

TECHNICAL SPECIFICATION FOR COMPOSITE PIN INSULATORS FOR USE IN 11 KV SYSTEM

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 Insulators shall be of the following type:

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.

| SNo. | Indian Standard 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:2071 | Methods of High Voltage Testing. | IEC:60060-1 |
| 3 | 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:60374 |
| 4 | | Thermal Mechanical performance test and mechanical performance test on string Insulators units | IEC:60575 |
| 5 | | Characteristics of string Insulator units of the long rod type. | IEC:60433 |
| 6 | | Hydrophobicity Clarification Guide. | STRI guide 1.92/1 |
| 7 | | Radio interference characteristics of overhead power lines and high voltage equipment. | CISPR118-2 Part 2 |
| 8 | IS:8263 | Methods of RI Test of HV Insulators | IEC:60437 |
| 9 | | Standard for Insulators – Composite-Distribution Dead - end type. | ANSI-C29.132- 2000 |
| 10 | IS:4759 | Hot dip zinc coatings on structural steel & other allied products. | ISO:1459 |
| 11 | IS:2629 | Recommended practice for Hot Dip galvanization for iron and steel | ISO:1461(E) |
| 12 | IS:6745 | Determination of weight of zinc coating on zinc coated Iron and steel articles. | ISO:1460 |
| 13 | IS:3203 | Methods of testing of local thickness of electroplated coatings. | ISO:2178 |
| 14 | IS:2633 | Testing of Uniformity of coating of zinc coated articles. | |
| 15 | | Standard specification for glass fiber standards. | ASTM D 578-05 |

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|----|---------|--|---------------|
| 16 | | Standard specification for compositional analysis by Thermogravimetry. | ASTM D 578-05 |
| 17 | IS:4699 | Specification for refined secondary zinc | |

3.0 TECHNICAL DESCRIPTION OF COMPOSITE INSULATORS::

3.1 Composite Pin Insulators long rod type to support conductor for 11KV overhead power lines :-

- 3.1.1 The Insulators shall be suitable for 3 Φ , 50 Hz, effectively earthed 11kV O/H distribution system in a moderately polluted atmosphere.
- 3.1.2 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 possess technical collaboration/ association with a manufacturer of composite Insulators of rating 11 kV 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.
- 3.1.3 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.
- 3.1.4 The size of Composite insulator, minimum creepage distance and mechanical strength along with hardware fittings shall be as follows:

| SN | Type of composite Insulator | Nominal system voltage kV (rms) | Highest system voltage kV (rms) | Visible discharge test voltage kV(rms) | Wet power frequency withstand voltage kV (rms) | Impulse withstand voltage kV (peak) | Minimum creepage distance (mm) | Min. failing load KN |
|----|-----------------------------|---------------------------------|---------------------------------|--|--|-------------------------------------|--------------------------------|----------------------|
| i. | 11KV Pin Insulator | 11 | 12 | 9 | 35 | 75 | 320 | 5 |

Note:- Min weight of the composite pin insulator should be **0.85 Kg.**

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 $d < 300$ 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 Interchangeably:-

The composite Insulators including the end fitting connection shall be of 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. BASIC FEATURES::

4.1 Design and construction:-

The composite Pin insulator shall have a core, housing & weather shed of insulating material and steel/aluminum alloy 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. For 11 KV Pin Insulator the diameter of the FRP rod should be minimum **24 mm**.

4.1.2 Housing (Sheath):-

The FRP rod shall be covered by a seamless sheath of a silicone electrometric compound or silicone alloy compound of a thickness of 3mm minimum. 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 shall be free from voids.

4.1.3 Weather sheds:-

The composite polymer weather sheds made of silicone electrometric 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 shed 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 aluminum alloy. They shall be connected to the rod by means of a controlled compression technique. The gap between fitting and sheath shall be sealed by a flexible silicone electrometric 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 details of end fittings for fixing the same with V cross arms and top clamps are given below :-

| S. N. | Item | Length of Stud | Minimum threaded portion of Stud | Min. Dia of Stud |
|-------|------|----------------|----------------------------------|------------------|
| 1 | 11KV | 150mm | 100mm | 20 mm |

Upper end fittings shall be suitable to hold Conductor for 11KV. The size of the fitting shall be in such a way that conductor could be bound firmly so that it may not slip from the groove while in service even under the adverse condition.

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 with out 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 87μ m thickness and shall be in accordance with the requirement of IS: 4759, 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 minute duration under the standard preece test. The galvanizing shall be carried out only after any machining.
- 6. EQUIPMENT MARKING::**
- 6.1 Each insulator unit shall be legibly and indelibly marked with the following details as per IEC-61109:
- Month & Year of manufacture
 - Min. failing load/guaranteed mechanical strength in kilo Newton followed by the word 'KN' to facilitate easy identification.
 - Manufacturer's name/Trade mark
- 7. 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 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:
- Long rod diameter with manufacturing tolerances
 - Minimum Creepage distance with positive tolerance
 - Protected creepage distance
 - Eccentricity of the long rod unit
 - Axial run out
 - Radial run out
 - Unit mechanical and electrical characteristics
 - Weight of composite long rod unit.
 - Materials
 - Identification mark
 - Manufacturer's catalogue number
- 7.3 At the time of placement of award the supplier shall submit three sets of full dimension manufacturing insulators drawings containing all the details to the Superintending Engineer (MM-I), PUVNL, Meerut.
- 7.4 At the time of placement of award the Supplier shall also submit fully dimensioned insulator crate drawing for different type of Insulators for approval of the owner.
- 7.5 **TESTS AND STANDARDS**
Insulators offered shall be manufactured with the same configuration & raw material 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 and all the design & type test should be checked as per UPPCL letter no. 1807/RESPO/Quality cell dt. 13.09.24
- 8.0 **DESIGN TEST(As per IEC 61109 clause 10)**
- 8.1 **Tests on interfaces and connections of end fittings**
- Pre-stressing-sudden load release pre-stressing thermal-mechanical pre-stressing
 - water immersion pre-stressing
 - Verification tests
 - Visual examination

