

SECTION – IV

TECHNICAL SPECIFICATION FOR THE 11KV POLYMER PIN INSULATORS WITH GI PINS

1.0. Scope

This specification covers design, manufacture, testing and supply of composite insulators for use in the 11KV overhead transmission lines and substations.

The composite insulator will be used on lines on which the conductor will be AAA/ACSR of size up to 100 sq.mm.

2.0. APPLICABLE STANDARDS

2.1. Standards

Following Indian/International Standards, which shall mean latest revision, with amendments/changes adopted and published, unless specifically stated otherwise in the specification, shall be referred while accessing conformity of insulators with these specifications.

- 2.1.1 In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent or better to those specified. In case of award, salient features of comparison between the standards proposed by the bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.		Definition, test methods and acceptance criteria for composite insulators for a.c. overhead lines above 1000V	IEC : 61109
2.	IS : 731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000V	IEC : 60383
3.	IS : 2071	Methods of High Voltage Testing	IEC : 60060-1
4.	IS : 2486	Specification for insulator fittings for overhead power lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC : 60120 IEC : 60372
5.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC : 60575
6.	IS : 13134	Guide for the selection of insulators in respect of polluted conditions	IEC : 60815
7.		Characteristics of string insulator units of the long rod type	IEC : 60433
8.		Hydrophobicity classification guide	STRI guide 1.92/1
9.		Radio interference characteristics of overhead power lines and high-voltage equipment	CISPR:18-2 part 2
10.	IS : 8263	Methods of RI Test of HV Insulators	IEC : 60437
11.		Standard for insulators – Composite-Distribution Dead-end type	ANSI C29 13-2000
12.	IS : 4759	Hot dip zinc coatings on structural steel & other allied products	ISO : 1459 ISO : 1461

13.	IS : 2629	Recommended Practice for Hot, Dip Galvanization for iron and steel	ISO-1461 (E)
14.	IS : 6745	Determination of weight of zinc coating on zinc coated iron and steel articles	ISO : 1460
15.	IS : 3203	Methods of testing of local thickness of electroplated coatings	ISO : 2178
16.	IS : 2633	Testing of Uniformity of coating of zinc coated articles	
17		Standard specification for glass fiber strands	ASTMD 578-05
18		Standard test method for compositional analysis by Thermogravimetry	ASTM E 1131-03
19	IS : 4699	Specification for refined secondary zinc	

The addresses of organizations who offer the above standards are given at Annexure-A

3.0. Technical Description of Composite Insulators:

3.1. Service condition

The polymer insulators to be supplied shall be suitable for satisfactory continuous operation under conditions as specified below:

Maximum ambient temperature	:	50°C
Minimum ambient temperature	:	-5°C
Relative humidity	:	0 to 100%

3.2. Composite Insulators long rod type for tension locations and pin/ post type for suspension locations

3.2.1. The insulators shall be suitable for 3Ph. 50Hz, effectively earthed 11KV O/H distribution system in a moderately/heavily polluted atmosphere.

3.2.2. Bidder must be an indigenous manufacturer and supplier of composite insulators of rating 11KV or above or must have developed proven in house technology and manufacturing process for composite insulators of above rating OR posses technical collaboration/association with a manufacturer of composite insulators of rating 11KV or above. The Bidder shall furnish necessary evidence in support of the above along with the bid, which can be in the form of certification from the utilities concerned, or any other documents to the satisfaction of the owner.

3.2.3. 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.

3.2.4. The size of composite insulator, minimum creep age distance and mechanical strength along with hardware fittings shall be as follows.

Sl. No.	Type of composite insulators	Nominal system voltage KV (rms)	Highest system voltage KV (rms)	Visible discharge test voltage KV (rms)	Wet power frequency withstand voltage KV (rms)	Dry lighting impulse withstand voltage KV (rms)	Minimum creepage distance (mm)	Weather Shed Dia (mm)	Min. failing load KN	Thickness of Silicone Sheath Minimum (mm)	Bare FRP ROD Diameter (mm)
1	Pin Insulator	11	12	9	35	75	320	95	5	3	24

3.3. 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 :

$\pm (0.04d + 1.5)$ mm when $d \leq 300$ mm

$\pm (0.025d + 6)$ mm when $d > 300$ mm

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.

