

## **Specification for Polymer Disc Insulator**

**Scope :** This specification cover the design, manufacturing, testing at manufacturers works, transport to site, insurance, storage of 11 KV & 33 KV Polymer Disc Insulator suitable for use in 11 KV & 33 KV Overhead Lines situated in any part of West Bengal under the jurisdiction of WBSEDCL.

### **General Requirements :**

**1.** The Composite insulators will be used on lines on which the conductor will be ACSR of size up to 100 Sq.mm. The insulators should withstand the conductor tension, the reversible wind load as well as the high frequency vibrations due to wind.

**2.** Insulator shall be suitable for 3 Phase, 50 Hz effectively earthed 11KV Overhead Lines and 33 KV Impedance Grounded distribution system in a moderately/heavily polluted atmosphere.

**3.** 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. 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.

**4.** Insulators shall be suitable for both Suspension & Strain type of load and shall be of tongue & clevis type.

**5.** Insulator shall be suitable for the long Rod Type. The diameter of Composite Insulator shall be as per technical specification.

**6.** 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 commendation of IEC- 60815/ IS: 13134.

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

$$\begin{aligned} &\pm (0.04d + 1.5) \text{ mm when } d \leq 300 \text{ mm} \\ &\pm (0.025d+6) \text{ mm when } d > 300 \text{ mm} \end{aligned}$$

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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.

**8 .** 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.

**9.** 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.

**10 .** Inter- changeability: The composite insulator together with the tongue & clevis fittings shall be of standard design suitable for use with the hardware of any other indigenous make confirming to relevant standards referred herewith.

**Service condition :** The insulators to be supplied against this specification shall be suitable for satisfactory continuous operation under the following topical condition :

- a ) Max. ambient temperature : 50 ° C
- b ) Min. ambient temperature : -5 ° C
- c ) Relative humidity : 10 % to 100 %
- d ) Avarage number of rainy days : 100 / annum.
- e ) Max. Anual Rainfall : 1500 mm
- f ) Max. Wind Pressure : 150 Kg/ sq. Meter
- g ) Max. Wind Velocity : 50 Km/ hour
- h ) Max. Altitude above MSL : 1000 Meter.
- i ) Seismic level : 0.3 g ( Horizontal acceleration )
- j ) Avarage Thunder storm : 45 Days per annum.
- k ) Climatic condition : Moderately hot and humid tropical climate, conductive to rust and fungus groth. Polution level is high. Some area with seashores having saline atmosphere.

**System Parameters :**

- a ) Nominal system voltage : 11 KV & 33 KV.
  - b ) Highest system voltage : 12 KV & 36 KV.
  - c ) Power frequency : 50 Hz.
  - d ) Number of Phases : Three.
  - e ) System earthing : 11 KV Solidly earthed,  
33 KV Impedence earth.
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**Standard :** The following Indian / International Standards with latest revisions and amendments shall be referred while accessing conformity of insulators with this specification.

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
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 Galvanisation 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 Thermo-gravimetric	ASTM E 1131-03
19	IS : 4699	Specification for refined secondary zinc	

**Technical Requirement :**

1 . Composite Insulators shall be designed to meet the light quality, safety and reliability and are capable of withstanding a wide range of environmental conditions.

- (a) Core : The internal insulating part
- (b) Housing : The external insulating part.
- (c) Metal and fittings : For attaching to hardware to support conductor.

**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 shall be manufactured through Pultrusion process. The FRP rod shall be void free.

**Housing (Sheath) :**

The FRP rod shall be covered by a seamless sheath of a silicone elastometric compound or silicone alloy compound of a thickness of 3 mm minimum. It shall be one-piece housing using injection Moulding Principle to cover the core. The elastomer housing shall be designed to provide the necessary creepage distance and protection against environmental influences, external pollution and humidity. Housing shall conform to the requirement of IEC 61109/92-93 with latest amendments.

It shall be extruded or directly moulded on 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.

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 filings). 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.

**WEATHERSHEDS :**

The composite polymer Weathersheds made of silicone elastometric compound or silicon alloy shall be firmly bonded to the sheath, vulcanized to the sheath or moulded as part of the sheath and

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shall be free from imperfections. The Weathersheds should have silicon content of minimum 30% by weight. The strength of the Weathersheds 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.

#### **METAL END FITTINGS:**

End fittings transmit the mechanical load to the core. They shall be made of Malleable Cast Iron or Spherical Graphite Cast Iron. Hardware of respective specified mechanical load and shall be hot dip galvanized with Zinc coated with minimum 99.95% purity of electrolytic high grade Zinc in accordance with IS 2629. The material used in fittings shall be corrosion resistant.

Metal end fittings shall be uniform and without sharp edges or corners and shall be free of cracks, flakes, silvers, slag, blow-holes shrinkages defects and localized porosity.

