VOLUME-II

SECTION – 2.5

POLYMERIC INSULATORS

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SECTION – 2.5

POLYMERIC INSULATORS

1.0.0 INTENT OF SPECIFICATION

This specification covers design, manufacturing, testing, inspection, packing and supply of Silicon Rubber housed composite Insulators for satisfactory operation on various transmission line (D/C towers & GIPCL D/C line on M/C towers) and Substations (PSS-1, PSS-2 & CTU Khavda-II GSS transmission line end of gantry) of 2375 MW Capacity Solar / Wind Hybrid RE Park at Great Rann of Kutch Area, Gujarat.

These insulators are to be used as insulating part of tower structures single/double suspension & tension (dead end) for 400kV D/C & M/C transmission line. The configuration on structure may be single or double insulators per phase at required locations.

The materials covered here under this specification shall be supplied complete inall respects, including all components, fittings and accessories which are necessary or are usual for their efficient performance and satisfactory maintenance under the various operating and atmospheric conditions. Such partsshall be deemed to be within the scope of the Contract, whether specifically included or not in the Specification or in the Contract Schedules.

2.0.0 CODES AND STANDARDS

Unless otherwise specified elsewhere in this specification, the rating as well as performance & testing of the Polymer Insulators shall conform but not limited to the latest revision & amendments available at the time of placement of order of all the relevant standards as listed hereunder, except as modified in this document

Sl. No.	Indian Standard	Title	International Standard
1	IS:209	Specification for Zinc	BS:3436
2	IS:406	Method for Chemical Analysis of Slab Zinc	BS:3436
3	IS:731	Porcelain insulators for overhead power lines with a nominal voltage greater than1000V	IEC:61109-1992
4	IS:2071 Part I, II, III	Method of High Voltage Testing	IEC:60060-1
5	IS:2486 Part-I, II, III	Specification for insulator fittings for overhead power lines with a nominalvoltage greater than 1000V- General Requirements, Tests, Dimensional Requirements, Locking Devices	IEC-60575, IEC-60120 IEC:60372 BS:3288-1972
6	IS:2629	Recommended practice for Hot Dip Galvanization for iron & steel	ISO:1461(E)
7	IS:2633	Testing for Uniformity of Coating of Zinccoated articles	ASTM A 123, CAN/CSA G 164

Sl. No.	Indian Standard	Title	International Standard
8	IS: 3203	Methods of testing of local thickness of electroplated coatings	ISO: 2178
9	IS: 4699	Specification for refined secondary zinc	
10	IS: 4759	Hot dip zinc coatings on structural steel &other allied products	ISO: 1459, ISO: 1461
11	IS:6745	Determination of Weight of Zinc coatingon Zinc coated iron and steel articles	BS:443-1969 ISO 1460-1973
12	IS: 8263	Methods of RIV Test of HV Insulators	IEC:60487 NEEMA:107 – 1964 CISPR/IEC:437-1973
13	IS:8269	Methods for Switching impulse test on HV insulators	IEC:60506-1975
14	IS:13134	Guide for the selection of insulators inrespect of polluted conditions	IEC: 60815
15		Standard for insulators– Composite -Distribution Dead end type	ANSI C29 13-2000
16		Standard specification for glass fiber strands	ASTM D 578-05
17		Standard test method for compositionalanalysis by Thermo gravimetry	ASTM E 1131-03
18		Characteristics of string insulator units ofthe long rod type	IEC: 60433
19		Verification of Dimensions of Polymer Insulators	IEC:61109
20		Hydrophobicity classification guide	STRI guide 1.92/1
21		Tests on insulators of Ceramic material or glass or glass for overhead lines with anominal voltage greater than 1000V	IEC:60383
22		Salt Fog Pollution Voltage Withstand Test	IEC:60507
23		Thermal Mechanical Performance testand mechanical performance test on string insulator units	IEC: 60575
24		Electrical Insulating materials used undersevere ambient conditions –Test methods for evaluating resistance to tracking anderosion	IEC 60587
25		Selection and dimensioning of high voltage	IEC:60815-3