- v. Steep-front impulse voltage test
- vi. Dry power-frequency voltage test

8.2. Tests on shed and housing material

- i. Hardness tests
- ii. Accelerated weathering test
- iii. Tracking and erosion test
- iv. Flammability test

8.3. Test on the core material

- i. Dye penetration test
- ii. Water diffusion

8.4 Assembled core load-time test

- i. Determination of the average failing load of the core of the assembled insulator
- ii. Control of the slope of the strength time curve of the insulator

8.5 Type Tests (As per IEC 61109 clause 11)

- i. Dry lightning impulse withstand voltage test
- ii Wet power frequency test
- iii. Damage limit proof test and test of the tightness of the interface between end fittings and insulator housing/bending test.
- iv. Radio interface test (As per REC specification 76/2006 for composite insulators for 11 KV & 33 KV system (clause 8.2)
- v. Recovery of hydrophobicity test (As per REC specification 76/2006 for composite insulators for 11 KV & 33 KV system (clause 8.2)
- vi. Chemical composition test for silicon content (As per REC specification 76/2006 for composite insulators for 11 KV & 33 KV systems (clause 8.2)
- vii. Brittle fracture resistance test ((As per REC specification 76/2006 for composite insulators for 11 KV & 33 KV system (clause 8.2)

8.6 Acceptance test (As per IEC 61109 clause 12)

- i. Verification of dimensions
- ii. Verification of end fittings
- iii. Verification of tightness of the interface between end fittings and insulators housing and of the specified mechanical load, SML/bending test
- iv. Galvanizing test
- v. Identification of marking (As per IEC 61109 clause 4 & 13)

8.7 Routine test (As per IEC 61109 clause 13)

- i. Visual examination
- ii. Mechanical routine test

The above tests are as per the IEC 61109/REC specification. Other required tests may also be included by Discom.

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

- (1) Name of trade mark of manufacturer
- (2) Month & year of manufacture
- (3) Min. failing load /guaranteed mechanicals strength in kilo Newton followed by the work KN to facilitate easy identification.
- (4) Name of Discom.

8.8 Tests During Manufacture

Following tests 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.

8.9 **Sample Batch for Type Testing**

8.9.1 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,

8.10 **Additional Tests:-**

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

8.10.2 The Owner 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 correction of deficiencies or replacement of defective items, all without any extra cost to the Owner,

8.11 **Co-ordination for Testing:-**

8.11.1 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.

8.11 **Quality assurance plan:-**

8.11.1 The successful bidder shall submit following information to the owner:

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

8.11.1.2 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.

8.11.1.3 List of manufacturing facilities available.

8.11.1.4 Level of automation achieved and lists of areas where manual processing exists.

8.11.5 List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

8.11.1.6 List of testing equipments available with the bidder for final testing of equipment along with valid calibration reports.

8.11.1.7 The manufacturer shall submit Manufacturing Quality Plan (MQP) for approval & the same shall be followed during manufacture and testing,

8.11.2 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.

8.12 **Guarantee:-**

The Supplier of Insulators shall guarantee overall satisfactory performance of the Insulators for the period of 18 months from the date of supply.

9 **INSPECTION:**

9.1 The Owner's 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 for 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 materials are later found to be defective.
- 10 **PACKING::**
- 10.1 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 100 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.

Annexure-A (Tests on insulator units)

- 1 RIV TEST (DRY):** -The insulator string along with complete hardware fittings shall have a radio interference voltage level below 100 micro volts at one MHz when subjected to 50 Hz AC voltage of 10 kV & 30 KV for 11 kV & 33 KV class insulators respectively under dry condition. The test procedure shall be in accordance with IS: 8263 / IEC: 60437/CISPRI 18-2.
- 2 BRITTLE FRACTURE RESISTANCE TEST: -**
Brittle fracture test shall be carried out on naked rod along with end fittings by applying "1 n HNO₃ acid" (63 g cone, HN03 added to 937 g water) to the 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 test duration. Test arrangement should ensure continuous wetting of the rod with Nitric acid.
- 3 RECOVERY OF HYDROPHOBICITY & CORONA TEST: -**
The test shall be carried out on 4mm thick samples of 5cm x 7cm: -
 - i) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the Hydrophobicity classification in line with STRI guide for Hydrophobicity classification. Dry the sample surface.
 - ii) The sample shall be subjected to mechanical stress by bending the sample over a ground electrode. Corona is continuously generated by applying 12 kV to a needle like electrode placed 1mm above the sample surface. The test shall be done for 100 hrs.
 - iii) Immediately after the corona treatment, spray the surface with water and record the HC classification. Dry the surface and repeat the corona treatment as at clause 7 above. Note HC classification. Repeat the cycle for 1000 hrs or until an HC of 6 or 7 is obtained. Dry the sample surface.
 - iv) Allow the sample to recover and repeat hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 - HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.
- 4 CHEMICAL COMPOSITION TEST FOR SILICON CONTENT**
The content of silicon in the composite polymer shall be evaluated by EDX (Energy Dispersion X-ray) Analysis or Thermo-gravimetric analysis. The test may be carried out at CPRI or any other NABL accredited laboratory.