They shall be connected to the rod by means of a controlled compression technique. As the main duty of the end fittings is the transfer of mechanical loads to the core the fittings should be properly attached to the core by a coaxial or hexagonal compression process and should not damage the individual fibers or crack the core.

The gap between fittings and sheath shall be sealed by flexible silicone elastometric compound or silicone alloy compound sealant, system of attached 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 IEC: 60120/IS:2486 Part-II/1989.

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 should or vision transmission.

#### **Workmanship :**

a ) 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.

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b ) 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.

c ) 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.

d ) The core shall be sound and free of cracks and voids that may adversely affect the insulators.

e ) Weather sheds shall be uniform in quality. They shall be clean, sound and smooth and shall be free from defects and excessive flashing at parting lines.

f ) 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.

g ) All ferrous parts shall be hot dip galvanized to give a minimum average coating of zinc equivalent to 610 gm/sq.m. or 87 $\mu$ 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.

### **Drawing :**

The bidder shall furnish along with the bid the outline drawing 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) Weight of composite long rod units
- (g) Identification mark
- (h) Manufacturer's catalogue number

**Marking:** Each insulator shall be legibly and indelibly marked to show the following:

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- a ) Name & Trade mark of the manufacturer
- b ) Month & Year of manufacturing
- c ) Voltage & Type
- d ) Minimum Failing Load ( in KN)
- e ) “WBSEDCL” marking

**Type Test :** The following Type Test shall have to be conducted as per reference IEC mentioned above on insulator unit, components, materials or complete strings :

- a ) Sudden Load Release Test
- b ) Thermal Mechanical Pre-stress Test
- c ) Dry Positive & Negative Lightning Impulse voltage withstand test
- d ) Dry Positive & Negative Lightning Impulse Flashover voltage test
- e ) Dry & Wet Power Frequency Voltage withstand test
- f ) Dry & Wet Power Frequency Voltage Flashover test
- g ) Mechanical Failing Load test.
- h ) Radio Interference test
- i ) Recovery of Hydrophobicity test.
- j ) Dye Penetration Test.
- k ) Water Diffusion Test
- l ) Chemical composition test for Silicon content
- m ) Brittle fracture resistance test.
- n ) Damage Limit proof & Mechanical Withstand Test.

**Routine Test :**

- a ) Identification of marking
- b ) Visual inspection
- c ) Mechanical routine test

**Acceptance Test :** The following test will be carried out at manufacturers works during inspection of the offered insulators before delivery :

- a ) Visual examination
  - b ) Verification of dimension
  - c ) Galvanizing test
  - d ) Mechanical performance test
  - e ) Mechanical Failing Load test
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## **Testing Facilities:**

The tenderer must clearly indicate what testing facilities are available in the works of the manufacturer and whether facilities are adequate to carry out all Routine & Acceptance Test.

These facilities should be available to WBSEDCL's Engineers if deputed or carry out or witness the tests in the manufacturer works. If any test cannot be carried out at the manufacturer's work, the reasons should be clearly stated in the tender. The insulators shall be tested in accordance with the procedure detailed in IEC 61109/92-93 with latest amendments.

## **Inspection:**

All Acceptance tests shall be carried out at manufacturer's works in presence of the WBSEDCL's and manufacturers representatives. In addition to above, all routine tests are also to be carried on the insulator as per relevant IS / IEC. The entire cost of acceptance and routine test that to be carried out as per relevant IS / IEC shall be treated as included in the quoted price of Insulator. The manufacturer shall give at least 21(twenty one) days advance notice intimating the actual date of inspection and details of all tests that are to be carried out from the date when the tests will be carried out.

Routine tests on all insulators shall be carried out as per IEC / IS and test reports shall be submitted along with respective inspection offer to CE, P&CD, WBSEDCL

## **Sampling & Rejection during inspection:**

The sampling and rejection procedure for Acceptance Test shall be as per IEC 61109.

## **Packing:**

a ) All insulators shall be packed in strong corrugated box of min. 7 ply duly palette 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.

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

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

d ) Each wooden case / crate / corrugated box shall have all the markings stenciled on it in indelible ink.

e) The bidder shall provide instructions regarding handling and storage precautions to be taken at site.

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## **Gurantee :**

In the event of any defect in the equipment / materials arising out of faulty design, materials, workmanship within a period of 12 (twelve) months of commissioning or 18 (eighteen) months from the date of last despatch of any integral part of the equipment / materials whichever is earlier the supplier shall guarantee to replace or repair the same to the satisfaction of the purchaser.

If the supplier fail to do so within a reasonable time, WBSEDCL reserves the right to effect repair or replacement by any other agency and recover charges for repair or replacement from the supplier.

