements for marking, packaging and shipping the overhead fibre optic cable.

(a) Drum Markings: Each side of every reel of cable shall be permanently marked in white lettering with the vendors' address, the Purchaser's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number including the name of the transmission line & segment no., factory inspection stamp and date.

(b) Cable Drums: All optical fibre cabling shall be supplied on strong drums provided with lagging of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

The spare cable shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied on each drum shall be determined by a "schedule" prepared by the Contractor.

OPGW cable installation requirements

Most of the OPGW fibre optic cables to be installed under this project shall be installed under live line conditions, i.e. with all the circuits of the transmission line charged to their rated voltage. However, some of OPGW cables may be installed in off-line conditions. The tentative bill of quantities for both live-line as well as off-line OPGW cable system installations have been specified in the appendices and the actual quantities for both types shall be finalised during project execution after detailed survey. The OPGW cable shall be installed at the top of the tower by replacing the existing ground wire. The Contractor shall carry out re-tensioning of the existing earth wire wherever required to maintain the adequate clearances for live line stringing of fibre optic cables. However, in exceptional cases installation of OPGW cable below conductor may also be considered on low voltage lines which shall be decided during detailed engineering.

Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-1138, 2009. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose. The cable shall consist of optical fibre units as defined in this specification. There shall be no factory splices within the cable structure of a continuous cable length.

The composite fibre optic overhead ground wire shall be made up of multiple buffer tubes embedded in a water tight aluminium/aluminium alloy/stainless steel with aluminium coating protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. Each buffer tube shall have maximum 12 no. of fibres. All fibres in single buffer tube or directly in central fibre optic unit is not acceptable. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre

Central Fibre Optic Unit

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen.

The OPGW design of dissimilar materials such as stainless steel tube with aluminium or aluminium –clad-steel wire strands are not allowed. Central fibre optic unit may be of aluminium or stainless steel tube with aluminium protective coating. In case of aluminium protective coating, the coating must completely cover the tubes leaving no exposed areas of tubing that can make electrical contact either directly or indirectly through moisture, contamination, protrusions, etc with the surrounding stranded wires. The tube may be fabricated as a seamless tube, seam welded, or a tube without a welded seam.

Basic Construction

The cable construction shall conform to the applicable requirements of this specification, applicable clauses of IEC 61089 related to stranded conductors and

Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed. The finished wires shall contain no joints or splices unless otherwise agreed to by the OPTCL and shall conform to all applicable clauses of IEC 61089 as they pertain to stranded conductors. The wires shall be so stranded that when the complete OPGW is cut, the individual wires can be readily regrouped and then held in place by one hand.

Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength shall not include the strength of the optical unit. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to that of the earthwire being replaced such that there is no or minimal consequential increase in stresses on towers. For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable IS 802:1995 and IS 875: 1987 shall be applied. However the OPGW installation sag & tension charts shall be based on IS 802 version to which the line is originally designed. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied. The Bidder shall submit sag-tension charts for the above cases with their bids.

Table 1.2(a)

OPGW Electrical and Mechanical Requirements

(1)	**Everyday Tension**	≤ 20% of UTS of OPGW
(2)	**D.C. Resistance at 20ºC:**	< 1.0 ohm/Km
(3)	**Short Circuit Current**	≥ 6.32 kA for 1.0 second

Operating conditions

Since OPGW shall be located at the top of the transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be same or similar as those required of conventional ground conductors.

Installation

OPGW installed under live line condition, i.e. with all circuits charged to the rated line voltage as specified in this section shall be generally in accordance with the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE STD. 524 with latest revisions), with additional instructions and precautions for live line working and fibre optic cable handling. Some of the cable may be installed in off-line condition also. The stringing procedure shall be submitted by the Contractor to OPTCL for approval prior to stringing .

A tower structural analysis shall be carried out by the Contractor, based on the relevant data to be provided by OPTCL, to ensure that with the replacement of existing earth wire with the OPGW cable, the tower members remain within the statutory safety limits as per Indian Electricity rules and if required the Contractor shall carry out the tower strengthening as necessary. The OPGW cable sections shall normally be terminated & spliced only on tension towers. In exceptional circumstances, and on OPTCL specific approval, cable may be terminated on Suspension towers, but in this case tower strength shall be examined to ensure that tower loads are within safe limits and if required, necessary tower strengthening shall be carried out by the Contractor.

Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Downlead clamps, splice enclosure etc. The Bidder shall provide documentation justifying the adequacy and suitability of the hardware supplied. The quantity of hardware & fittings to meet any eventuality during site installation min@ 1% shall also be provided as part of set/km for each transmission line without any additional cost to OPTCL. The Contractor shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document shall consist of three parts: (1) A technical particulars sheet (2) An assembly drawing i.e. level 1 drawing and (3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured in accordance with type test procedures . The Contractor shall supply all the components of the

suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

(b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

(c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in technical specifications.

One damper minimum on each side per OPGW cable for suspension points and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration damper shall be based on vibration analysis.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable 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 OPGW cable 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 messenger cable shall be made of high strength galvanised steel/stain less steel. It shall be of preformed and post formed quality in order to

prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanised in accordance with the recommendations of IS:4826 for heavily coated wires.

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 blow holes 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.

The contractor 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 OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformation of the OPGW strands and premature fatigue failure in operation.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl No.	Description	Technical Particulars
1	Span Length in meters Ruling design span : Maximum span : Minimum Span :	 400 meters 1100 meters 100 meters
2	Configuration :	As per Specifications
3	Tensile load in each :	As per sag tension calculations
4	Armour rods used :	Standard preformed armour rods/AGS
5	Maximum permissible dynamic strain :	+/- 150 micro strains

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations.

The damper placement charts shall include the following

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)

(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of damper

2.1.3 Fibre Optic Splice Enclosures (Joint Box)

All splices shall be encased in Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of required number of optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. No more than 12 fibres shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalised after Survey. Contractor shall be responsible for splicing of fibres and installation of splice enclosures.

2.1.3.1 Optical Fibre Splices

Splicing of the optical fibre cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical fibre splicing shall comply with the following:

(a) All fibre splices shall be accomplished through fusion splicing.

(b) Each fibre splice shall be fitted with a splice protection sheath fitted over the final splice.

(c) All splices and bare fibre shall be neatly installed in covered splice trays.

(d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.

(e) For splicing, fibre optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

Fibre Optic Approach Cables

For purposes of this specification, a fibre optic approach cable is defined as the Armoured underground fibre optic cable required to connect Overhead Fibre Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the fibre cable on the power line and the Fibre Optic Distribution Panel (FODP) installed within the building. The estimated fibre optic approach cabling length requirements are indicated in the **Annexure-V(A) & Annexure-V(B).** However, the Contractor shall supply & install the optical fibre approach cable as required based on detailed site survey to be carried out by the Contractor during the project execution and the Contract price shall be adjusted accordingly.

Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

Jacket Construction & Material

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

Optical, Electrical and Mechanical Requirements

Approach cable shall contain fibres with identical optical/ physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), fibre support/bedding structure, core wrap/bedding, and an overall impervious jacket.

The fibre optic approach cable shall have a minimum outer jacket thickness of 3.0 milli meters and shall meet the following requirements.

i. Fire retardant and no acid gas evolution.
ii. Resistance to ultra-violet deterioration.
iii. Anti-moisture penetration.

1	Number of optical fibres in OFAC	24
2	Mode	DWSM (Dual Window Single Mode)
3	Optimised wavelength (nm)	1550 / 1310
4	Mode field diameter (μm)	9.2 +/- 0.5
5	Outside (Clad) diameter (μm) :	125 +/- 0.5
6	Attenuation	0.22 dB / Km Max. at 1550 nm 0.36 dB / Km Max at 1310 nm
7	Chromatic Dispersion At 1310 nm At 1550 nm	 2.8 ps/ (nm.km) 18 ps/ (nm.km)
8	Polarisation Mode dispersion	≤ 0.1 ps Sqrt.Km

2.1.5 Installation of Approach Cable

The existing cable trenches/ cable raceways proposed to be used shall be identified in the survey report. The Contractor shall make its best effort to route the cable through

the existing available cable trenches. Where suitable existing cable trenches are not available, suitable alternatives shall be provided after OPTCL approval. However, the approach cable shall be laid in the HDPE pipe in all condition.

Suitable provisions shall be made by the Contractor to ensure adequate safety earthing and insulated protection for the approach cable.

All required fittings, supports, accessories, ducts, inner ducts, conduits, risers and any item not specially mentioned but required for laying and installation of approach cables shall be supplied and installed by the Contractor.

Optical Fibre Termination and Splicing

Optical fibre terminations shall be installed in Fibre Optic Distribution Panels (FODP) designed to provide protection for fibre splicing of preconnectorized pigtails and to accommodate connectorized termination and coupling of the fibre cables. The Contractor shall provide rack /wall mounted Fibre Optic Distribution Panels (FODPs) sized as indicated in the appendices and shall terminate the fibre optic cabling up to the FODPs. The location of FODP rack shall be fixed by the Contractor, with the Employer's approval.

Fibre Optic Distribution Panel

At each location requiring the termination of at least one fibre within a cable, all fibres within that cable shall be connectorized and terminated in Fibre Optic Distribution Panels in a manner consistent with the following:

(a) All fibre optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All fibres within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided fibre optic couplings.

(b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and fibre terminations.

(c) FODPs for indoor use shall be supplied in suitable cabinets/racks with locking arrangement

(d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded. The FODP shall meet or exceed ingress protection class IP55 specifications.

(e) Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

Optical Fibre Connectors

Optical fibres shall be connectorised with FC-PC type connectors preferably. Alternatively connector with matching patch cord shall also be acceptable. Fibre optic couplings supplied with FODPs shall be appropriate for the fibre connectors to be supported. There shall be no adapters.

2.1.7 Service Loops

For purposes of this specification, cable and fibre service loops are defined as slack (extra) cable and fibre provided for facilitating the installation, maintenance and repair of the optical fibre cable plant.

(a) Outdoor Cable Service Loops: In-line splice enclosures installed outdoors and mounted on the utility towers, shall be installed with sufficient fibre optic cable service loops such that the recommended minimum bend radius is maintained while allowing for installation or maintenance of the cable to be performed in a controlled environment at ground level.

(b) Indoor Cable Service Loops: FODPs shall provide at least three (3) metres of cable service loop. Service loops shall be neatly secured and stored, coiled such that the minimum recommended bend radius' are maintained.

(c) Fibre Units Service Loops: For all fibre optic cable splicing, the cable shall be stripped back a sufficient length such that the fan-out of fibre units shall provide for at least one (1) metre of fibre unit service loop between the stripped cable and the bare fibre fan-out.

(d) Pigtail Service Loops : Connectorised pigtails spliced to bare fibres shall provide at least 1 metre of service loop installed in the FODP fibre organizer and at least one (1) metre of service loop to the couplings neatly stored behind the FODP coupling panels.

(e) Fibre Service Loops : At least 0.5 metre of bare fibre service loop shall be provided on each side of all fibre splices. The bare fibre service loops shall be neatly and safely installed inside covered splice trays.

2.1.8 Methodology for Installation and Termination

All optical fibre cable termination, installation, stringing and handling plans, guides and procedures, and engineering analysis (e.g. tension, sag, vibration etc.) shall be submitted to OPTCL for review and approval in the engineering/design phase of the project, prior to establishing the final cable lengths for manufacture. Installation procedures including details of personnel and time required shall be documented in detail and submitted to OPTCL for approval. All installation practices shall be field proven and ISO accredited.

All cable segments shall include service loops as specified in this specification .The maximum allowable stringing tension, maximum allowable torsional shear stress, crush strength and other physical parameters of the cable shall not be exceeded. The preventative measures to be taken shall be documented in detail and submitted to OPTCL in advance of installation.

Optical fibre attenuation shall be measured after installation and before splicing. Any increase in attenuation or step discontinuity in attenuation shall not be acceptable and shall constitute a cable segment failure. In the event of cable damage or any fibre damage, the complete section (tension location to tension location) shall be replaced as mid-span joints are not acceptable.