Sl. No.	Indian Standard	Title	International Standard
		insulators intended for use in polluted conditions: Polymer Insulatorsfor AC systems	
26		Composite insulators for A.C. Overheadlines with nominal voltage greater than1000V – Definitions, test methods and acceptance criteria	IEC 61109
27		Composite string insulator units for overhead lines with a nominal voltageabove 1000V : i) Standard strength classes and endfittings ii) Dimensional and electrical characteristics	 IEC 61466-1 IEC 61466-1
29		Polymeric insulators for indoor and outdoor use with nominal voltage greater than 1000V- General definitions, tests, methods and acceptance criteria.	IEC 62217
30	IS 3188	Characteristic of String insulator Units	
31	IS:5300- 1980	Porcelain Guy Strin insulators	

Material meeting with the requirements of other authoritative standards, which ensure equal or better performance than the standards mentioned above, shall also be considered. When the material offered by the bidder conforms to other standards, salient points of difference between standards adopted & the standardsspecified in this specification shall be clearly brought out in the relevant schedules. Three copies of such standards with authentic translation in English shall be furnished along with the bid.

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 CORE

3.1.1 The core shall be glass-fiber reinforced epoxy resin rod (FRP) of high strength. Both, glass fiber and resin shall be optimized in the FRP rod. Glass fibers with low content in alkalies shall be boron free E glass or Boron free electrically corrosion resistance (ECR) glass. Use of resin with hydrolysis trend due to water penetration should be prevented i. e. matrix of the FRP rod shall be Hydrolysis resistant. Suitability of Epoxy matrix as well as interface between matrix and fibers is to be considered as design parameter to prevent brittle fracture. The FRP rod should be void free and shall be manufactured through Pultrusion process.

3.2.0 HOUSING (SHEATH)

3.2.1 The core of the Polymer insulator shall be completely covered by a continuous housing consisting of a sheath-weathershed. For moulding of entire weathershed structure on to the rod in a one shot moulding process to be employed to avoid multiple interfaces.

3.2.2 Hardware i.e. metal fittings may be installed on the rod prior to moulding of the shed controlling

moulding lines. The base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers. The thickness of compounding material on core should be minimum 3 mm.

3.2.3 Manufacturer should furnish a description of its Quality Assurance Programme including fabrication, testing and inspection for any material (i.e. rubber), components (i.e. rod) or hardware (i.e. end fittings). The manufacturer has had fabricated by others should also be included. Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer. Insulator should have hermetically sealed structure in which the housing material is moulded to cover the interface between the end fittings and the FRP Prod. This seal should never be broken during testing or otherwise.

3.3.0 END FITTINGS

3.3.1 The Polymer insulators shall be socket and ball type with the necessary coupling arrangement such that pin shall move freely in the socket but do not get disengaged while in service under various operating and atmospheric conditions.

3.3.2 The socket & ball type metal end fittings shall be designed to transmit the mechanical load to the core & the end fittings shall maintain uniform and consistent mechanical strength Material and methods used in the fabrication of metal parts shall be selected to provide good toughness and ductility. Metal end fittings shall be made from a quality malleable cast iron or forged steel or Spheroidal Graphite Iron (SGI) and shall be hot dipped galvanized in accordance with IS 2629. Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, slivers, slag, blow-holes shrinkage defects and localized porosity.

3.3.3 The attachment to the FRP rod shall be performed with a symmetrically controlled crimping method control by acquistic method that compresses the metal radically onto the rod without damage to the rod fibers or resin matrix while providing a strength equal to or greater than the defined and specified ultimate strength to the insulator. The material used in fittings shall be corrosion resistant.

3.3.4 Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard. No joints in ball & socket or pin will be allowed. Outer portion of ball or socket should be Zinc sleeved with minimum 99.95% purity of electrolytic high-grade Zinc. The finished surface shall be smooth and shall have a good performance. The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection. The design of the fittings and the insulators shall be such that there is no local corona formation or discharges likely to cause the interference to either sound or vision transmission.

3.4.0 GRADING RINGS

3.4.1 Grading rings shall be provided when system voltages are equal to or greater than 400kV. For 400kV transmissions, grading ring is to be provided at the energized end only.(end towards conductor)

3.4.2 All grading rings and brackets shall be designed as an integral part of the insulator assembly with a positive mounting system that allows mounting in one position. The design of the grading ring shall be such that ring can only be mounted with its orientation towards the weather sheds for maximum RIV and Corona control. Grading rings shall be designed in such a manner that

the rings can be readily installed and removed with hot line tools without disassembling any other part of the insulator assembly.