3.4. Interchangeability

The composite insulators including the end fitting connection shall be standard design suitable for use with the hardware fittings of any make conforming to relevant IEC/IS standards.

3.5. Corona and RI performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The insulator and metal parts shall be so designed and manufactured that it shall avoid local corona formation and not generate any radio interference beyond specified limit under the operating conditions.

3.6. Maintenance

- 3.6.1. The composite insulators offered shall be suitable for use of hot line maintenance technique so that usual hot line operation can be carried out with ease, speed and safety.

4.0. Technical description of composite Insulators.

4.1 Design and construction

The composite insulator shall have a core, housing & weather shed of insulating material and steel/aluminum hardware components for attaching it to the support/conductor.

4.1.1. Core

It shall be a glass-fiber reinforced epoxy resin rod of high strength (FRP rod). Glass fibers and resin shall be optimized in the FRP rod. Glass fibers shall be boron free electrically corrosion resistant (ECR) glass fiber or boron free E-Glass and shall exhibit both high electrical integrity and high resistance to acid corrosion. The matrix of the FRP rod shall be Hydrolysis resistant. The FRP rod shall be manufactured through Pultrusion process. The FRP rod shall be void free. The diameter of FRP rod should be 24 mm only. **The length of FRP Rod minimum 200 mm.**

4.1.2 Housing (Sheath)

The FRP rod shall be covered by a seamless sheath of a silicone elastomeric compound or silicone alloy compound of a thickness of **3 mm minimum measurable everywhere including on weathersheds.**

It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core and shall have chemical bonding with the FRP rod. The strength of the bond shall be greater than the tearing strength of the polymer. Sheath material in the bulk as well as in the sealing/bonding area shall be free from voids.

4.1.3. Weather sheds

The composite polymer weather sheds made of silicone elastomeric compound or silicon alloy shall be firmly bonded to the sheath, vulcanized to the sheath or molded as part of the sheath and shall be free from imperfections. The weather sheds should have silicon content of minimum 30% by weight. The strength of the weather sheds to sheath interface shall be greater than the tearing strength of the polymer. The interface, if any, between sheds and sheath (housing) shall be free from voids.

4.1.4. End Fittings

End fittings transmit the mechanical load to the core. They shall be made of spheroidal graphite cast iron, malleable cast iron or forged steel or aluminium alloy. They shall be connected to the rod by means of a controlled compression technique. The gap between fittings and sheath shall be sealed by a flexible silicone elastomeric compound or silicone alloy compound sealant. System of attachment of end fitting to the rod shall provide superior sealing performance between housing, i.e., seamless sheath and metal connection. The sealing must be moisture proof.

The dimensions of end fittings of Insulators shall be in accordance with the standard dimensions stated in IS: 2486/IEC60120.

5.0. Workmanship

- 5.1. All the materials shall be of latest design and conform to the best engineering practices adopted in the high voltage field. Bidders shall offer only such insulators as are guaranteed by them to be satisfactory and suitable for continued good service in power transmission lines.
- 5.2. The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners.
- 5.3. 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.
- 5.4. The core shall be sound and free of cracks and voids that may adversely affect the insulators.
- 5.5. Weather sheds shall be uniform in quality. They shall be clean, sound, smooth and shall be free from defects and excessive flashing at parting lines.
- 5.6. End fittings shall be free from cracks, seams, shrinks, air holes and rough edges. End fittings should be effectively sealed to prevent moisture ingress; effectiveness of

sealing system must be supported by test documents. All surfaces of the metal parts shall be perfectly smooth without projecting points or irregularities, which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

- 5.7. All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 μ m thickness and shall be in accordance with the requirement of IS:4579. The zinc used for galvanizing shall be of purity 99.5% as per IS : 4699. 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 galvanized metal parts shall be guaranteed to withstand at least four successive dips each lasting for one (1) minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.