Any or all additional steel work or modifications required to attach the fibre cabling to the overhead transmission/ distribution line towers shall also be carried out by the Contractor. It shall be the Contractors responsibility to provide adequate

communications among all crew members and support staff to ensure safe and successful installations

2.1.9 Cable Raceways

To the extent possible, existing cable raceways shall be utilised. The Contractor is required to provide and install any additional indoor cable raceways which may be required for proper implementation of the fibre optic cabling system. This requirement shall be finalised during survey. The cable raceways shall conform to the following:

(a) All cable raceways shall be sized to support full loading requirements plus at least a 200% safety loading factor.

(b) Indoor cable raceways shall be fabricated from construction grade aluminum, galvanized iron or anodized sheet metal or any other suitable material approved by OPTCL. Suitable anti-corrosion measures shall be provided. Steel fabricated raceways shall be finished inside and out, treated to resist rust and to form a metal-to- paint bond.

(c) Mechanical construction drawings of the cable raceways shall be submitted for OPTCL's information & review.

2.0 Inspection & Testing Requirement

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

Except where otherwise specified, the Contractor shall provide all manpower and materials for tests, including testing facilities, logistics, power and instrumentation, and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory, production tests and other test during manufacture specified herein shall be treated as included in the quoted unit price of materials including the expenses of Inspector/Employer's representative as per clause-41 of ITB..

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

3.1 Testing Requirements

Following are the requirements of testing :

1. Type Testing
2. Factory Acceptance Testing
3. Site Acceptance Testing

3.1.1 Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

(a) All cable & equipment being supplied shall conform to type tests as per technical specification.

(b) The test reports submitted shall be of the tests conducted within last seven (7) years for OPGW cable prior to the date of proposal/offer submitted. In case the test reports are older than seven (7) years for OPGW cable on the date of proposal/offer, the Contractor shall repeat these tests at no extra cost to the Employer.

(c) The Contractor shall submit, within 30 days of Contract Award, copies of test reports for all of the Type Tests that are specified in the specifications and that have previously (before Contract award) been performed. These reports may be accepted by the Employer only if they apply to materials and equipment that are essentially identical to those due to be delivered under the Contract and only if test procedures and parameter values are identical to those specified in this specifications carried out at accredited labs and witnessed by third party / customer’s representatives.

In the event of any discrepancy in the test reports or any type tests not carried out, same shall be carried out by Contractor without any additional cost implication to the Employer.

In case the Type Test is required to be carried out, then following shall be applicable:-

(d) Type Tests shall be certified or performed by reputed laboratories using material and equipment data sheets and test procedures that have been approved by the Employer. The test procedures shall be formatted as defined in the technical specifications and shall include a complete list of the applicable reference standards and submitted for Employer approval at least four (4) weeks before commencement of test(s). The Contractor shall provide the Employer at least 30 days written notice of the planned commencement of each type test.

(e) The Contractor shall provide a detailed schedule for performing all specified type tests. These tests shall be performed in the presence of a representative of the Employer.

(f) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

(g) In case of failure during any type test, the Supplier is either required to manufacture a fresh sample lot and repeat all type tests successfully or repeat that particular type test(s) at least three times successfully on the samples selected from the already manufactured lot at his own expenses. In case a fresh lot is manufactured for testing then the lot already manufactured shall be rejected.

3.1.2 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. For optical fibres/ Fibre Optic cables, at least three reels/ drums of each type of fibre/cable proposed shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection. For Splice enclosures at least three samples shall be offered for selection.

3.1.3 List of Type Tests

The type testing shall be conducted on the following items

(a) Optical fibres
(b) OPGW Cable
(c) OPGW Cable fittings
(d) Vibration Damper
(e) Splice Enclosure (Joint Box)
(f) Approach Cable

3.1.3.1 Type Tests for Optical Fibres

The type tests listed below in table 2-1 shall be conducted on DWSM fibres to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

Table 3-1
Type Tests For Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	As per Section-01 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with	As per Section-01 of TS	IEC 60793-1-40
3	Attenuation at Water Peak		IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)	As per Section-01 of TS	IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation With Bending (Bend Performance)	As per Section-01 of TS	IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.	As per Section-01 of TS	IEC 60793-1-45 Or EIA/TIA 455- 164A/167A/174
7	Chromatic Dispersion	As per Section-01 of TS	IEC 60793-1-42 Or EIA/TIA 455- 168A/169A/175A
8	Cladding Diameter	As per Section-01 of TS	IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of attenuation	As per Section-01 of TS	IEC 60793-1-40 Or EIA/TIA 455-59
10	Core -Clad concentricity error	As per Section-01 of TS	IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing	As per Section-01 of TS	IEC 60793-1-30 Or EIA/TIA 455-31B

3.1.3.2 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in Table 2-2 Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 3-2
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure	
1	Water Ingress Test	IEEE 1138-2009	IEEE 1138-2009 (IEC 60794-1-2 Method F5 or EIA/TIA 455-82B)	
			: Test duration : 24 hours	
2	Seepage of filling compound	IEEE 1138-2009	IEEE 1138-2009 (EIA/TIA 455-81B)	Preconditioning period:72 hours. Test duration: 24 hours.
3	Short Circuit Test	IEEE 1138-2009	IEEE 1138-2009	Fibre attenuationshall be continuously monitored and recorded througha digital data logging system or equivalent means. A suitable temperature sensor such as thermocouple shall be used to monitor and record the temperature inside the OPGW tube in addition to monitoring & recording the temperatures between the strands and between optical tube and the strand as required by IEEE 1138. Test shall be conducted with the tension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
		Or IEC60794-4-10 / IEC 60794-1-2 (2003) Method H1		Initial temperature during the test shall be greater than or equal to ambient field temperature.
4	Aeolian Vibration Test	IEEE 1138-2009 Or IEC60794-4-10 / IEC 60794 -1-2, Method E19	IEEE 1138-2009	Fibre attenuationshall be continuously monitored and recorded througha digital data logging system or equivalent means. The vibration frequency and amplitude shall be monitored and recorded continuously. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring. Test shall be conducted with

Table 3-2
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure	
				the tension/suspension clamps proposedto be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
5	Galloping test	IEEE 1138-2009	IEEE 1138-2009	Test shall be conducted with the tension/suspension clamps proposedto be supplied. The cable and clamps shall be visually inspected for mechanical damage and photographed after the test. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
6	Cable Bend Test	Procedure 2 in IEC 60794-1-2 Method E11		The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC 60794-1-2 E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking and crimping.
7	Sheave Test	IEEE 1138-2009 OR IEC 60794-1-2 (2003) Method E1B	IEEE 1138-2009	Fibre attenuationshall be continuously monitored and recorded through a digital data loggingsystem or equivalent means. The Sheave dia. shall be based on the pulling angle and the minimum pulley dia employed during installation. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
8	Crush Test	IEEE 1138-2009	IEEE 1138-2009	The crush test shall be carried out on a sample of

Table 3-2
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure	
			(IEC 60794-1-2, Method E3/ EIA/TIA 455-41B)	approximately one (1) metre long in accordance with IEC 60794-1-2 E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results.
9	Impact Test	IEEE 1138-2009	IEEE 1138-2009, (IEC 60794-1-2 E4/ EIA/TIA 455-25B)	The impact test shall be carried out in accordance with IEC 60794-1-2 E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporaryincrease in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure.
10	Creep Test	IEEE 1138-2009	IEEE 1138-2009	As per Aluminium Association Method, the best-fit straight line shall be fitted to the recorded creep data and shall be extrapolated to 25 years. The strain margin of the cable at the end of 25 years shall be calculated. The time when the creep shall achieve the strain marginlimits shall also be calculated.
11	Fibre Strain Test	IEEE 1138-1994	IEEE 1138-1994	

Table 3-2
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
12	Strain Margin Test	IEEE 1138-2009	IEEE 1138-2009
13	Stress strain Test	IEEE 1138-2009	IEEE 1138-2009
14	Cable Cut-off wavelength Test	IEEE 1138-1994	IEEE 1138-1994
15	Temperature Cycling Test	IEEE 1138-2009	IEEE 1138-2009 Or IEC 60794-1-2, Method F1
16	Corrosion (Salt Spray) Test	EIA/TIA 455-16A	
17	Tensile Performance Test	IEC 60794-1-2 E1 / EIA/TIA 455-33B	The test shall be conducted on a sample of sufficient length in accordance with IEC 60794-1-2 E1. The attenuation variation shall not exceed 0.05 dB/Km up to 90% of RTS of fibre optic cable. The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached and the value recorded.
18	Lightning Test	IEC 60794-4-10 / IEC 60794-1-2 (2003)	The OPGW cable construction shall be tested in accordance with IEC 60794-1-2, Method H2 for Class 1.
19	DC Resistance	On a fibre optic cable sample of minimum 1 metre length, two contact clamps shall be fixed with a predetermined bolt torque. The	

Table 3-2
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
	Test (IEC 60228)	resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20°C.	
-End Of Table-			

3.1.3.3 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed below:

(i) Mechanical Strength Test for Suspension/Tension Assembly
Applicable Standards: IEC 61284, 1997.

Suspension Assembly

The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:
The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed 16^{o}. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

Part 2:
The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Tension Assembly

The Tension Assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:

The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased at a constant rate and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then remove in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made and any evidence of visual deformation shall be documented.

Part 2:

The Tension Dead-End and associated components shall then be reassembled and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of Part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during Part 2 of the Test.

Any result outside these parameters shall constitute a failure.

(ii) Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps. Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative positions between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 17 kN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions are met:

- No slippage* shall occur at or below the specified minimum slip load.

  * Definition of no slippage in accordance with IEC 61284, 1997:- Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

- Slippage shall occur between the specified maximum and minimum slip load of 12 - 17 kN.

- There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.

- The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be considered as slip.

- The Armour Rods shall not be displaced from their original lay or damaged**.

  ** Definition of no damage in accordance with convention expressed in IEC 61284: 1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

(iii) Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on an 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load shall gradually be applied up to 20 % of the RTS of OPGW. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead -End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.

* Definition of no movement as defined in IEC 61284: Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure.

(iv) Grounding Clamp and Structure Mounting Clamp Fit Test

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kgm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also the fibre optic cable shall be checked to ensure free movement within the core using dial callipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

(v) Structure Mounting Clamp Strength Test

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

3.1.3.4 Type Test on Vibration Damper

The testing standard of vibration damper for OPGW shall be as per applicable international standard i.e. IEC 61897.

(a) Dynamic Characteristic Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band ranging from 0.18/d to 1.4/d – where d is the OPGW cable diameter in meters. The damper assembly shall be vibrated vertically with a ±1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

(i) Force Vs frequency

(ii) Phase angle Vs frequency

(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

Acceptance criteria for vibration damper:

(i) The above dynamic characteristics test on five damper shall be conducted.

(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.

(iii) The above mean reactance response curve should lie within following limits:

V.D. for OPGW - 0.060 f to 0.357 f kgf/mm*

Where f is frequency in Hz.

(iv) The above mean phase angle response curve shall be between 25^{o} to 130^{o} within the frequency range of interest.

(v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.

(vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

(i) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as 25% of RTS of fibre optic cable for a span ranging from 100 m to 1100 m.

(ii) The self damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.

(iii) The power dissipation curve obtained from Damper Characteristics Test shall be used for analysis with damper.

(iv) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.

(v) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

(vi) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

(c) Fatigue Tests

(i) Test Set Up

The fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 25% of RTS of fibre optic cable and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ±25/f mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

(1) There shall not be any resonant frequency shift before and after the test by more than ± 20%

(2) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than ± 20%

Beside above tests, the type tests listed below in the table shall also be conducted on Vibration Damper

Sl No.	**Test Name**	**Test Procedure**
1	Visual examination & Dimensional and material verification	IEC 61897 Clause 7.1 & 7.2
2	Clamp Slip test	IEC 61897 Clause 7.5
3	Clamp bolt tightening test	IEC 61897 Clause 7.7
4	Attachments of weights to messenger cable	IEC 61897 Clause 7.8
5	Attachment of clamps to messenger cable	IEC 61897 Clause 7.8
6	Damper effectiveness evaluation	IEC 61897 Clause 7.11.3.2

3.1.3.5 Type Tests for Splice Enclosures (Joint Box)

Following Type tests shall be demonstrated on the Splice Enclosure(s) (Splice Enclosure/Box). For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 or IEC 60794-1 procedures).

(i) Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of -40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20 / IEC 60794-1-C10. The variation in attenuation shall be less than ±0.05dB. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

(ii) Humid Heat test

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the internal humidity rate measured, less than 2%.