## **Quality Assurance Plan :**

- 1 . The successful bidder shall submit following information along with the bid.
  2. Test certificates of the raw materials and bought out accessories.
  3. Statement giving list of important raw material, 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.
  4. List of manufacturing facilities available.
  5. Level of automation achieved and lists of areas where manual processing exists.
  6. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
  7. List of testing equipments available with the bidder for final testing equipment along with valid calibration reports.
  8. The manufacturer shall submit Manufacturing Quality Assurance Plan (QAP) for approval & the same shall be followed during manufacture and testing.
  9. 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.
  10. 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.
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11. 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.

12. The Supplier shall keep the Owner informed in advance of the time of starting and the progress of manufacture of material i/n their various stages so that arrangements could be made for inspection.

13. No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the owner in writing waives off the inspection. In the later case also the material shall be dispatched only after satisfactory testing specified herein has been completed.

14. 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.

## **ANNEXURE: A**

### **Test 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 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: 437/CISPR 18-2.

2. Brittle Fracture Resistance Test : Brittle fracture test shall be carried out on naked rod along with end fittings by applying “1n HNO<sub>3</sub> acid” (63 g conc. HNO<sub>3</sub> 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 :**

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 (Extract enclosed at Annexure-D) Dry the sample surface.

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(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 1 mm above the sample surface. Tentative arrangement shall be as shown in Annexure-E. 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-2 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.

#### **Specific Technical particulars for 11 KV & 33 KV Disc Insulator**

	<b>11 KV Disc</b>	<b>33 KV Disc</b>
Type of insulator	Polymeric composite Disc Insulator	Polymeric composite Disc Insulator
Reference Standard	IEC 61109	IEC 61109
Material of FRP Rod	Boron free ECR	Boron free ECR
Material of sheds	Silicon Rubber	Silicon Rubber
Type of metal end fittings	Tongue & Clevis	Tongue & Clevis
Material of end fittings	SGCI / MCI	SGCI / MCI
Material of sealing compound	RTV Silicon	RTV Silicon
Colour of sheds	Grey	Grey
Rated voltage	11 KV	33 KV
Highest voltage	12 KV	36 KV
Dry Power Frequency Withstand voltage	60 KV	95 KV
Wet Power Frequency Withstand voltage	35 KV	75 KV
Dry Power Frequency	75 KV	130 KV

Flashover Voltage		
Visible Discharge Voltage (PF)	9 KV	27 KV
Wet Power Frequency Flashover Voltage	45 KV	90 KV
Dry Lightning Impulse withstand voltage	Positive : 75 KV Negative :80 KV	Positive : 170 KV Negative : 180 KV
Dry Lightning Impulse Flashover voltage	Positive : 95 KV Negative : 100 KV	Positive : 210 KV Negative : 230 KV
RIV at 1 MHz when energised at 10 KV / 30 KV (rms) under dry condition	< 50 microvolt	< 70 microvolt
Creepage distance ( min )	320 mm	900 mm
Min Failing load	45 KN	70 KN
Dia of FRP Rod	16 mm	16 mm
Length of FRP Rod ( min )	200 mm	425 mm
Dia of weather sheds	100 mm	110 mm
Thickness of housing	3 mm	3 mm
Dry arc distance	170 mm	380 mm
Method of fixing sheds to housing	Injection moulding	Injection moulding
No of weather sheds (min)	Three	Eight
Type of sheds	Aerodynamic	Aerodynamic
Type of packing	Wooden/Corrugated box	Wooden/Corrugated box
No of insulator in each pack	Thirty	Twenty
Guarantee	12 months from commissioning or 18 months from the date of last despatch.	12 months from commissioning or 18 months from the date of last despatch.

**Annexure B**

**G T P to be filled up by the Bidder**

**Name of the manufacturer :**

**Address of works :**

	<b>11 KV Disc</b>	<b>33 KV Disc</b>
Type of insulator		
Reference Standard		
Material of FRP Rod		
Material of sheds		
Type of metal end fittings		
Material of end fittings		
Material of sealing compound		
Colour of sheds		
Rated voltage		
Highest voltage		
Dry Power Frequency Withstand voltage		
Wet Power Frequency Withstand voltage		
Dry PF Flashover Voltage		
Wet PF Flashover Voltage		
Dry Lightning Impulse withstand voltage		
Positive		
Negative		
Dry Lightning Impulse Flashover voltage		
Positive		
Negative		
RIV at 1 MHz when energised at 10 KV / 30 KV (rms) under dry condition		
Creepage distance ( min )		
Visible Discharge Voltage (PF)		
Minimum Failing load		

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Dia of FRP Rod		
Length of FRP Rod		
Dia of weather sheds		
Thickness of housing		
Dry arc distance		
Method of fixing sheds to housing		
No of weather sheds		
Type of sheds		
Dia of bottom end fitting		
Centre to centre distance between Tongue & Clevis		
Weight of composite insulator		
Type of packing		
No of insulator in each pack		
Weight of Insulator		
Gross weight of package		
Marking		
Gurantee		

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