6.0. Equipment Marking :

- 6.1 Each insulator unit shall be legibly and indelibly marked with the following details as per IEC-61109 :

- (a) Month & Year of manufacture
- (b) Min. failing load/guaranteed mechanical strength in kilo Newton followed by the word 'kN' to facilitate easy identification.
- (c) Manufacturer's name/Trade mark.

- 6.2 One 10 mm thick ring or 20mm thick spot of suitable quality of paint shall be marked on the end fitting of each composite long rod of particular strength in case of 11KV insulators for easy identification in case both types of insulators are procured by the utility. The paint shall not have any deteriorating effect on the insulator performance.

7.0 Bid Drawings :

- 7.1 The Bidder shall furnish full description and illustration of the material offered.
- 7.2 The bidder shall furnish along with the bid the outline drawing (3 copies) of each insulator unit including a cross sectional view of the long rod insulator unit. The drawing shall include but not be limited to the following information :
- (a) Long rod diameter with manufacturing tolerances
 - (b) Minimum Creepage distance with positive tolerance
 - (c) Protected creepage distance
 - (d) Eccentricity of the long rod unit
 - (i) Axial run out
 - (ii) Radial run out
 - (e) Unit mechanical and electrical characteristics
 - (f) Size and weight of ball and socket/tongue & clevis
 - (g) Weight of composite long rod units
 - (h) Material
 - (i) Identification mark
 - (ii) Manufacturer's catalogue number
- 7.3 After placement of award, the supplier shall submit full dimensioned manufacturing insulator drawing containing all the details in four (4) copies to Owner for approval. After getting approval from Owner and successful completion of all the types tests, the supplier shall submit 10 more copies of the drawing to the Owner for further distribution and field use.
- 7.4 After placement of award the supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators for approval of the owner.

8.0 Tests and Standards

Insulators offered shall be manufactured with the same configuration & raw materials as used in the insulators for which design & type test reports are submitted. The manufacturer shall submit a certificate for the same. **The design & type test reports submitted shall not be more than 5 years old.**

8.1. Design tests

Manufacturer should submit test reports for Design Tests as per IEC- 61109 along with the bid. Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract.

UV Test : The test shall be carried out in line with clause 7.2 of ANSI C29.13

8.2. Type Tests

8.2.1 The following type tests shall be conducted on a suitable number of individual insulator units, components, materials or complete strings and submitted along with the bid. The type test will not be later **5 years**.

Sl. No.	Description of type test	Test procedure/standard
1.	Dry lightning impulse withstand voltage test	As per IEC 61109
2.	Wet power frequency test	As per IEC 61109
3.	Mechanical load-time test	As per IEC 61109
4.	Radio interference test	As per IEC 61109 revised
5.	Recovery of Hydrophobicity test	Annexure-B (This test may be repeated every 3 years by the manufacturer)
6.	Chemical composition test for silicon content	Annexure-B (or any other test method acceptable to the owner)
7.	Brittle fracture resistance test	Annexure-B

8.2.1. It shall be the option of the purchaser to accept the insulators based on type test reports submitted by the manufacturer. The purchaser shall be free to repeat the type test & may witness the same.

Note : The purchaser, for the purpose of facilitating the type tests, may ask the bidders to quote test charges separately.

8.2.2. All the type test given in clause No. 8.2 in addition to routine & acceptance test shall be carried out on insulator along with hardware fittings wherever required.

8.3. Acceptance (sample) tests

The test samples after having with stood the routine test shall be subjected to the following acceptance test.

a)	Verification of dimensions	:	IEC : 61109
b)	Verification of the locking system (if applicable)	:	IEC : 61109
c)	Galvanizing test	:	IS : 2633/IS : 6745
d)	Verification of the specified Mechanical load (if applicable)	:	IEC : 61109

8.4. Routine Tests

Sl. No.	Description	Standard
1.	Identification of marking	As per IEC : 61109
2.	Visual inspection	As per IEC : 61109
3.	Mechanical routine test	As per IEC : 61109

8.5. Test during manufacture

Following test shall also be carried out on all components as applicable

a)	Chemical analysis of zinc used for galvanizing
b)	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.
c)	Chemical analysis, hardness tests and magnetic particle inspection for forgings.

8.6. Sample Batch for Type Testing

8.6.1. The bidder shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the owner. The bidder shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the owner.