(iii) Rain Withstand Test / Water Immersion test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be subjected to 24 hours of simulated rain in accordance with IEC 60060 testing requirements. No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

(iv) Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrations on two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the vibrations' axes. The variation in attenuation, of the fibres, shall be less than ±0.05dB. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO cable at the entry point.

(v) Bending and Torsion test

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

a) 3 torsion cycles of ±180° shall be exercised on the cable. Each cycle shall be less than one minute.

b) 3 flexure cycles of the cable, of ±180° with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ±0.05dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly. No defects/fissures shall be noted on the joint ring or on the splice enclosure

(vi) Tensile test

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

(vii) Drop Test

With 2 lengths of 11 metres of cable fixed to the box, it shall be dropped five times from a height of 10 metres. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test surface shall be carried out in accordance with IEC 60068-2-32.

3.1.3.6 Type Tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in Table 2-3: Type Tests for Fibre Optic Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 3-3:
Type Tests Fibre Optic Approach Cable

S.NO.	Test Name	Test Procedure
1	Water Ingress Test	(IEC 60794-1-F5 / EIA 455-82B) Test duration : 24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning : 72 hours, Test duration : 24 hours.
3	Crush Test	(IEC 60794-1-E3/ EIA 455-41)
4	Impact Test	(IEC-60794-1-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength Test	(EIA 455-170)

Table 3-3:
Type Tests Fibre Optic Approach Cable

S.NO.	Test Name	Test Procedure
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A) – 2 cycles

-End Of Table-

3.1.3.6.1 Impact Test

The Impact test shall be carried out in accordance with IEC:60794-1-E4. Five separate impacts of 2.0 kg shall be applied at different locations. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.05 dB/km shall constitute failure.

3.2 Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on OPGW Cable and associated hardware & fittings, Approach Cable, Joint Box, FODP etc. and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued Material Inspection & Clearance Certificate (MICC). Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorised representatives unless waiver for witnessing by Employer’s representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.

The factory acceptance tests for the supplied items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces etc.

For Test equipment FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer’s final inspection certificate/ report.

3.2.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected.

For the OPGW cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, Joint box and other similar items.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

3.2.2 Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), alongwith information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

3.2.3 Factory Acceptance Tests on Optical Fibre to be supplied with OPGW

The factory acceptance tests listed in table below are applicable for the Optical fibres to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138/IEC 60794. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above mentioned IEEE standards unless specified otherwise in the technical specifications.

Table 3-4
Factory Acceptance Tests for Optical Fibres: Optical Tests

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	T S,Table 1-1(a)	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation	TS, Section 1.1.2	EIA/TIA 455-59
3	Attenuation at Water Peak	TS ,Table 2-1(a)	EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B
-End of table-			

The test report for the above tests for the fibers carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

3.2.4 Factory Acceptance Test on OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table follow the requirements set forth in IEEE standard 1138 / IEC 60794. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one sample in each lot.

Table 3-5
Factory Acceptance Tests on OPGW
Applicable standard: IEEE 1138 / IEC 60794

S. No.	Factory Acceptance Test on Manufactured OPGW
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Rated Tensile Strength
5	Lay Length Measurements

3.2.5 Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table 2-6. The sampling plan shall be as per relevant standard:

Table 3-6
Factory Acceptance Tests On OPGW Fittings

S. No.	Factory Acceptance Test
Suspension Assembly	
1	UTS/Mechanical Strength of the assembly
2	Clamp Slip Test
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Mechanical strength of each component
5	Galvanising test
Tension Assembly	
6	Clamp Slip Strength test
7	Visual Material verification and dimensional checks as per approved DRS/Drawings
8	Mechanical strength of each component
	Galvanising Test
Vibration Damper	
10	Galvanising test on damper, masses and messenger wires
11	Damper response (resonant frequencies)
12	Clamp Slip test
13	Strength of messenger wires
14	Attachments of weights to messenger cable
15	Attachments of clamps to messenger cable
16	Clamp bolt tightening test
17	Clamp bolt torque test
18	Dynamic characteristic test.
19	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	

Table 3-6
Factory Acceptance Tests On OPGW Fittings

S. No.	Factory Acceptance Test
20	Clamp fit test
21	Clamp Strength test
22	Visual Material verification and dimensional checks as per approved DRS/Drawings
End of Table	

3.2.6 Factory Acceptance Test on Approach Cable

The factory acceptance tests for Approach Cable specified below in Table 2-7:

Table 3-7
Factory Acceptance Tests On Approach Cable

S. No.	Factory Acceptance Test
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings

3.2.7 Factory Acceptance Test on Splice Enclosure (Joint Box) /FODP

The factory acceptance tests for Splice Enclosures/FODP as specified below in Table: 2-8

Table 3-8
Factory Acceptance Tests on Splice Enclosures (Joint Box)/FODP

S. No.	Factory Acceptance Test
1	Visual check of Quantities and Specific Component Number for each component of Splice Enclosure/FODP and dimensional checks against the approved drawings.

3.2.8 Factory Acceptance Test on Test Equipment & other items

As per technical specification and approved DRS/Documents.

3.3 Site Acceptance Tests

The Contractor shall be responsible for the submission of all material & test equipment supplied in this contract for site tests and inspection as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for FO cable etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for FO installation.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

3.3.1 Minimum Site Acceptance Testing Requirement for FO Cabling

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

3.3.1.1 Phases of Site Acceptance Testing

SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links.

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment for SAT shall be called Pre-SAT activities. The Pre-SAT activities shall be described in the installation manuals and Field Quality Plan documents.

Sag and tension of OPGW shall generally be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Table 2-9(a) through 2-9(c) below:

Table 3-9(a)
Fibre Optic Cable Pre-Installation Testing

Item:	Description:
1.	Physical Inspection of the cable assembly for damage
2.	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm
3.	Fibre Optic Cable length measurement using OTDR

Table 3-9(b)
Fibre Optic Cable Splicing Testing

Item:	Description:
1.	Per splice bi-directional average attenuation with OTDR
2.	Physical inspection of splice box/enclosure for proper fibre / cable routing techniques
3.	Physical inspection of sealing techniques, weatherproofing, etc.

Table 3-9(c)
Fibre Optic Cable Commissioning Testing

Item:	Description:
1.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR.
2.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter.
3.	Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also).
4.	Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan.
-End of Table-	

GUARANTEED TECHNICAL PARTICULARS OF OPGW CABLE & HARDWARE ACCESSORIES

Sl.No.	Description.	Technical Particulars
1.	Make & Model	
2.	No. of Fibres in OPGW	24
3.	Mode	DW-SM
4.	Buffer type	Loose
5.	Buffer tube diameter	2.2mm
6.	Buffer tube material	PBT
7.	No. of buffer tubes	4
8.	No. of fibres per tube	6
9.	Identification/numbering of individual tubes	Red, green blue and natural.
10.	No.of empty tubes (if any)	1
11.	Filling material	Moisture proof & Hydrogen adherent jelly.
12.	Strength members	1
13.	Binding yarn/tape	Tapes
14.	(i)10% Aluminium clad steel wire (ii)20.3% IACS	(i) 2.25mm (Dia) & 12 Nos. (ii) 2.6 mm (Dia) & 11 Nos. (iii) Other design meeting to the electrical & mechanical parameters as per detail technical specification.
15.	Aluminium alloy wires (Diameter & Number)	2.25mm & 3 Nos.
16.	Aluminium tube diameter	Design dimensional parameters of OPGW should meet the SAG-Tension criteria as enclosed at **Appendix-A**
17.	Approximate outside diameter	
18.	Cable diameter	
19.	Cable cross section area	
20.	Min. Breaking load/ Ultimate Tensile Strength	82.10kN
21.	Fibre Strain margin	0.6%
22.	Weight Kgs/Km	488 kgs/km
23	Crush strength	1000kg with a 10cm^2 piste
24.	Modulus of Elasticity	135.8kN/mm^2
25.	Minimum bending radius	300mm
26.	Maximum bending radius	Short term 300mm Long term 400mm
27.	Maximum permissible tensile stress	-
28.	Permissible CTS Tensile stress	0.669kN/- mm^2
29.	Coefficient of inner expansion	15.3 X 10^{-6} per ^{0}C
30	Coefficient expansion Cladding Core	6.3 X 10^{-6} per ^{0}C
31	Nominal operating temperature range	-10 ^{0}C to 70 ^{0}C
32	SC current transient peak temperature	41 KA
33	Maximum allowable temperature for lightning strike	200
34	Available length of cable per drum:	

	Min Max	2500 mtrs 3500 mtrs or as per site requirement.
35	Splice loss (Min. & Max. Allowable)	0.05 dB. 0.01 dB
36	Operating Temperature range-	-10 ^{0}C to 70 ^{0}C
37	Expected Cable Life	25 years.
38.	Fibre production method	-
39.	Core diameter.	9.2 +/-0.5 µm
40	Core non circularity	-
41.	Cladding diameter	125+/-0.5 µm
42	Core Clad Concentricity Error	< 1 µm
43	Cladding non circularity	< 2%
44	Protective coating type & material Primary Secondary.	 Acrylate PBT
45	Protective coating Diameter	-
46	Coating concentricity	>70%
47	Colour Coding scheme compliant with EIA 395/IEC3047	
48	Attenuation Coefficient @ 1310nm – @1559nm-	 .36 dB/km .22 dB/km
50	Mode field non Circularity	< 2%
51	Romatic Dispersion 1310 nm 1550 nm	 2.8 ps/ (n.km) 18 ps/(nm.km)

3.TECHNICAL SPECIFICATION

OPTIC FIBRE EQUIPMENT AND NETWORK CONFIGURATION

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OPTIC FIBRE EQUIPMENT AND NETWORK CONFIGURATION

Introduction

This section describes the Fibre Optic Communication network configuration and the equipment characteristics for communication system to be installed under the project. The sub-systems addressed within this section are:

(1) Fibre Optic Transmission System (FOTS)

Termination Equipment Subsystems
Network Management System (NMS)
MDF, DDF and Cabling

The requirements described herein are applicable to and in support of network configurations depicted in **Annexure-II** and Network Management System (NMS) for monitoring and control of this communication network. TMN and NMS have been interchangeably used in this specification.

General Network Characteristics

Description

The proposed fibre optic communication network shall support the voice & data communication requirements of RTUs and the SCADA/EMS system. The communication system shall provide data & voice connectivity across the various locations or connectivity of RTUs with Control Centres. The RTUs located at various locations will report to Control Center using IEC 60870-5-101 or IEC 60870-5-104 Protocol. The proposed communication system shall provide connectivity of some RTUs over TCP/IP protocol using Ethernet interface and other RTUs over serial interface.

The fibre optic network shall be based on Synchronous Digital Hierarchy (SDH) i.e. STM-4. However, the offered equipment can be upgraded to STM-16 by changing the optical card only. The Contractor can propose a system based on higher bit rate systems, if required, so as to meet the link budget requirements or any other specification requirement. The detailed BOQ is described in **Annexure-V(A-C).**

Functional Requirement

The primary function of the communication network is to provide a highly reliable voice and data communication system in support of the SCADA/EMS. The communications support requirement for SCADA/EMS system is for low & high speed data, express voice circuits and administrative voice circuits as defined in appendices. A brief summary of the communication system requirements is as follows:

(a) High speed E1 channel support

(b) 64kbps & nx64kbps data channel support

(c) Low speed (300 -1200 bps) data channel support

(d) Voice (2 wires, 4 wires) channel support.

(e) Data transport supporting Network Management channels

The connectivity envisaged between RTUs and Control Centre is Wide Area Network (WAN) on TCP-IP using IEC 60870-5-104 protocol and IEC 60870-5-101 protocol.

General Systems Requirements

Required characteristics are defined and specified herein at the system level, subsystem level, and equipment level.

3.2.3.1 System Synchronization

The Contractor shall synchonize all the equipments under the contract using Master clock (PRC). The Contractor shall provide the GPS based clock. In addition to GPS input reference, the synchronization clock must have provision to take INPUT reference coming from other clock. The contractor shall submit the synchronisation plan as per standard ITU-T G.811. All sync equipments proposed under this contract should meet ITU-T G.811 criterion. The holdover quality of clock shall meet ITU-T G.812 standard requirements.

The Contractor shall provide system wide synchronization fully distributed throughout the telecom network and connected to all equipments. The Contractor shall submit the synchronization plan for the entire network meeting the requirement of ITU-T G.803.