3.4.3 Grading ring height (is the distance from the end of the end fitting to the top of corona ring) should be so selected that maximum field minimizes and uniformly distributed along the insulator. Manufacturer should provide reports of successful electric field modeling testing for the specific insulator design. The EFM should be three dimensional with result containing drawing depicting the electric field in various colours, each of a different voltage level. The result of this study should show that the voltage field surrounding the polymer insulators is optimum along the entire length of the insulator, with the affected hot end of the insulator being a critical location. The threshold at which corona may or may not be present should be defined as a figure in KV/mm for the designed insulator

3.5.0 VERIFICATION OF HOUSING MATERIAL

3.5.1 The manufacturer should provide written verification about housing material, for which base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers considered will provide satisfactory performance in the particular environment It shall meet following requirements Be homogenous, impermeable, with no fissures, bubbles and strange materials inclusions. Be designed in order to avoid formation of localized discharges and to prevent interfaces humid penetration. Be resistant to corona, UV radiation, ozone, atmospheric contamination, water penetration and power arcs.

3.6.0 BALL AND SOCKET DESIGNATION

3.6.1 The dimensions of the Ball and Socket shall be 20mm & 24mm designation for 120 kN and 160/210 kN Polymer insulators in accordance with the standard dimensions stated in IEC:60120/ IS:2486(Part-II)

3.7.0 MARKINGS

3.7.1 Each insulator shall be legibly and indelibly marked with the following details as per IEC – 61109.

1. Name or trademark of the manufacturer.
2. Voltage and Type.
3. Month and year of manufacturing.
4. Minimum failing load / guaranteed mechanical strength in kilo Newton followedby the word ‘KN’ to facilitate easy identification.
5. Country of manufacture

3.7.2 One 10 mm thick ring of suitable quality of paint shall be marked on the end fitting of particular strength for easy identification of Polymer insulators. The paint shall not have any deteriorating effect on the insulator performance.

Following codes shall be used as identification mark:

For 160KN Polymer insulator : Green

For 120KN Polymer insulator : Grey

3.8.0 DETAILS OF COMPOSITE POLYMER INSULATORS

3.8.1 The Composite Polymer insulator shall be suitable for a three phase 50 Hz, effectively earthed 400kV transmission systems in a Zone – V as per IS 1893 and C5-M as per ISO 12944 polluted atmosphere.

3.8.2 The specified values and dimensions, impulse and power frequency voltages, electromechanical strength [EMS] of Polymer insulators are as under. The values given are minimum which apply to all cases. Specified withstand and flashover voltages are referred to standard atmospheric condition.

3.8.3 Composite Polymer Insulators shall have sheds with good self-cleaning properties. Insulator shed profile, spacing, projection etc., and selection in respect of polluted conditions shall be generally in accordance with the recommendation of IEC-60815/IS: 13134

3.8.4 Dimensional Tolerance of Composite Insulators

The tolerances on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows in line with IEC 61109:

± (0.04d + 1.5) mm when d≤300mm

± (0.025d+6) mm when d>300mm

Where, “d” being the dimensions in millimeters for diameter, length or creepage distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance

3.9.0 BID DRAWINGS

3.9.1 The Bidder shall furnish full description and illustration of the material offered.

3.9.2 The Bidder shall furnish along with the bid the outline drawing of each insulator unit along with grading rings including a cross sectional view of the long rod insulator unit. The drawing shall include but not limited to the following information:

Major Dimensions with manufacturing tolerances

(a) Minimum Creepage distance with positive tolerance
(b) Protected creepage distance
(c) Unit mechanical and electrical characteristics
(d) Size and weight of ball and socket parts
(e) Weight of composite long rod units
(f) Materials

3.9.3 After placement of award, the Manufacturer/contractor shall submit full dimensioned insulator drawings containing all the details as given in Clause No.3.9.2 above, in three (3) copies to GIPCL for approval. After getting approval from GIPCL and successful completion of all the

type tests, the Manufacturer/contractor shall submit 04 more copies of the same drawing along with a soft copy to the GIPCL for further distribution and field use at GIPCL's end.

