# Annexure –4A

# Technical Specifications
# for
# Silicon Polymer Rod Type Insulator

**CONTENTS:-**

## 1. SCOPE

This specification covers design, manufacture, testing at manufacturer's works before dispatch and supply of Silicon Rubber Composite long rod Insulators.

## 2. CODES AND STANDARDS

2.1 The insulators shall comply in all respects with IEC standards 61109 Edition 2.02008-05,62217-2005,62039 60120,20 & 60120, 16/16A,60815-1986, 60587method 1, class 1A4.5 or 1B4.5, 60383-1& 60383-2 or ANSI C29.11, 29.12, ASTM A153 with their latest amendments & editions.

2.2 Insulators conforming to any other internationally accepted standards, which ensure equal or higher quality than the standards mentioned above will also be acceptable. Where the material is offered according to any such international standard, an English version of the standard shall be attached to the tender.

## 3 GENERAL REQUIREMENTS

For evaluation of bidder's qualifications, bidder should submit a reference list showing supply experience of polymer insulators of the manufacturer. The polymer insulators shall be designed, manufactured and tested in accordance with the requirements of the following standards unless otherwise noted.

| | |
|---|---|
| **i** | **IEC pub. 61109 Edition 2.0 2008-05:<br>Composite insulators for A.C. overhead lines with a nominal voltage greater than1000V- Definitions, test method and acceptance criteria.** |
| **ii** | **IEC Pub. 60815-1986:<br>Guide for the selection of Insulators in respect of polluted conditions.** |
| **iii** | **IEC 60120-For the selection of coupling** |
| **iv** | **IEC Pub: 60587 for Track resistance of the material** |
| **v** | **IEC 62039 Selection guide for polymeric materials for outdoor use under HV stress.** |
| **vi** | **IEC- 60383 for galvanizing thickness or ANSI C 29.11, 29.12/ASTM A 153 or any other with latest amendments.** |
| **vii** | **IEC Pub 62217-2005 Polymeric insulators for indoor & outdoor use with nominal voltage>1000v-General definitions test methods and acceptance criteria.** |

Note: The manufacturer must be an ISO: 9001 certified company. Manufacture having additional certification EMS & OHSAS shall be preferable.

## 4 LOCATIONS

The Silicone Rubber Composite Insulators are to be used for the 220 KV lines located near thermal power stations using coal, near sea coast and in the vicinity of cement factories which are getting polluted by certain deposits from the sea, salt deposits in the water vapor from cooling towers coal dust & cement/Fly ash & also Highly polluting Gases as $H_2S$ & $NH_3$.

$H_2S$ →209.96 ppb.
$NH_3$→38001 ppb.

## 5 DESIGN AND TYPE

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

| Sr. No. | Type of String | Size of composite Insulator (*Core dia. x Nominal length) (mm) | Minimum Creepage Distance (mm) | Electro-Mechanical Strength of Insulator Unit (KN) | Mechanical Strength of Insulator String along with Hardware fittings (KN) |
|---|---|---|---|---|---|
| **1** | **Suspension** | **20 x 2175** | **8600** | **90** | **90** |
| **2** | **Tension** | **20 x 2175** | **8600** | **120** | **120** |

* The core dia. of composite insulators is indicative only. The bidder shall offer Composite long rod insulators of suitable core dia. to meet specified E&M strength requirements.

5.2 Insulators shall have sheds of the open aerodynamic or shallow under rib profile or a combination of both with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be decided as per relevant practices but in keeping mind a very highly linearized voltage distribution decided only after a 3D study of Electric Field Voltage Distribution with corona rings and without corona rings by industry approved software tools and attain the best of the class Electric Field Voltage Distribution. A copy of values shall be submitted along with the offer and shall be revalidated with actual insulator design before mass production clearance from the AEML.

5.3 The overall shed and shank diameter design calculations shall be submitted. It is suggested to have s/p equal to or greater than 1 where ‘s’ stands for shed spacing and ‘p’ stands for shed projection. Similarly the shank dia. also needs to design keeping in view salinity resistance.

5.4 All insulators shall be designed and proportioned such that any dust, external contamination on the surface gets cleaned itself and does not require any washing or cleaning throughout the life of transmission line of minimum 40 years. However, the insulator shall be capable of withstanding high-pressure water washing.