The system equipment requiring “clock” shall be connected to the master clock using external clocking. For this purpose, appropriate interfaces(s) in the transmission & termination equipment being supplied and all other associated hardware shall be provided by the Contractor.

3.2.3.2 System Maintainability

To facilitate performance trending, efficient diagnosis and corrective resolution, the system shall permit in-service diagnostic testing to be executed both locally and from remote locations, manually and/or initiated under TMN control. Such testing shall not affect the functional operation of the system.

Preventive and problem oriented maintenance of the communications system shall be performed using diagnostics tools such as TMN and test equipment. They shall support complete maintenance of all system elements and shall permit the diagnosis of any fault without requiring additional test equipment. The Contractor shall provide specialized training required to operate above mentioned diagnostic tools. For all redundant systems, disconnection and repair of any failed device shall not interrupt the operation of the system.

3.2.3.3 System Upgradeability and Expandability

Equipment supplied shall be sized (though not necessarily equipped) to support system/ subsystem expansion to full capacity as provided by specified aggregate transmission rates. Equipment units provisioned for equipped subunits shall be terminated at appropriate patching facilities or termination blocks. Power supplies and TMN shall be sized for maximum equipped system capacity.

3.2.3.4 Equipment Availability

The availability requirements are as follows, which shall be demonstrated at site for the equipments being provided under this contract:

The availability of each fibre optic link (E1 to E1) shall be at least 99.999%.
The availability of network end to end (E1 to E1) shall be at least 99.998%.
(3) The average per link subscriber to subscriber availability shall be at least 99.97%. The per link subscriber to subscriber availability is defined as the availability between any two data or voice subscribers between RTU to reporting Control Centre.
(4) The network-wide subscriber to subscriber availability shall be atleast 99.8% .The network-wide subscriber to subscriber availability is defined as the availability between any two data or voice subscribers on the wideband network.

The calculated availability is defined as the theoretical availability determined by a statistical calculation based on the mean-time-between-failure (MTBF) and the mean-time-to-repair (MTTR) of the components and subsystems comprising the

FOTS. The down time of the fibre optic cable shall not be considered in the aforesaid availability calculations.

In order to ensure that the equipment & configuration proposed by the bidders shall be capable of demonstrating the specified availability figures it is required that the Bidders shall include in their proposal a calculated availability analysis for the proposed equipment/ sub system. The calculated failure rates of the units and the calculated availabilities of the equipment being offered shall be provided in the proposal. The analysis shall be based on an availability block diagram and shall include the mean-time-between failure (MTBF) and mean-time-to-repair (MTTR) of all of the components on the link. The Contractor shall indicate in the analysis the MTBF and MTTR and the resulting availability of each point-to-point link. For this analysis, an MTTR of at least 4 hours shall be assumed.

3.2.4 General Equipment Characteristics

All Contractor supplied equipment shall be new and of the finest production quality. OPTCL will not accept modules or printed-circuit boards that are modified by appending wires or components. Wired strapping options shall be incorporated in the board design to meet the above requirement.

All applicable requirements stated in this section shall equally apply to the TMN equipment as specified in this Section.

3.2.4.1 Revision Levels and Modifications

All hardware, firmware and software delivered as part of the communications network shall be field proven and at the most of current revision level. All modifications and changes necessary to meet this requirement shall be completed prior to the start of the factory tests or under special circumstances, on written approval by OPTCL, prior to the completion of SAT.

All field modifications of the hardware, firmware and software that is required to meet installation and/or performance specifications, shall be fully documented as part of the deliverables, both as a separate field modifications record and as corrected equipment/configuration documentation.

3.2.4.2 Equipment Capacities

Equipment supplied shall be sized and equipped with sufficient capacity to support BoQ and configuration requirements as identified in the Annexure-3(A-B) . Each subsystem supplied shall be sized (to be equipped as specified) to support full subsystem expansion.

Data communications channelization required to support the TMN subsystems specified in Technical Specifications (TS) are not identified in the appendices. Therefore, the Contractor is required to size and equip the system to include all channelization and channel cards required to support the TMN function.

3.2.4.3 Redundancy Requirements and Protection Schemes

Equipment redundancy and Automatic Protection Schemes (APS) are specified in the **Table 2-1.** The failure of one element shall not prevent the use of any other that has not failed.

Table 2-1

Equipment Redundancy Requirements Summary

Fiber Optic transmission Equipment :	
SDH equipment	
Power Supply & Converters ----------	1:1 APS or distributed power supply
	1:1 APS
Common Control* Cards ----------	
DACS (Cross Connect)	1:1 APS or distributed power supply
Power Supply ----------	1:1 APS
Common control* cards----------	1:1 APS or distributed power supply
MUX, DROP/INSERT	
Power Supply ----------	
*** = Common control cards which are essentially required for operation of the equipment.**	

The offered equipment shall support at least SNCP **as per standard ITU-T G.841**. In case the equipment offered by the Bidder does not support the above mentioned minimum protection methods, the bidder shall have to provide all additional equipment needed to provide same level of flexibility, redundancy and functionality at no additional cost to OPTCL. The bidders shall provide details of protection schemes supported in the Bid document.

The offered equipment shall support automatic switchover function between the redundant modules and all required modules and hardware to support the automatic switch over shall be provided by the Contractor.

3.2.4.4 Lost Signal Recovery

At any digital signal level, reapplication of a lost signal shall result in automatic resynchronization and full restoration to normal operation without manual intervention. All alarms incident to the signal failure, shall be automatically cleared at the equipment, rack and monitoring levels and normal operation indications restored and reported if applicable.

3.2.4.5 Equipment Lifespan

All equipment supplied shall have a minimum expected life of fifteen (15) years. from the date of operational acceptance.

3.2.4.6 General Site Considerations

All fiber optic links up to 250 kms transmission line route length shall be implemented by the Contractor without repeaters. In order to meet the link budget requirement, the Contractor shall provide all the necessary equipment only in the end stations. The contractor may provide the optical amplifier, wave length translator, optical cards or high capacity SDH equipment with suitable rack/sub-rack to meet the maximum distance limit. All the provided equipment shall be monitored by centralized NMS which is already in operation at SLDC.

3.2.5 Fibre Optic Link Lengths

The fiber optic route lengths are as specified in **Annexure- IA & IB.** The lengths specified in appendices are the transmission line route lengths; however the actual fiber cable length shall exceed the route lengths on account of extra cable

requirement due to upcoming LILO sub-stations , sag, jointing & splicing, approach cabling etc. For bidding purposes the Contractor may assume an additional cable length of 5% of given route length **+** 1Km towards approach cable for calculating the link length. The exact cable lengths shall be determined by the Fibre Optic cable package Contractor during the survey. The same shall be forwarded to this package Contractor for final link design during the detailed engineering of the project. In case of change in the specified BoQ, the contract price shall be adjusted accordingly.

Fibre Optic Transmission System

The Fibre Optic Transmission System (FOTS) is defined herein to include ETSI digital optical line termination equipment. The FOTS shall be based on SDH technology. Minimum aggregate bit rate shall be STM-4 and equipped with minimum 2 nos. of 16 port E1 interface(G.703) card & one no. of minimum 4 port Ethernet interface (IEEE 802.3/IEEE 802.3u) card supporting layer 2 switching as tributaries. The Ethernet interfaces shall support VLAN (IEEE 802.1P/Q), spanning tree (IEEE 802.1D) quality of service.

The Contractor shall provide (supply and install) connectorised jumpers (patch cords) for FODP-to-equipment and equipment-to-equipment connection. Two number spare jumpers shall be provided for each equipment connection. Fiber jumpers shall be of sufficient lengths as to provide at least 0.5m of service loop when connected for their intended purpose.

3.3.1 SDH Equipment

2.3.1.1Functional Requirement

The BOQ is provided in the **Annexure-V(A) & Annexure-V(B).** For the purpose of BOQ, the SDH Equipment is considered to be divided in three parts i.e. Optical cards (Line), Tributary Cards (Electrical tributaries such as E1 & Ethernet 10/100 Mbps) and Base Equipment (Consisting of Common Cards, Power supply cards, sub-rack, cabinet, other hardware and accessories required for installation of equipment i.e. everything besides optical cards and tributary cards).

The offered SDH equipment shall be upgradeable to STM-16 by changing optical line cards only. Cross connection (VC4) capability of offered SDH equipment shall be provided according to STM-4 equipment. The contractor shall demonstrate the STM 4 to STM 16 upgradeability during FAT.

SDH ADM

The aggregate interfaces shall be (at least) STM-4 (622 Mbit/s) towards at least 3 directions (Protected as specified in this specifications). At present the equipment shall be equipped with a 2 nos., min.16 E-1 port electrical tributary cards & one no., min.4 port Ethernet interface card as tributaries. The Equipment shall provide access to full STM4 payload.

3.3.1.2 Redundancy and Protection

Two fibre rings shall be implemented wherever the network permits. On linear sections of the network, protected links using 4 fibres shall be implemented.

3.3.1.3 Service Channel

Service channels shall be provided as a function of the SDH equipment and shall be equipped with Service Channel that shall provide at a minimum: One voice channel (order wire) with analog interface (0.3 to 3.4 kHz) and one data channel. Both omnibus and selective calling facilities shall be provided. There shall be a facility to extend the line system order-wire to any other system or exchange lines on 2W/4W basis.

3.3.1.4 Supervision and Alarms

ISM (In Service Monitoring) circuitry shall be provided as a function of the SDH equipment. Local visual alarm indicators shall be provided on the equipment, as a rack summary alarm panel. Alarms shall be as per ITU-T Standards G.774, G.783 and G.784. Additionally, F2/Q2 interfaces for a local craftsperson terminal interface and remote equipment monitoring is required.

The Equipment shall support collection of at least four (4) external alarms for monitoring and control of station associated devices by the TMN.

3.3.1.5 Synchronisation

The equipment shall provide synchronisation as per Table 2-2. One 2MHz synchronisation output from each equipment shall be provided.

3.3.1.6 Electrical and Optical I/O Characteristics and General Parameters

Table 2-2 provides the electrical and optical characteristics as well as other general parameters for SDH equipment.

Table 2-2
Electrical and Optical I/O Characteristics and General Parameters

Optical Wavelength NOTE (1)	1310/1550nm
Optical Source NOTE (2)	Laser
Optical Source Lifespan	Better than 5 X10^5 hours
Optical Fibre Type	G.652 D

Optical Connectors	Type FC-PC
Transmission Quality	Per ITU-T G.821, G.823, G.826
Source Primary Power	-48 Vdc
Equipment Specifications	Per ITU-T G.783
Tributary, Electrical Interface	Per ITU-T G.703, 75 Ω
Ethernet Interface	10/100 Mbps
SDH Bit Rates	Per ITU-T G.703
Optical Interfaces	Per ITU-T G.957, G.958
Frame and Multiplexing Structure for SDH	Per ITU-T G.707
Synchronization	Per ITU-T G.813
Management Functions	Per ITU-T G.774, G.784
Protection Architectures	Per ITU-T G.841
Built In Testing and Alarms	Per ITU-T G.774, G.783, G.784

NOTE

(1) Optical wavelength shall be selected considering the characteristics of the optical fibre and the link budget.

NOTE (2) **Eye Safety for Laser Equipment:** To avoid eye damage, when a receiver detects a line interruption, it is required that the optical power of the laser shall be reduced to safe limits on the transmitter in the opposite direction as per ITU-T G.958.

NOTE (3) In case other than FC-PC connector is provided in the equipment, suitable patch cord with matching FC-PC connector are to be provided to connect with FODP.

3.3.2 Optical Link Performance Requirements

The optical fibre link performance requirements are specified as follows:

3.3.2.1 Link Budget Calculations

The fibre optic link budget calculations shall be calculated based upon the following criteria:

(1) Fibre attenuation: The fibre attenuation shall be taken to be the guaranteed maximum fibre attenuation i.e. 0.21 dB/Km @1550nm and 0.35 dB/km @1310nm.

(2) Splice loss: Minimum 0.05 dB per splice. One splice shall be considered for every 3 kms.

(3) Connector losses: Losses due to connectors shall be considered to be minimum 1.0 dB per link.

(4) Equipment Parameters: The equipment parameters to be considered for link budget calculations shall be the guaranteed “End of Life (EOL)” parameters. In case, the End of Life parameters are not specified for the SDH equipment, an End of Life Margin of at least 2 dB shall be considered and a similar margin shall be considered for optical amplifiers.