3.9.4 After placement of award the Manufacturer/contractor shall also submit fully dimensioned insulator crate drawing for different type of insulators.

4.0.0 MATERIAL DESIGN AND WORKMANSHIP

4.1.0 GENERAL

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 high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on 400kV Transmission lines.

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.

4.2.0 INTERCHANGEABILITY

The Polymer 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.

4.3.0 CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) PERFORMANCE

All surfaces shall be even, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under all operating conditions.

4.4.0 SUITABILITY FOR LIVE LINE MAINTENANCE

The Polymer insulators shall be compatible for use with hot line or live line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety. The Suppliers shall indicate the methods generally adopted in routine hot and cold line maintenance of EHV lines for similar Polymer insulators supplied by them. Suppliers shall also indicate the recommended periodicity of such maintenance.

5.0.0 TEST ON INSULATORS

The following tests shall be carried out on the Composite Polymer insulator:

5.1.0 TYPE TESTS

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.

5.2.0 ACCEPTANCE TESTS

This shall mean those tests which are to be carried out on 10% samples taken from each lot offered for pre-dispatch inspection for the purpose of acceptance of the lot.

5.3.0 ROUTINE TESTS

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

5.4.0 STAGE 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.

5.5.0 TEST VALUES

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

5.6.0 TEST PROCEDURES AND SAMPLING NORMS

The norms and procedure of sampling for the above tests shall be as per the relevant Indian Standard or other internationally accepted standards. This will be discussed and mutually agreed to between the successful Supplier and Purchaser before placement of order. The standards and norms 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 and procedure for the same shall be as mutually agreed to between the successful supplier and purchaser in the quality assurance programme. The supplier shall offer at least three times the quantity of material required for conducting all the type tests for sample selection.

Before sample selection, the supplier shall be required to conduct the entireacceptance test successfully in presence of purchaser's representative.

5.6.1 TYPE TESTS

1. The following type tests shall be conducted on all types of the Polymer insulator with hardware fittings:
    (a) Power frequency voltage withstand test with corona control rings and arcing horn under (dry/wet) conditions
    (b) Power frequency voltage flash over test with corona control rings and arcing horn under (dry/wet) conditions
    (c) Power frequency voltage flash over test without corona control rings and arcing horn under (dry/wet) conditions
    (d) Switching surge voltage withstand test under wet condition.

(e) Impulse voltage withstand test under dry condition.

(f) Voltage Distribution test

(g) Impulse voltage flash over test under dry condition

(h) Corona and RIV Test under dry condition.

(i) Mechanical strength test

(j) Vibration test.

(k) Power Arc Test

(l) Salt fog pollution withstand Test

2. On composite Insulator Unit: -

(a) Tests on interface and connection of metal fittings

- Dry Power Frequency Voltage Test
- Sudden Load Release Test
- Thermal Mechanical Test
- Steep Front Impulse Voltage Test
- Dry Power Frequency Voltage Test

(b) Assembled Core Load Time Test

- Determination of the Average failing load of the core of the assembled unit
- Control of slope of the strength time curve of the insulator

(c) Accelerated Ageing Test of 5000 hours

(d) Flammability Test

(e) Recovery of Hydrophobic Test

(f) Mechanical Load Time Test

(g) Brittle Fracture resistance test

(h) Test of Housing, Tracking and Erosion Test

(i) Test for the Core Material

- Dye Penetration Test
- Water Diffusion Test

5.6.2 ACCEPTANCE AND ROUTINE TESTS

On Polymer Insulators following Acceptance & Routine tests shall be conducted:

1. Acceptance tests:

a) Verification of dimensions	IEC: 61109
b) Verification of Locking System	-
c) Galvanizing test	IS-731
d) Verification of specified Mechanical Load	IEC: 575
e) Recovery of Hydrophobicity	As per annex-2B

2. Routine tests:

a) Visual Inspection — IS-731

b) Mechanical routine test — IS-731

c) Electrical routine test — IEC: 383

5.6.3 TESTS DURING MANUFACTURE (STAGE TESTS)

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 forforgings

d) Crack detection test for metal parts

5.6.4 ADDITIONAL TESTS

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 thematerial complies with the intent of this specification.