8.7. Additional Tests :

8.7.1 The purchaser reserves the right at his own expenses, for carrying out any other tests (s) of reasonable nature carried out at supplier's premises, at site, or in any other place in addition to the aforesaid type, acceptance and routine tests to satisfy himself that the material comply with the specifications.

8.7.2 The purchaser also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test center. In case of evidence of non compliance, it shall be binding on the part of the Supplier to prove the compliance of the items to the technical specifications by repeat tests or corrections of deficiencies or replacement of defective items, all without any extra cost to the purchaser.

8.8. Co-ordination for Testing

8.8.1. The supplier shall have to co-ordinate testing of insulators with hardware fittings to be supplied by other supplier and shall have to guarantee overall satisfactory performance of the insulators with the hardware fittings.

8.8.2. The bidder shall intimate the purchaser about carrying out of the type tests along with detailed testing programme at least 3 weeks advance of the scheduled date of testing during which the owner will arrange to depute his representative to be present at the time of carrying out the tests.

8.9. Quality assurance plan

8.9.1. The successful bidder shall submit following information to the owner :

8.9.1.1 Test certificates of the raw materials and bought out accessories.

- 8.9.1.2 Statement giving list of important raw materials, their grades along with names of sub-suppliers for raw materials, list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of bidder's representative.
- 8.9.1.3 List of manufacturing facilities available.
- 8.9.1.4 Level of automation achieved and lists of areas where manual processing exists.
- 8.9.1.5 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- 8.9.1.6 List of testing equipment's available with the bidder for final testing of equipment along with valid calibration reports.
- 8.9.1.7 The manufacturer shall submit manufacturing Quality Plan (MQP) for approval & the same shall be followed during manufacture and testing.
- 8.9.1.8 The successful bidder shall submit the routine test certificates of bought out raw materials/accessories and central excise passes for raw material at the time of inspection.

8.10. Guarantee

The supplier of insulators shall guarantee satisfactory performance of the insulators for a period of 18 months from the date of receipt of material at stores by the consignee in good condition.

8.11. Test reports

At least three copies of type test reports shall be furnished. One copy shall be returned duly certified by the owner, only after which the commercial production of the concerned material shall start.

- 8.11.2 Copies of acceptance test reports shall be furnished in at least three (3) copies. One copy shall be returned duly certified by the owner, only after which the material shall be dispatched.
- 8.11.3 Record of routine test reports shall be maintained by the supplier at his works for periodic inspection by the owner's representative.
- 8.11.4 Test certificates of test during manufacture shall be maintained by the supplier. These shall be produced for verification as and when desired by purchaser.

9.0 Inspection

- 9.1 The purchaser representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.
- 9.2 The material for final inspection shall be offered by the supplier only under packed condition. The owner shall select samples at random from the packed lot of carrying out acceptance tests. The lot offered for inspection shall be homogeneous and shall contain insulators manufactured in 3-4 consecutive weeks.

- 9.3 The supplier shall keep the owner informed in advance of the time of starting and the progress of manufacture of material in their various stages so that arrangements could be made for inspection.
- 9.4 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the owner in writing. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.
- 9.5 The acceptance of any quantity of material shall in no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective.

10.0 Packing:

- 10.0 All insulators shall be packed in strong corrugated box of min. 7 ply duly palletted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 50 Kg to avoid handling problem. The crates shall be suitable for outdoor storage under wet climate during rainy season.
- 10.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- 10.3 Suitable cushioning, protective padding or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.
- 10.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate/corrugated box shall have all the markings stenciled on it in indelible ink.
- 10.5 The bidder shall provide instructions regarding handling and storage precautions to be taken at site.
11. **Samples:** Two samples of the above material offered against this specification shall accompany the tender and are non-returnable. The tenders received without samples are liable for rejection.

The measurements of the two samples submitted by the bidders should meet the following requirements; otherwise the bidders will be treated as non responsive.

Sl. No.	Creepage Distance (min)	Minimum failing load	Weight	Dia. of bare FRP Rod
1	320 mm	5 KN	0.9 kg \pm 2% tolerance	24 mm

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