(5) Optical path Penalty: An optical path penalty of at least 1 dB shall be considered to account for total degradations due to reflections, inter symbol interference, mode partition noise and laser chirp.

(6) Maintenance Margin: A maintenance margin of at least 2.5 dB/100Km shall be kept towards cabling, repair splicing, cable ageing and temperature variations etc.

(7) Other losses: Other losses, if any required specifically for system to be supplied shall also be suitably considered.

(8) Dispersion: The fibre dispersion shall be taken to be the guaranteed maximum dispersion i.e. 18 ps/nm.Km @1550 nm & 3.5 ps/nm.km @ 1310 nm for DWSM fibres.

(9) Bit Error Rate: The link budget calculations shall be done for a BER of 10^{-10}.

The bidders shall determine the total link loss based on the above parameters and shall submit the system design (including link budget calculations) for each category of fibre optic link in the Bid.

For finalising the FOTS system design & BOQ, above methodology shall be adopted taking into account fibre attenuation, dispersion and splice loss determined during the detailed engineering. Accordingly, additions and deletions from the contract shall be carried out based on unit rates indicated in the contract.

3.3.2.2 Link Performance

The Link performance for ES, SES and BER for the fibre optic links shall correspond to National Network as defined in ITU-T G.826.

3.3.2.3 FODP to SDH Equipment Optical Amplifier Connectivity

The Contractor shall be responsible for connectivity between the FODP and the SDH equipment. The Contractor shall provide FC PC coupled patch cords. The location of FODP shall be finalized during detailed engineering.

The patch-cord length between the FODP & equipment rack shall be suitably protected from rodents, abrasion, crush or mechanical damage.

Termination Equipment Subsystem

The Termination Equipment Subsystem is defined to include the equipment that interfaces (adapts) the subscriber (user) to the Fibre Optic Transmission System (FOTS). A Functional description of these equipments are as follows:

3.4.1 Functional Description

The transmission network node provides subscriber interface to the transmission network and/or switching/routing. For clarity, the basic functions accomplished at the network nodal points, are described briefly as follows:

Primary Multiplexer shall be used to accomplish subscriber connectivity to the Digital Communication Network. Subscriber Line Units shall provide analog to digital and direct digital conversion to 64 Kbps digital channel. In the CEPT standard hierarchy, thirty (30) such 64 Kbps digital channels shall be Time Division Multiplexed (TDM) resulting in a single 2.048 Mbps (E-1) digital bit stream.

Digital Drop-Insert and Branching Equipment shall be used to digitally interface a small number of channels at spur locations without requiring successive D/A and A/D conversions of the throughput channels.

Digital Cross connect Equipment (DACS) shall be used to provide software controlled dynamic routing/rerouting of the primary (E-1) bit stream as well as the 30 channels of the E1 bit stream.

The equipment shall also have an interface for external 2048 kHz synchronisation signal according to ITU-T Recommendation G.703.

3.4.2 First Order (Primary) Multiplexing

The Contractor shall be required to provide E-1 Drop & Insert Multiplexer and E-1 Channel Bank primary multiplexing in compliance with the electrical input-output characteristics provided in **Table 2-3.**

3.4.2.1 Drop & Insert Primary Multiplexing

Drop & Insert primary multiplexing in conformance with CEPT E-1 characteristics shall be required at locations where the subscriber requirement is minimal. The drop and insertion of up to thirty 64 Kbps channels supporting subscriber line units (SLU) shall be required at intermediate locations. The Drop & Insert Muxes supplied shall be performance and card compatible with the Channel Bank Equipment provided so that all Subscriber Line Interface cards are interchangeable.

Table 2-3
CEPT E-1 Standard First Order Multiplexing
Electrical Input/Output Characteristics

Applicable Standards:	CEPT per CCITT Recommendation G.702, G.703, G.711 and G.712
Number of Tributaries:	30 X 64 Kbps
Alternative Sub-rate Tributaries:	n X 64 Kbps V.36 64Kb/s V.11/V.36
Output Aggregate Rate: **Interface Code:** **Impedance:** **Peak Level @ 120 ohm:** **Peak Level @ 75 ohm:** **Maximum Insertion Loss:**	2.048 Mb/s ± 50 ppm HDB3 75 ohm unbalanced 3.0 volts ± 10% 2.37 volts ± 10% 6 db
Signal Waveform: **Frame Structure:** **Jitter Performance:**	Per CCITT G.703 Per CCITT G.742 Per CCITT G.823

Table 2-3

CEPT E-1 Standard First Order Multiplexing

Electrical Input/Output Characteristics

Power Supply Voltage:	-48 Vdc

3.4.2.2 Channel Banks (Mux, Drop/Insert)

User voice and data equipment interfacing requirements are defined at the subscriber line level. Primary multiplexing in conformance with CEPT E-1 characteristics shall be used to provide first order multiplexing of up to thirty 64 Kbps channels supporting Subscriber Line Units (SLUs).

3.4.2.3 Subscriber Line Units\Subscriber Line Interface Cards

The terms Subscriber Line Interface Cards and Subscriber Line Units have been used interchangeably throughout the specification. Multiple configurations of SLUs shall be required to provide subscriber to primary multiplexer Bank interfacing for a variety of voice and data communications. In case there are changes in number or type of cards because of changes in channel requirements, the contract price shall be adjusted accordingly.

The SLU interface requirements are discussed in the following subparagraphs:

(A) Voice Channels

The voice channel requirement is for (I) 4-Wire E&M trunking in support of PABX trunks & PLCC VF and (II) 2-Wire telephonic interfaces. 2 wire SLUs shall be DTMF/TP optioned for 2-wire loop start or 2-wire GND start. The voice cards shall utilize ITU.T A - law companded PCM G.711, 64 kbits/s encoding. The voice card requirements are indicated in the BoQ in **Annexure-III(A) & Annexure-III(B)**

(B) Sub-Channel Data Multiplexing

For this Project, the RTU data interface to the wideband telecommunications network node shall be defined at the DTE level at low-speed rates of 300, 600 and 1200 baud. The port shall be compatible with RS232C interface. The Contractor shall be required to furnish 64 Kbps SLU asynchronous dataplexing for at least 4 selectable low speed DTE interfaces whenever multiple asynchronous data circuits are required.

(C) Synchronous Data

The Contractor shall provide a direct DTE interface for synchronous communications at speed of 64Kbps and compatible with CCITT G.703 Kbit/s, V.35 and X.21 interfaces. Data rate selection shall be switch selectable or programmable.

(D) Nx64 kbps Synchronous Data

There is also a requirement for N x 64 kbps V.35, X.21 interfaces. The tentative quantities have been identified in the **Annexure-III(A) & Annexure-III(B) .**

However the final BOQ shall be worked out during detailed design and contract price shall be adjusted accordingly.

3.4.3 Digital Access Cross connect System

The Contractor shall be required to provide Digital Access Cross connect Systems (DACS) capable of switching 16 or more E-1 lines in compliance with the electrical input-output characteristics provided in **Table 2-4**. DACSs shall be fully compatible with CEPT E-1 tributary standards.

DACSs shall be provided at locations specified in the **Annexure-II** and shall be used to establish and reconfigure cross-connections at the tributary level of up to 480 x 64Kb/s channels. DACS E-1 line interface shall be fully capable of accessing each E-1 line.

Within the context of this specification, sizing of DACS system is defined as 4 x n where n is the maximum size of the port switching matrix. Thus a DACS sized as 8 x 16 means that 8 E1 ports are interfaced over a 16 port (E1) matrix.

A DACS system shall consist of the switch matrix, all routing logic and timing circuitry for internally sourced, line derived or externally supplied network timing and full software support.

The DACSs to be provided under this contract shall consist of at least a 16 port switching matrix, with 16 ports equipped, i.e. 16 X 16 size. The DACS shall also be able to switch the signalling of the voice channels along with the voice channels. The DACS shall not use, decrease or block the specified capacity of the switching matrix while switching the signalling. The DACS shall support the Channel Associated Signallling (CAS) and Common Channel Signalling (CCS) both as per ITU-T G. 704.

The DACS shall provide user friendly control and management software. The user shall be able to operate the DACS locally through craft terminal, via an RS-232 interface or remotely under TMN supervisory control.

Table 2-4
CEPT E-1 Digital Access Cross Connect System
Required Operating Characteristics

E-1 Trunk Capacity:	Minimum 16-Port Switch Matrix Minimum 4-Port I/O per card
Tributary Capacity:	30 X 64 Kbps
Compatibility:	CEPT E-1, CEPT E-1 tributary channel
Frame Delay:	Minimum < 1 frame Maximum < 2 frames
E-1 Port Interface: **Interface Code:** **Impedance:** **Peak Level @ 75 ohm:** **Maximum Insertion Loss:**	2.048 Mb/s ± 50 ppm HDB3 75 ohm unbalanced 2.37 volts ± 10% 6 db
Signal Waveform: **Frame Structure:** **Jitter Performance:**	Per CCITT G.703 Per CCITT G.742 Per CCITT G.823
Synchronisation:	Internal, external source and synchronized on incoming E-1
Routing: **Routing Table Capacity:**	Fully non-blocking tributary to/from E-1 channel Minimum of 9 routing tables for reconfiguration
Supervisory Ports: **Supervisory Port Interface:** **Interface:**	Serial Com Ports RS-232 Standard ASCII ANSI compatible terminal
Supervisory Channel:	Async data rates, software selectable: speed of 110-9600 bps, odd or even parity 7 or 8 bits.

Table 2-4
CEPT E-1 Digital Access Cross Connect System
Required Operating Characteristics

Power Supply Voltage:	-48 VDC

3.4.3.1 Required DACS Applications

The DACS provided shall be fully capable of implementing standard applications such as "Groom and Fill", Drop & Insert/Bypass, Broadcast and Alternative Routing.

3.4.3.2 Menus and Reports

DACSs throughout the network shall be required to function as fully integrated subsystems of the Telecommunications Management Network (TMN) commissioned at SLDC..

The DACS software shall provide menu driven management of DACS and shall provide at least the following:

(I) Active Configuration: The user shall be able to modify the current active configuration.

(II) Configuration : The configurations other than the active one shall be listed, edited, viewed, renamed, deleted and activated . Actions shall be allowed manually, upon a carrier failure or specified alarm condition, remotely or on a scheduled basis.

(III) Reports : The user shall have selection of pre formatted specific reports and "Report Options" to be used to select where the next reports will be sent.

(IV) Administration: This shall provide the user, options to control, view and maintain various logs and the DACS software.

(V) Alarms: This shall display Alarm Status on all active ports and shall have an alert mechanism that readily identifies an alarm event to the user through TMN (locally as well as remotely). The alarms shall have different colours based on the importance of the alarm.

3.5 MDF, DDF and Cabling

For the purposes of the specification, the contractor shall provide cabling, wiring, DDF patching facilities and MDFs interfacing to the wideband telecommunications system. Equipment and material components for MDF, DDF and cabling are also part of this procurement. It shall be the Contractor's responsibility to provide all cable support required for full supplied equipment interconnection with the MDF and shall be in accordance with communications industry standard practices and the requirements mentioned in the technical specifications.

3.5.1 MDF and DDF Patching Facilities

The Contractor shall supply and install all cabling, wiring, connectors, cross connects, Digital Distribution Frames (DDF) and Main Distribution Frames (MDF) associated with the installation and interconnection of equipments procured under this package equipment being procured under other packages and existing/constituent owned equipment as follows:

(i) DDF for termination of new SDH equipment E-1 ports

(ii) Cabling (including connectors) for E1 level connections from DDF to existing SDH equipments, DDF to Existing & new PDH equipments and DDF to un-licensed Radio equipment. To the extent possible, existing cable at site shall be used.

(iii) All Ethernet ports shall be terminated with RJ-45 connector. Provision for 100% expansion with connector for terminating additional Ethernet ports shall be provided.

(iv) MDF for termination of all the subscriber channels at new PDH node

(v) Cabling and connectors required to enable subscriber-to-subscriber circuits over the telecom network. The Line side of the MDF shall be cabled to the Primary Multiplex and the equipment side shall be cabled to the MDF of the assigned subscriber (PLCC, PABX, Telephone at wideband locations etc).

(vi) Any other cables, connections etc required for a fully functional, integrated telecom system.

The connections amongst various equipment such as FOTS, termination equipment and subscriber MDFs etc shall always be routed through DDF and MDF to provide maintenance access.