5.6.5 COORDINATION FOR TESTING:

For polymer insulator strings, the Supplier is required to produce type test reports to the satisfaction of the Purchaser. However, in case the Purchaser desires, the Supplier shall conduct all the type tests on the complete string with relevant hardware fittings. Responsibility of arranging required hardwares for the purpose of type testing will remain with the insulator Supplier.

5.7.0 TEST SCHEDULE

5.7.1 TYPE TESTS

The material offered shall be fully type tested as per this specification and the Supplier shall furnish four sets of type test reports along with the offer. These tests must not have been conducted earlier than five years.

For any change in the design/type, already type tested and the design/type offered against this bid, the purchaser reserves the right to demand repetition of some or all type tests without any extra cost.

5.7.2 ACCEPTANCE AND ROUTINE TESTS

All Acceptance and Routine tests as stipulated herein shall be carried out by the Supplier in the presence of Purchaser’s (Board's) representative.

Immediately after finalization of the programme of acceptance/ routine testing, the Supplier

shall give sufficient advance intimation to the Purchaser, to enable him to depute his representative for witnessing the test.

5.8.0 INSPECTION

1. Purchaser and its representatives shall at all times be entitled to have access to the works and to all places of manufactures where insulators are manufactured, and the successful Supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of material, inspection of manufacturing process of insulators and for conducting necessary tests as specified herein.
2. The successful Supplier shall keep the Purchaser informed in advance of the time of starting and progress of manufacture of insulators in its various stages so that arrangements could be made for inspection.
3. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.
4. The acceptance of any quantity of insulators shall in no way relieve the successful 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

5.9.0 QUALITY ASSURANCE PLAN

5.9.1 The Supplier hereunder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection. Information shall be separately given for individual type of material offered.

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

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

iii) List of manufacturing facilities available.

iv) Level of automation achieved and list of areas 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 test and inspections.

vi) Special features provided in Polymer insulators to make it maintenance free.

vii) List of testing equipment available with the Supplier for final testing of Polymer insulators specified and test plant limitation, if any, vis-a-vis the type, special, acceptance and routine tests specified in the relevant standards.

5.9.2 The successful Supplier shall within 30 days of placement of order submit the following information to the Purchaser.

i) List of raw material as well as bought out accessories and the name of material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality assurance plan (QAP) withhold points for Purchaser's inspection. The QAP and Purchaser's hold points shall be discussed between the Purchaser and the Supplier before the QAP is finalized.

The successful Supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the insulator.

5.10.0 DOCUMENTATION

The Supplier shall furnish full description and illustrated catalogues of insulators offered, along with the bid. The supplier shall also furnish along with the bid the outline drawing of Polymer insulator unit including cross-sectional view. The drawing shall include the following information:

Shed diameter and unit spacing with manufacturing tolerance.

i) Creepage distance.
ii) Unit mechanical and electrical characteristics for the complete string- suspension and tension. Unit
iii) Size and weight of ball and socket part.
iv) Weight of Polymer unit.
v) Materials for the cap and pin.
vi) Identification mark.
vii) Manufacturer's catalogue number.
viii) Brief installation instructions.
ix) Any other Relevant technical details required during detail engineering.

5.11.0 TEST REPORTS

i) Four copies of type test reports shall be furnished to the Purchaser within one month of conducting the tests. One copy will be returned duly certified by the Purchaser to the Supplier within three weeks thereafter and on receipt of the same Supplier shall commence with the commercial production of the Polymer insulators.

ii) Four copies of acceptance test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be dispatched.

iii) All records of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Purchaser.

iv) All test reports of tests conducted during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when requested for by the Purchaser.

5.12.0 GUARANTEED PARTICULARS AND PERFORMANCE GUARANTEE:

i) The bidder shall furnish all relevant technical guaranteed particulars of the long rod Polymer Insulators offered. Offers without such details may not be considered.

ii) The Polymer Insulators shall be guaranteed for satisfactory performance for a period of 12 months from the date of commissioning of line. Any defect due to faulty material or workmanship found during guarantee period shall be rectified free of cost to the GIPCL. The replacement will have to be organized expeditiously and within one month from the date of intimation.

iii) The contractor must ensure that the material supplied from specific vendor also guaranteed for the period specified in the bid against the manufacturing defect.