3.5.1.1 Digital Distribution Frame Functional Requirements

The Contractor shall provide DDF for Digital Signal Cross connect (DSX) Broadband-quality (better than 20 MHz) patching facilities configured "normally-thru" with Equipment, Line and Monitor Patch Jacks. DDFs shall provide the following basic functions:

(i) "Normally thru" circuit routing
(ii) Circuit rerouting via patch cord assemblies
(iii) Circuit disconnect and termination

All DDFs shall be sized and equipped to support the offered configuration of the provided equipment. Independent Transmit and Receive patch jack assemblies (line and equipment) shall provide for separate transmit and receive single-plug patching. Transmit and receive patch jack assemblies shall be located side-by-side such that dual-plug patch cord assemblies may be used to route both transmit and receive for the same circuit.

3.5.1.2 Main Distribution Frames

The Contractor shall make provision for cross connection of subscriber services to the subscribers utilizing Krone type or equivalent and shall provide full connectivity up to and terminated on the equipment side of the appropriate DDFs and line side of MDFs. The Contractor shall terminate on the equipment side of patching facilities provided by other contracts and shall provide DSX type patching facilities supporting aggregate bit streams (i.e. dataplexers and E-1 Channel Banks). Separate Patch panels or MDFs shall be provided for Data and Voice. All cross connects shall be accomplished utilizing one, two or three pair patch cords. Patch plugs are permissible for direct one-to-one circuit "cut-thru".

3.6 Patch Cords

The Contractor has to supply FC PC coupled Patch cords as described in BOQ. The Patch cord return loss shall be equal to or better than 40 dB and insertion loss equal to or less than 0.5 dB.

3.7 Telecommunication Management Network / Network Management System

The Contractor shall take responsibility for operational support to the FOTS and associated interface with existing Telecommunications Management Network System (TMN) commissioned at SLDC. This TMN shall provide the capability to monitor, reconfigure, and control elements of the telecommunications network from a centralized location and at each node of the network where equipment is located. This TMN system shall assist Employer/Owner in the operations and maintenance of the wideband communication resources of the including detection of degraded circuits, system performance, the diagnosis of problems, the implementation of remedial actions and the allocation or reallocation of telecommunications resources and addition/deletion of network elements.

3.7.1 Performance Management

Performance management is concerned with evaluation of the use of network equipments and their capability to meet performance objectives. Minimum specific requirements that shall be satisfied include the following:

a. Provide support for an operator to initiate, collect, and terminate performance metrics under both normal and degraded conditions. For example, BER of each link, together with other data measured at each node, shall be available on operator request.

b. Monitor point to point & end to end signal quality and history. Provide operator controls to monitor performance of specified events, measures, and resources. Specifically provide displays to permit the operator to:

1. Select/deselect network equipments, events, and threshold parameters to monitor

2. Set monitoring start time and duration or end time

3. Set monitoring sampling frequency

4. Set/change threshold values on selected performance parameters

5. Generate alarm events when thresholds are exceeded.

6. Set multiple thresholds on certain performance parameters. Alarm categories include as a minimum a warning and a failure.

7. Calculate selected statistical data to measure performance on selected equipment based on both current and historical performance data maintained in performance logs. Performance data provided is limited to what is available from the equipment Contractors.

8. Provide graphical displays of point to point and end to end current performance parameter values. Provide tabular displays of current, peak, and average values for performance parameters.

9. Generate reports on a daily, weekly, monthly, and yearly basis containing system statistics.

3.8 Communication Channel requirement & Integration:

The NMS information of existing PDH & SDH system shall be transported through the new communication network up to the NMS location i.e at SLDC, Bhubaneswar. The NMS information of the new SDH & PDH system being procured under both the packages shall be transported through the existing communication network using 64 kbps/2Mpbs (G.703) interfaces. Hence new SDH & PDH system being procured under both the packages is required to run on the existing NMS.

The bidders shall describe in the proposal the TMN data transport proposed to be used by the bidder in detail including capacity requirements and various components/equipment proposed to be used.

3.9 Craft Terminal

Each equipment (SDH equipment, Mux, Drop/Insert and DACS etc.) on the fibre optic communication network shall include provision for connecting a portable personal computer (PC)/ Laptop to be known as craft terminal to support local commissioning and maintenance activities. Through the use of this PC and local displays/controls, the operator shall be able to:

a. Change the configuration of the station & the connected NEs.

b. Perform tests

c. Get detailed fault information

The craft terminal shall be connected to the interface available in the communication equipment. Portable (laptop) computers (Craft terminals), each complete with necessary system and application software to support the functions listed above, shall be supplied to OPTCL as per BOQ.

2.9.1 Hardware Requirement:

The craft terminal(Laptop) shall have suitable processor(s) which shall be sufficient to meet all the functional requirement and expansion capabilities stipulated in this specification. Only reputed make like Dell, IBM, HP, Compaq make shall be supplied.

The craft terminal shall have minimum configuration of 2.4 GHz, 2 GB RAM, 256 MB

VRAM, DVD RW drive, 320 GB Hard Disk Drive, keyboard, mouse/trackball etc.,

parallel, serial/USB (2.0) ports to accommodate printers, and Internal/external

Data/Fax modem and a battery back-up of at least 120 minutes. VDUs shall be 15"

TFT active matrix color LCD with a minimum resolution of 1024 X 768.

3.10 General Software/Firmware Requirements

Due to various alternative design approaches, it is neither intended nor possible to specify all software and firmware characteristics. It is the intent herein to provide design boundaries and guidelines that help to ensure a demonstrated, integrated program package that is maintainable and meets both hardware systems requirements and the customer's operational requirements.

3.10.1 Operating System Software

Operating system software shall be provided to control the execution of system programs, application programs, management devices, to allocate system resources, and manage communications among the system processors. The contractor shall make no modifications to the OEM's operating system, except as provided as USER installation parameters.

3.10.2 Applications Software

All applications software shall be written in a high-level programming language unless developed using industry proven application programs and development tools provided with the system. The contractor shall make no modifications to the applications program except as provided as USER development tools.

3.10.3 Software Utilities

A utility shall be provided to convert all reports into standard PC application formats such as excel.

3.10.4 Revisions, Upgradations, Maintainability

All firmware and software delivered under this specification shall be the latest field proven version available at the time of contract approval. Installed demonstration for acceptance shall be required. All firmware provided shall support its fully equipped intended functional requirements without additional rewrite or programming.

All software shall be easily user expandable to accommodate the anticipated system growth, as defined in this specification. Reassembly recompilation or revision upgrades of the software or components of the software shall not be necessary to accommodate full system expansion.

Software provided shall be compliant with national and international industry standards.

3.10.5 Help

All applications shall be supported by USER accessible HELP commands that shall assist the user in the performance of its tasks. HELP commands for an application shall be available to the user from within the active application and shall not interfere with the activities of the application.

GUARANTEED TECHNICAL PARTICULARS OF OLTE

	Particular	Unit	Required
1	2	3	4
1	**General**		
a	Type of multiplexer		SDH+PDH
b	Complying to ITU-T rec.		Yes
c	Transmission Capacity	Mbit/s	STM-4: 620 Mbps
d	Upgradable Capacity	Gbps	STM16
e	Redundant central processor (SDH/PDH)		Shall be available
f	PDH cross connect capacity		Minimum 120x2Mbit/s
g	The equipment is type tested		Yes
h	Minimum no of protected (MSP) direction	Nos	Five
2	**Available SDH ports:**		
a	SDH based on SFP technology		Yes
b	Optical line interface card (to support up to 160 Kms)		Yes
c	Electrical SDH interfaces		STM1 : 16 minimum
d	Optical SDH interfaces		STM4 : 16 minimum
3	**Teleprotection Interfaces**		
a	Integrated Distance Teleprotection Interface		Yes
b	Integrated Optical Teleprotection Interface		Yes
c	Addressing of protection commands		Yes
d	Loop Test for measuring delay time		Yes
e	Interface for Commands TxRx for DPS		4 Commands/interface
f	Number of Independent commands Min/ Max/	Number	4 Commands/32 commands
g	Transmission time max.	ms	6
h	Protection voltage max.	VDC	250
i	1+1 com path protection		Yes
j	Digital display type counter module to count Tx & Rx Commands operation for each command with count storage circuitry selectable working voltage 48V/110V/220V and with arrangement on front of module to reset counter (Tx & Rx) for each command separately		Yes
4	User Interfaces		
4.1	Voice Interfaces for trunk lines:		
a	Minimum number of channels per card	Nos.	8
b	Analogue, 4wire with E&M: Input level Output level	dBr	+9.5 to -16/+7.0 to -16.5

c	Analogue, 2wire with E&M: Input level Output level	dBr	+9.5 to -12.5-1.0 to -20
4.2	**Voice Interfaces for remote subscriber**:		
a	2wire, subscriber side	dBr	-5to+4 / -7.5to-1
b	Minimum number of subscriber	Nos.	10
5	**Data module**		
a	V.24/V.28 (RS-232) minimum ports/interface	Nos.	4
b	V-35 minimum ports/interface	Nos.	4
c	Integrated LAN port available of DATA Interface		Yes
d	Software programmable board available to assign different types of data interface to each port		Yes
6	**Ethernet interface**		
a	Ethernet: ports (Optical/Electrical)	No.	4 ports
b	Ethernet: Router functionality		
	Routing protocols		Static IP route OSPF
7	**Integrated alarm gathering module:**		
a	Number of external alarms per module	No.	8
8	Configuration Management		
	Type/Name of configuration tool		
a	For local/remote operation		Yes/Yes
b	Data communication network (DCN)		Ethernet /IP
c	Integrated management for SDH/PDH		Yes
9	**Network Management System**		
	Type/Name of configuration tool		
a	For local/remote operation		Yes/Yes
b	Data communication network (DCN)		TCP/IP
c	Integrated management of SDH/PDH		Yes
10	**Power Supply**		
a	Operation	VDC	48
b	Fully redundant power supply (for SDH/PDH)		Yes
c	Dual power feeder		Yes
d	AC power supply	VAC	230

----------End of the Section----------

GUARANTEED TECHNICAL PARTICULARS OF OPGW CABLE & HARDWARE ACCESSORIES

GUARANTEED TECHNICAL PARTICULARS OF OLTE

	Particular	Unit	Required
1	2	3	4

1	**General**		
a	Type of multiplexer		SDH+PDH
b	Complying to ITU-T rec.		Yes
c	Transmission Capacity	Mbit/s	STM-4: 620 Mbps
d	Upgradable Capacity	Gbps	STM16
e	Redundant central processor (SDH/PDH)		Shall be available
f	PDH cross connect capacity		**Minimum 32x2Mbit/s**
g	The equipment is type tested		Yes
h	Minimum no of protected (MSP) direction	Nos	Three (expandable up to four MSP directions of which at least two directions support STM-16)
2	**Available SDH ports:**		
a	SDH based on SFP technology		Yes
b	Optical line interface card (to support up to 160 Kms)		Yes
c	Electrical SDH interfaces		E1, Electrical interface
d	Optical SDH interfaces		6 ports minimum
3	**Teleprotection Interfaces**		External Teleprotection interface via G.702(2mbps,E1). There shall be option for the interface of future integration of protection coupler.
4	User Interfaces		
4.1	Voice Interfaces for trunk lines:		
a	Minimum number of channels per card	Nos.	8
b	Analogue, 4wire with E&M: Input level Output level	dBr	+9.5 to -16/+7.0 to -16.5
c	Analogue, 2wire with E&M: Input level Output level	dBr	+9.5 to -12.5-1.0 to -20
4.2	**Voice Interfaces for remote subscriber**:		
a	2wire, subscriber side	dBr	-5to+4 / -7.5to-1
b	Minimum number of subscriber	Nos.	10
5	**Data module**		
a	V.24/V.28 (RS-232) minimum ports/interface	Nos.	4
b	V-35 minimum ports/interface	Nos.	4
c	Integrated LAN port available of DATA Interface		Yes
d	Software programmable board available to assign different types of data interface to each port		Yes
6	**Ethernet interface**		
a	Ethernet: ports (Optical/Electrical)	No.	Ethernet-4 ports(Electrical) Required and there shall be option for Ethernet port (optical) for future interface of optical signal
b	Ethernet: Router functionality		
	Routing protocols		Ethernet interface unit with layer-2 switching

			functionality.
7	**Integrated alarm gathering module:**		
a	Number of external alarms per module	No.	8
8	Configuration Management		
	Type/Name of configuration tool		
a	For local/remote operation		Yes/Yes
b	Data communication network (DCN)		Ethernet /IP
c	Integrated management for SDH/PDH		Yes
9	**Network Management System**		
	Type/Name of configuration tool		
a	For local/remote operation		Yes/Yes
b	Data communication network (DCN)		TCP/IP
c	Integrated management of SDH/PDH		Yes
10	**Power Supply**		
a	Operation	VDC	48
b	Fully redundant power supply (for SDH/PDH)		Yes
c	Dual power feeder		Yes
d	AC power supply	VAC	230

ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

DISC / PORCELAIN LONG ROD INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS

TECHNICAL SPECIFICATION FOR DISC / PORCELAIN LONG ROD INSULATORS FOR SUBSTATION AND TRANSMISSION LINE WORKS.

1.0 SCOPE.

1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery FOR (destination) for Indian manufacturers of disc / porcelain long rod 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.

1.2 Following are the list of documents constituting this package.

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

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.

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.

2.0 **STANDARDS**:

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

2.2 The standards mentioned above are available from:

Reference.	Abbreviation.	Name & Address:
BS		British Standards, British Standards

		Institution, 101, Pentonvile Road, N-19 ND,U
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, ORISSA
ISO		International Organisation for Standardization. Danish Board of Standardization Dansk Standardizing Sraat Aurehoegvej-12 DK-2900 Helleprup DENMARK.
NEMA		National Electric Manufacturers Association 1`55, East 44th. Street New York, NY 10017 USA

3.0 PRINCIPAL PARAMETERS.

3.1 DETAILS OF DISC INSULATORS:

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 OPTCL in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type, radio interference 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.

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

3.2 SPECIFICATION DRAWINGS:

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.

4.0 GENERAL TECHNICAL REQUIREMENTS FOR DISC INSULATORS:

4.1 Porcelain:

The porcelain used in the manufacture of the shells shall be nonporous, of high dielectric, mechanical and thermal strength, free from internal stresses blisters, laminations, voids, forgone matter imperfections or other defects which might render it in any way unusable for insulator shells. Porcelain shall remain unaffected by climatic conditions ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through vitrification.

The insulator shall be made of highest grade, dense, homogeneous, wet-process porcelain, completely and uniformly vitrified throughout to produce uniform mechanical and electrical strength and long life service. The porcelain shall be free from warping, roughness, cracks, blisters, laminations, projecting points, foreign particles and other defects, except those within the limits of standard accepted practice. Surfaces and grooves shall be shaped for easy cleaning. Shells shall be substantially symmetrical.

4.1.1 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.

4.2 METAL PARTS:

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.

4.2.2 Security Clips:

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

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.

4.4 MATERIALS DESIGN AND WORKMANSHIP:

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.

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.

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.

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.

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.

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.).

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

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).

4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

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

(a)

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).

(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) (b) Wet-kV (rms)	 80 45	 80 45	 85 50	 90 50
7.2	Power frequency Withstand Voltage Disc (a) Dry-kV (rms) (b) Wet-kV (rms)	 85 50	 85 50	 90 55	 95 55
7.3	Impulse Withstand Voltage Disc 1.2/50 micro second (a) Positive – kV(Peak) (b) Negative – kV(Peak)	 125 125	 125 125	 130 130	 135 135
7.4	Impulse Flashover Voltage Disc 1.2/50 micro second (a) Positive – kV(Peak) (b) Negative – kV(Peak)	 135 130	 135 130	 140 135	 145 140

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.

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.

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.

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.

5.2 INSULATOR STRINGS:

5.2.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phases 132/22 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.

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 3.12

5.3 STRING CHARACTERISTICS

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%

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

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.

5.4 TECHNICAL DESCRIPTION OF PORCELAIN LONG ROD INSULATORS

5.4.1 Details of Long Rod Insulators

5.4.2 The insulator string shall consist of standard porcelain long rod insulators with normal sheds for a three phase, 50 Hz, effectively earthed 132/220/400 kV transmission system. Insulators shall be long rod type with Ball and socket connections.

5.4.3 Insulators shell has normal sheds/alternate sheds with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.

5.4.4 The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string alongwith hardware fittings shall be as follows :

5.4.5 Description of long rod insulator string (equivalent to disc insulator string)

5.5 PRINCIPAL PARAMETERS OF THE PORCELAIN LONG ROD INSULATORS:-

Sl. No.	System Voltage (kV)	Type of String.	Length of Porcelain long rod Insulator (mm)	Minimum creepage distance of Porcelain long rod Insulator(mm),	No. of Porcelain long rod Insulator units per string	Electro- mechanical strength of Porcelain long rod Insulator string fittings (KN)
1.	132	Single Suspension	1305	2628	1 X 1	1 X 70kN
2.	132	Double Suspension	1305	2628	2 X 1	2 X 70kN
3.	132	Single Tension	1450	2920	1 X 1	1 X 120kN
4.	132	Double Tension	1450	2920	2 X 1	2 X 120kN
5.	132	Single Suspension	1305	3625	1 X 1	1 X 70kN
6.	132	Double Suspension	1305	3625	2 X 1	2 X 70kN
7.	132	Single Tension	1450	3625	1 X 1	1 X 120kN
8.	132	Double Tension	1450	3625	2 X 1	2 X 120kN
9.	132	Single Tension	1700	3625	1 X 1	1 X 160kN
10.	132	Double Tension	1700	3625	2 X 1	2 X 160kN
11.	220	Single Suspension	2030	4088	1 X 2	1 X 90kN
12.	220	Double Suspension	2030	4088	2 X 2	2 X 90kN
13.	220	Single Tension	2175	4380	1 X 2	1 X 120kN
14.	220	Double Tension	2175	4380	2 X 2	2 X 120kN
15.	220	Single Suspension	2030	5180	1 X 2	1 X 90kN

16.	220	Double suspension	2030	5180	2 X 2	1 X 90kN
17.	220	Single Tension	2175	5550	1 X 2	1 X 120kN
18.	220	Double Tension	2175	5550	2 X 2	2 X 120kN
19.	220	Single Tension	2550	5550	1 X 2	1 X 160kN
20.	220	Double Tension	2550	5550	2 X 2	2 X 160kN
21.	400	Single Suspension	3335	9200	1 X 3	1 X 120kN
22.	400	Double suspension	3335	9200	2 X 3	2 X 120kN
23.	400	Single Tension	3910	9200	1 X 3	1 X 160kN
24.	400	Double Tension	3910	9200	2 X 3	2 X 160kN

(i) Bidders may quote for the relevant strings.
(ii) Length of long rod insulator strings shall be matching with the corresponding disc insulator strings.

5.5.1 STANDARD TECHNICAL PARTICULARS FOR 132kV PORCELAIN LONG ROD INSULATOR STRING

Sl.	Description	Unit	Standard Technical Particular value		
			70 KN/ 90KN Insulator	**120 KN Insulator**	**160 KN Insulator**
1.0	**General**				
a)	Size and Designation of ball & Socket assembly	mm	16 mm Alt-B as per IS 2486 / IEC: 60120	20 as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120
2.0	**Dimensions**				
a)	Core diameter	mm	55 to 75	60 to 75	75 to 85
b)	Tolerance on core diameter	± mm	(0.04d+1.5)	(0.04d+1.5)	(0.04d+1.5)
c)	Minimum nominal creepage distance 1. Normal 2. Anti Fog	mm	2628 3625	2920 3625	----- 3625
3.0	Colour of glaze of finished porcelain insulator		Brown	Brown	Brown
4.0	Mechanical Strength of Long Rod	kN	70	120	160
5.0	**Minimum electrical values**				
a)	Power frequency **Withstand** voltage (DRY/WET)	kV rms	310/275	310/275	310/275
b)	Power frequency **Flashover** voltage (DRY/WET)	kV rms	325/295	325/295	325/295
c)	Impulse **Withstand** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	650/650	650/650	650/650
d)	Impulse **Flashover** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	670/670	670/670	670/670

6.0	**Eccentricity of Long Rod**				
a)	Max. axial/radial run out		1.2 % of insulator length	1.2 % of insulator length	1.2 % of insulator length
b)	Max. angular displacement	deg	15	15	15
7.0	**Galvanizing**				
a)	Minimum mass of zinc coating	Gm/ sq.m.	600	600	600
b)	Minimum no. of one minute dips in the standard preece test	Nos.	6 dips	6 dips	6 dips
c)	Minimum purity of zinc used for galvanizing	%	99.95	99.95	99.95

5.5.2 STANDARD TECHNICAL PARTICULARS FOR 220kV PORCELAIN LONG ROD INSULATOR STRING

Sl.	Description	Unit	Standard Technical Particular value			
			70 KN Insulator	90 KN Insulator	120 KN Insulator	160 KN Insulator
1.0	**General**					
a)	Size and Designation of ball & Socket assembly	mm	-----	16 mm Alt-B as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120
2.0	**Dimensions**		-----			
a)	Core diameter	mm	-----	55 to 75	60 to 75	75 to 85
b)	Tolerance on core diameter	± mm	-----	(0.04d+1.5)	(0.04d+1.5)	(0.04d+1.5)
c)	Minimum nominal creepage distance 1. Normal	mm	-----	4088	4380	-----
	2. Anti Fog		-----	5180	5550	5550
3.0	Colour of glaze of finished porcelain insulator		-----	Brown	Brown	Brown
4.0	Mechanical Strength of Long Rod	kN	-----	90	120	160
5.0	**Minimum electrical values**		-----			
a)	Power frequency **Withstand** voltage (DRY/WET)	kV	-----	500/460	500/460	500/460
b)	Power frequency **Flashover** voltage (DRY/WET)	kV	-----	520/480	520/480	520/480
c)	Impulse **Withstand** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	1050/1050	1050/1050	1050/1050
d)	Impulse **Flashover** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	1100/1100	1100/1100	1100/1100
e)	Corona extinction voltage level	kV	-----	156	156	156
f)	Max. RIV for string including corona rings at 156kV rms	micro volts	-----	500	500	500
6.0	**Eccentricity of Long Rod**					

a)	Max. axial/radial run out		-----	1.2 % of insulator length	1.2 % of insulator length	1.2 % of insulator length
b)	Max. angular displacement	deg	-----	15	15	15

7.0	**Galvanizing**					
a)	Minimum mass of zinc coating	Gm/ sq.m.	-----	600	600	600
b)	Minimum no. of one minute dips in the standard preece test	Nos.	-----	6 dips	6 dips	6 dips
c)	Minimum purity of zinc used for galvanizing	%	-----	99.95	99.95	99.95

5.5.3 STANDARD TECHNICAL PARTICULARS FOR 400kV PORCELAIN LONG ROD INSULATOR STRING

Sl.	Description	Unit	Standard Technical Particular value			
			70 KN Insulator	90 KN Insulator	120 KN Insulator	160 KN Insulator
1.0	**General**					
a)	Size and Designation of ball & Socket assembly	mm	-----	-----	20 as per IS 2486/ IEC: 60120	20 as per IS 2486/ IEC: 60120
2.0	**Dimensions**		-----	-----		
a)	Core diameter	mm	-----	-----	60 to 75	75 to 85
b)	Tolerance on core diameter	± mm	-----	-----	(0.04d+1.5)	(0.04d+1.5)
c)	Minimum nominal creepage distance 1. Normal	mm	-----	-----	-----	-----
	2. Anti Fog		-----	-----	9200	9200
3.0	Colour of glaze of finished porcelain insulator		-----	-----	Brown	Brown
4.0	Mechanical Strength of Long Rod	kN	-----	-----	120	160
5.0	**Minimum electrical values**		-----	-----		
a)	Power frequency **Withstand** voltage	kV rms	-----	-----	720/680	720/680
b)	Power frequency **Flashover** voltage	kV rms	-----	-----	740/700	740/700
c)	Impulse **Withstand** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	-----	1550/1550	1550/1550
d)	Impulse **Flashover** test voltage 1.2 x 50 µs (Dry) POSITIVE / NEGATIVE	kV(peak)	-----	-----	1600/1600	1600/1600
e)	Wet Switching impulse withstand voltage (POSITIVE / NEGATIVE)	kV(peak)	-----	-----	1050/1050	1050/1050
f)	Corona extinction voltage level	kV rms	-----	-----	320	320
g)	Max. RIV for string including corona rings at 320kV rms	micro volts	-----	-----	1000	1000
6.0	**Eccentricity of Long Rod**					
a)	Max. axial/radial run out		-----	-----	1.2 % of insulator length	1.2 % of insulator length
b)	Max. angular displacement	deg	-----	-----	15	15
7.0	**Galvanizing**					
a)	Minimum mass of zinc coating	Gm/	-----	-----	600	600
b)	Minimum no. of one minute dips in	Nos.	-----	-----	6 dips	6 dips
c)	Minimum purity of zinc used for	%	-----	-----	99.95	99.95

6.0 SPECIFICATION DRAWINGS:

The specification in respect of the long rod insulators indicated above is given at Annexure-II. This 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 shall be in line with the specification.