5.13.0 PACKING AND FORWARDING

i) All Polymer insulators shall be packed in suitable PVC/Plastic tubes/any other suitable packing. The packing shall provide protection against rodents. The supplier shall furnish detailed design of the packing. For marine transportation crates shall be paletted.

ii) The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

iii) Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

iv) All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings.

v) Each case/crate shall have all the markings stenciled on it in indelible ink.

vi) The supplier shall guarantee the adequacy of the packing and shall be responsible for any loss or damage during transportation handling, storage and installation due to improper packing indelible ink.

5.14.0 GUARANTEED TECHNICAL SPECIFICATIONS OF POLYMERIC INSULATORS & ACCESSORIES

(The following sets of GTP are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. Bidder shall submit comprehensive GTP during the detailed engineering along with the relevant technical brochures and drawings. The bidder shall fill in the guaranteed technical particulars in the Proforma given in this section and submit the same with his tender, without which bid will not be considered.)

GTP- 1

400 kV 160KN Tension Type Silicone Rubber Housed long rod composite polymer insulator

Sl. No.	Description	Unit	400kV:160KN Tension type	To be filled by the bidder
1.	Manufacturer			
2.	Country of Origin		India	
3.	Insulator type Origin		400kV:160KN Tension type composite long rod insulators	
4.	Standard according to which the insulators will be manufacturedand tested		IEC – 61109	
5.	Name of material used in manufactureof insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRProd)		ECR boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Silicon content by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI/SGI/Forged steel	
6d	Sealing compound forend fittings		Silicon Sealant	
6e	Colour		Grey	
7	Electrical Characteristic			
7a	Nominal systemvoltage	KV	400	
7b	Highest systemvoltage	KV	420	
7c	Dry power frequency withstand voltage	kV (rms)	630	
7d	Wet power frequency withstand voltage	kV (rms)	680	
7e	Dry Flashover Voltage	kV (rms)		
7f	Wet Flashover voltage	kV (rms)		
7g	Dry lighting impulse withstand voltage	kV (rms)		
	I) Positive		1550	
	ii) Negative		1550	
7h	RIV at 1 MHz when energised at 320kVrms under dry condition	micro volts	<500 micro volts	
7i	Creepage Distance	Mm	13020 @ 31mm/kV	

Sl. No.	Description	Unit	400kV:160KN Tension type	To be filled by the bidder
	(Minimum)			
8	Mechanical Characteristics			
8a	Minimum failing load	KN		
9	Dimensions ofinsulators			
9a	Weight	Kgs		
9b	Diameter of FRP rod	mm		
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		
10	Method of fixing ofsheds to housing			
	i) Single mould			
	ii) Modular construction (injection moulding/ compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in each pack			
13c	Gross weight ofpackage	Kgs		
14	Dimensioned drawings of the insulator (including weight with tolerancein weight)			

GTP – 2

400kV 120 KN Suspension Type Silicone Rubber Housed long rod compositepolymer insulator

Sl. No.	Description	Unit	400kV:120 KN	To be filled by the bidder
1.	Manufacturer			
2	Country of Origin		India	
3.	Insulator type Origin		400kV:120KN type composite long rod insulators	
4.	Standard according to which the insulators willbe manufactured and tested		IEC - 61109	
5.	Name of material used in manufacture of insulator with class/ grade		Silicone Rubber	
6a.	Material of core (FRP rod)		ECR Boron free	
	i) E-glass of ECR glass			
	ii) Boron content			
6b	Material of Housing & weather – sheds (Siliconcontent by weight)		Silicon Rubber (40%)	
6c	Material End Fitting		MCI / SGI /Forged steel	
6d	Sealing compound for end fittingsq		Silicon Sealant	
6e	Colour		Blue	
7	Electrical Characteristic			
7a	Nominal system voltage	KV	400	
7b	Highest system voltage	KV	420	