7.0 GENERAL TECHNICAL REQUIREMENTS:

7.1 **PORCELAIN**:

The porcelain used in the manufacture of the shell shall be nonporous of high dielectric, mechanical and thermal strength free from internal stress blisters and thermal strength from internal stresses blisters, laminations, voids, foreign matter. Imperfections or other defects, which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid alkalis, and zinc of dust. The manufacturing shall be by the wet process and impervious character obtained by through vitrification.

7.2 PORCELAIN GLAZE:

Surfaces to come in contact with cement shall be made rough by stand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature coefficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

7.3 METAL PARTS:

7.3.1 Cap and Ball pins:

Twin Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip g galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat malleable cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity with minimum of 6 dips. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

7.3.2 SECURITY CLIPS:

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

7.4 FILLER MATERIAL:

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

8.0 MATERIAL DESIGN AND WORKMANSHIP:

8.1 GENERAL:

i) All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials 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 voltage

8.2 INSULATOR SHELL:

The design of the insulator shell 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 temperature cycle test followed by mallet test. Shells shall be dried under controlled conditions of humidity

and temperature.

8.3 METAL PARTS:

i) The twin ball pin and cap shall be designed to transmit the mechanical stresses 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 insulator or 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 parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any macroscopically visible cracks, insulations and voids.

8.4 GALVANIZING:

All ferrous parts shall be hot dip galvanized six times in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 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.

8.4.1 CEMENTING:

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials.

8.5 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 sore adding after installation to prevent complete withdrawal from the socket. The locking device shall be 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 when placed in position and under no circumstances shall it allow separation of insulator units and fitting 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk 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 position shall not be less than 50 N (5 Kgs.) or more than 500N (50 Kgs.)

8.6 BALL AND SOCKET DESIGNATION:

The dimensions of the balls and sockets for 80 KN long rod insulators shall be of 16mm and for 120 KN shall be of 20mm designation in accordance with the standard dimensions stated in IS: 2486 (Part-III).

8.7 DIMENSIONAL TOLERANCE OF PORCELAIN LONG ROD INSULATORS

It shall be ensured that the dimensions of the long rod insulators are within the limits as per relevant IEC/ ISS.

9.0 TESTS (FOR DISC/PORCELAIN LONG ROD INSULATORS) :

9,1 The following tests shall be carried out on the insulator string and disc insulators.

9.2 TYPE TEST:

This shall mean those tests, which are to be carried out to prove the design, process of manufacture and general conformity of the material and product with the intents of this specification. These tests shall be conducted on a representative number of samples prior to commencement of commercial production. The Bidder shall indicate his schedule for carrying out these tests.

9.3 ACCEPTANCE:

This shall mean these tests, which are to be carried out on samples taken from each lot offered for pre-despatch inspection for the purpose of acceptance of the lot.

9.4 ROUTINE TESTS:

This shall mean those tests, which are to be carried out on each insulator to check the requirements, which

are likely to vary during production.

9.5 TESTS DURING MANUFACTURE:

Stage tests during manufacture shall mean those tests, which are to be carried out during the process of manufacture to ensure quality control such that the end product is of the designed quality conforming to the intent of this specification.

9.6 TEST VALUE:

For all type and acceptance tests the acceptance values shall be the value guaranteed by the bidder in the guaranteed technical particulars of the acceptance value specified in this specification of the relevant standard whichever is more stringent for that particular test.

9.7 TEST PROCEDURE AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or the Internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and normal according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms land procedure for the same shall be as specified in Annexure-IV attached hereto as mutually agreed to between the supplier and the purchaser in the quality assurance programme.

9.8 TYPE TESTS:

The following type test shall be conducted on a suitable number of individual unit components, materials or complete strings.

9.8.1 On the complete insulator string with hardware fittings.

a)	Power frequency voltage withstand test with corona control rings and under wet condition.	: IEC: 60383
b)	Switching surge voltage withstand test under wet condition (For 400kV and above only)	: IEC: 60383
c)	Impulse voltage withstand test under dry condition.	: IEC: 60383
d)	Impulse voltage flashover test under dry condition.	: IEC: 60383
e)	Voltage distribution test.	: Applicable only for Disc insulators only
f)	Corona & RIV test under dry condition.	: As per this specification
g)	Mechanical strength test.	: As per this specification
h)	Vibration.	: As per this specification

9.8.2 On Insulators:

a)	Verification of dimensions.	: IS: 731/ IEC: 60383
b)	Thermal mechanical performance test:	: IEC:60575
c)	Power frequency voltage withstand and flashover (I) dry (ii) wet.	: IEC: 60383
d)	Impulse voltage withstand flashover test (dry)	: IEC: 60383
e)	Visible discharge test (dry)	: IS:731
f)	RIV test (dry)	: IS:8263/ IEC: 60437

All the type tests given under clause No.9.8.1 above shall be conducted on single suspension and Double Tension insulator string alongwith hardware fittings.

9.9 ACCEPTANCE TESTS:

9.9.1 For insulator:

a) Visual examination	: IS:731/IEC:60383
b) Verification of dimensions.	: IS:731/IEC:60383
c) Temperature cycle test.	: IS:731/IEC:60383
d) Galvanizing test.	: IS:731/IEC:60383
e) Mechanical performance test.	: IEC:60575
f) Test on locking device for ball and socket coupling.	: IEC:60372
g) Eccentricity test.	: IEC: 60383
h) Electro-mechanical/Mechanical strength test.	: IEC: 60383 (Disc/Long Rod)
i) Puncture test.	: IS:731 (Applicable only for Discs)
j) Porosity test.	: IS:731/IEC:60383

9.10 ROUTINE TESTS:

9.10.1 For insulators:

a) Visual inspection.	: IS:731/IEC:60383
b) Mechanical routine test.	: IS:731/IEC:60383
c) Electrical routine test.	: IEC:60383 (Applicable only for Discs)

9.11 TEST DURING MANUFACTURE: On all components as applicable**.**

a) Chemical analysis of zinc used for galvanizing.	: As per the Specification
b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings.	: As per the Specification
c) Chemical analysis, hardness test and magnetic particle inspection for forgings.	: As per the Specification
d) Hydraulic Internal Pressure tests on shell.	: Applicable only for Discs
e) Crack detection test for metal parts.	: As per the Specification

9.12 ADDITIONAL TEST:

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/ laboratory or at any other recognized laboratory/ research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

9.13 CO-ORDINATION FOR TESTING:

For insulator strings, the supplier shall arrange to conduct testing of their disc/Porcelain long rod insulators with the hardware fittings to be supplied to the purchaser by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc/Porcelain long rod insulator with the hardware fittings.

NOTE:

In respect of electrical tests on a complete string consisting of insulators and hardware guarantee of values of responsibility of testing shall be with hardware manufacturer of RIV, corona and voltage distribution test (Applicable for Disc insulator strings only) and with insulator manufacturer for all other tests.

9.14 TEST CHARGES AND TEST SCHEDULE:

9.14.1 TYPE TEST:

The insulator offered shall be fully type tested as per this specification. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory. The bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than five years. The purchaser reserves the right to demand repetition of some or all type tests in the presence of purchasers' carrying representative. For this purpose the bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type already type tested and the design/type offered against this specification, purchaser reserves the right to demand repetition of tests without any extra cost.

9.14.2 ACCEPTANCE AND ROUTINE TEST:

All acceptance and routine tests as stipulated herein shall be carried out by the supplier in the presence of purchaser's representative.

9.14.3 Immediately after finalisation of the programme of type/ acceptance/ routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

For type tests involving tests on a complete insulator string with hardware fittings, the purchaser will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.

9.14.4 In case of failure of the complete string in any type tests, the supplier whose product has failed in the tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the purchaser as to the items that has caused the failure in any of the type tests shall be final and binding.

10. INSPECTION:

10.1

i. Purchaser and its representative shall at all times be entitled to have access to the works and to all places of manufacturer where insulators are manufactured and the supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.

ii. The supplier shall keep the purchaser informed in advance of the time of starting and of progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.

iii. No material shall be dispatched from its point of manufacture unless the materials has been satisfactorily inspected and tested.

iv. The acceptance of any quantity of insulators shall in no way relieve the supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such insulators are later found to be defective.

10.2 IDENTIFICATION / MARKING:

10.2.1 Each unit of insulator shall be legibly and indelibly marked with the trade mark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in kilo-newtons abbreviated by 'KN' to facilitate easy identification and proper use.

10.2.2 The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

11. QUALITY ASSURANCE PLAN:

11.1 The bidder hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection.

i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw materials in presence of

bidder's representative, copies of test certificates.

ii. Informations and copies of test certificates as in (i) above in respect of bought out materials.

iii List of manufacturing facilities available.

iv Level of automation achieved and lists of area where manual processing exists.

v List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such tests and inspection.

vi Special features provided in the equipment to make it maintenance free.

vii. List of testing equipping available with the bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

11.2 The supplier shall within 30 days of placement of order submit the following information to the owner.

i) List of raw material and the names of sub-suppliers selected from those furnished alongwith the offer.

Sl.No.	Description	EMS value	No of Discs	Size of Disc (mm)	CD of Disc (mm)	No of PLRI	Size of PLRI (mm)	CD of PLRI (mm)
1	132kV Single Suspension string	70/90KN – Normal	1 X 9	255 x 145	320	1 X 1	1305	2628
2	132kV Double Suspension string	70/90KN – Normal	2 X 9	255 x 145	320	2 X 1	1305	2628
3	132kV Single Suspension string	70/90KN – Anti Fog	1 X 9	255 x 145	430	1 X 1	1305	3625
4	132kV Double Suspension string	70/90KN – Anti Fog	2 X 9	255 x 145	430	2 X 1	1305	3625
5	132kV Single Suspension string	120KN – Anti Fog	1 X 10	280 x 145	430	1 X 1	1450	3625
6	132kV Double Suspension string	120KN – Anti Fog	2 X10	280 x 145	430	2 X 1	1450	3625
7	132kV Single Tension string	160KN – Anti Fog	1 X 10	305 x 170	475	1 X 1	1700	3625
8	132kV Double Tension string	160KN – Anti Fog	2 X10	305 X 170	475	2 X 1	1700	3625
9	220kV Single Suspension string	90KN – Normal	1 X 14	255 x 145	320	1 X 2	2030	4088
10	220kV Double Suspension string	90KN – Normal	2 X 14	255 x 145	320	2 X 2	2030	4088
11	220kV Single Suspension string	90KN – Anti Fog	1 X 14	255 x 145	430	1 X 2	2030	4380
12	220kV Double Suspension string	90KN – Anti Fog	2 X 14	255 x 145	430	2 X 2	2030	4380
13	220kV Single Suspension string	120KN – Anti Fog	1 X 15	280 x 145	430	1 X 2	2175	5180
14	220kV Double Suspension string	120KN – Anti Fog	2 X15	280 x 145	430	2 X 2	2175	5180

15	220kV Single Tension string	160KN – Anti Fog	1 X 15	305 x 170	475	1 X 2	2550	5550
16	220kV Double Tension string	160KN – Anti Fog	2 X15	305 X 170	475	2 X 2	2550	5550
17	400kV Single Suspension string	120KN – Anti Fog	1 X 25	280 x 145	430	1 X 3	3335	9200
18	400kV Double Suspension string	120KN – Anti Fog	2 X25	280 x 145	430	2 X 3	3335	9200
19	400kV Single Tension string	160KN – Anti Fog	1 X 25	305 x 170	475	1 X 3	3910	9200
20	400kV Double Tension string	160KN – Anti Fog	2 X25	305 X 170	475	2 X 3	3910	9200