Sl. No.	Description	Unit	400kV:120 KN	To be filled by the bidder
9c	Length of FRP rod	mm		
9d	Dia Weather – Shed	mm		
9e	Thickness of Housing	Mm		
9f	Dry arc distance	Mm		
10	Method of fixing of shedsto housing			
	i) Single mould			
	ii) Modular construction			
	(injection moulding/ compression moulding)			
11	No of weather sheds	Nos		
12	Type of sheds			
12a	Aerodynamic			
12b	With under-rubs			
13	Packing details			
13a	Type of packing			
13b	No of insulator in eachpack			
13c	Gross weight of package	Kgs		
14	Dimensioned drawings ofthe insulator (including weight with tolerance in weight)			

ANNEXURE 2B

TESTS ON COMPLETE COMPOSITE INSULATOR WITH HARDWARE FITTINGS

1 CORONA EXTINCTION VOLTAGE TEST (DRY)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320kV (rms) line to ground under dry condition for 400kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulatedin IEC: 60383.

2 RIV TEST (DRY)

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305kV line toground under dry condition for 400kV AC line. The test procedure shall be in accordance with IS: 8263/ IEC: 60437.

3 MECHANICAL STRENGTH TEST

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% ofthe 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 furtherincreased 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 load is reached, and the value recorded.

4 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 suspension string, a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and the each sub-conductor (each tensioned at 43kN for 400kV) shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductor throughout the duration of the test.Vibration dampers shall not be used on the test span. All the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies ofthe insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than $1000/f^{1.8}$ where f is the frequency of vibration in cycles/sec. The insulator stringshall be vibrated for not less than 10 million cycles without any failure. After the test, the insulators shall be examined for looseness of pins and cap or any crack. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and

insulators after the vibration test. The insulators shall be subjected to the Mechanical performance test followed by mechanical strength test as per relevant standards.

5 SALT - FOG POLLUTION WITHSTAND TEST

This test shall be carried out in accordance with IEC-60507. The salinity level for composite long rod insulators shall be 80 Kg/m^3 NACL.

6 COMPOSITE LONG ROD INSULATOR UNITS

6.1 BRITTLE FRACTURE RESISTANCE TEST

Assembled core load time test with container that contains in HNO_3 concentric acid this is applied at the naked FRP rod. The rod should be held at 80% of SML for the duration of the test. The rod should not fail within the 96-hour testduration.

6.2 RECOVERY OF HYDROPHOBICITY TEST

(i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allowthe surface to dry and spray with water. Record the HC classification. Dry the sample surface

(ii) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester. Holding the electrode approximately 3 mm from the sample surface slowly move the electrode overan area approximately 1'' x 1''. Continue treating this area for 2-3 minutes, operating the tester at maximum output.

(iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic with an HC value of 6 to 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.

(iv) Allow the sample to recover and repeat the Hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24to 48 hours, depending on the material and the intensity of the corona treatment

6.3 SILICONE CONTENT TEST

Minimum content of silicone as guaranteed by supplier shall be verified through FT-IR spectroscopy & TGA analysis.

7 HIGH PRESSURE WASHING TEST

The washing of a complete insulator of each E&M rating is to be carried out at 3800 KPa with nozzles of 6mm diameter at a distance of 3m from nozzles to the insulator. The washing shall be carried out for 10minutes. There shall be no damage to the sheath or metal fitting to housing interface.

8 TORSION TEST

Three complete insulators of each E&M rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimenadequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion testmust pass the Dye Penetration Test as per IEC 61109.

9 TESTS ON ALL COMPONENTS (AS APPLICABLE)

9.1 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING

Samples taken from the zinc ingot shall be chemically analyzed as per IS 209- 1979. The purity of zinc shall not be less than 99.95%.

9.2 TESTS 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 detailsregarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

9.3 TESTS ON CASTINGS

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 Owner in Quality Assurance Programme.

10 POWER ARC TEST:

Three insulators having any one design of end fittings shall be tested for power arc endurance while tensioned horizontally at 3000lb. An arc shall be initiated across the insulator by means of a Copper shorting fuse wire. The arc shall burn 15 to 30 cycles and its current magnitude is determined by ampere- time product(IxT) equal to a minimum of 150kA cycles. Each insulator is only acceptable if there is no exposure of the core, no mechanical separation of the insulator, and no cracks in the housing.