## 6 TYPE TESTED INSULATORS

Type Test Certificate from an accredited laboratory of Silicon Rubber Composite Insulators shall be submitted by the bidder along with the Bid. Type test certificate should not be older than 5 years from the date of submission of Bid. If Type test results of Silicon Rubber Composite Insulators are not available, the bidder shall do the same at his own cost.

## 7 MATERIALS

7.1 Core

a) The reinforced E-CR (Electrically Corrosion Resistant) fiberglass core shall be epoxy fiberglass rod having superior electrical performance and mechanical strength & with Brittle Fracture Resistant quality.
b) The insulator core shall be mechanically and electrically sound, free from voids, foreign substances, and other manufacturing flaws.
c) Fiberglass Reinforced Plastic is of 20 mm or larger diameter shall be required for insulators of 3 m or longer to prevent excessive bending.

7.2 Housing (Sheath and Sheds)

a) The fiberglass core of the polymer insulators shall be equipped with housing made of high temperature vulcanized (HTV) Silicone Rubber. The Silicone elastomeric compound for housing shall have Si-O chemical backbone with fumed Silica and tracking control filler, ATH.
b) The housing shall be manufactured of 100 percent Silicone Rubber before fillers are added. The housing shall have shore 'A' hardness of not less than 60. The track resistance of the material shall meet IEC 60587 method 1 class 1A4.5 or 1B4.5 requirements.
c) The housing shall one piece molding of entire weather shed structure (sheds with the shank) on to the Fiberglass Plastic core rod of polymer insulator. The material of sheath and sheds shall be the same (i.e. insulator design shall be with one continuous polymer housing bonded to the central core of the polymer insulator).The distance between adjacent sheds over the sheath should be greater than 25mm.
d) The interface between the housing and rod shall be chemically bonded to prevent contaminants and moisture ingress. The bonding strength between the sheath and rod shall be greater than the breaking strength of the polymer material itself.
e) The end fittings (electrodes) shall not be covered with the housing to prevent electrical puncture through the housing.
f) The minimum thickness to housing shall be not less than 3.0 mm. Shed profile shall be in accordance with IEC pub.60815.
g) The color of the housing material shall be array, uniform and consistent.
h) Polymer insulator shall be designed to withstand high-pressure water washing with 3800 kappa, nozzle diameter 6mm the distance of 3m from nozzle to polymer insulator.

7.3 End-fitting

a) The end fittings shall be designed to transmit the mechanical load to the core and to develop the uniform and consistent mechanical strength of the insulators.
b) The material and the methods used in the fabrication of the end fittings shall be selected to provide good toughness and ductility. The metal shall be heat-treated appropriately to produce the minimum strength and ductility requirements.
c) Forgings shall be uniform in quality and without sharp edges or corners. Forgings shall be free of cracks, pipe, flakes, heat checks, seams, laps, and silvers, scabs, affected. Before forged end fittings are galvanized, all die flashing shall be carefully removed, without reducing the size below the dimension requirements.
d) Castings shall be uniform in quality and without sharp edges or corners. Castings

shall be free of cracks, blowholes, shrinkage defects, and localized porosity to the extent that the strength or suitability of the item is affected.

e) All ferrous material (except stainless steel) shall be hot-dip galvanized in accordance with ASTM A153. The galvanized thickness shall satisfy IEC Pub.60383-1clause 26.2.2 and IS: 2633 after the crimping.
f) Ball fitting shall be made of forged steel.

7.4. Assembly

a) The end fittings shall be attached to the core through crimping process (compression) so that end fittings uniformly transmit the mechanical load to the core. In the crimping process, the equipment such as Acoustic Emission Detector which can reject the harmful, cracks occurred on the FRP core shall be applied. The information concerned the above equipment, such as method and description, shall be submitted prior to award of this contract.
b) The bonding material used in the construction of insulators, particularly for joining the metal parts with the insulator, shall not cause fracture by expansion or loosening by contraction and must have high compression and shearing strengths and be free from change in volume due to ageing and temperature changes. It shall not give rise to chemical reaction with the metal fittings and/or thermal instability or chemical changes either in the insulator or the metal parts themselves.
c) The end fittings of polymer insulators after complete assembly with the core and housing shall be coaxial with one another.

7.5 Sealing

The junction of the metal end fitting and housing shall be sealed to prohibit the entrance of the moisture and foreign materials. Bidder is allowed to use properly sealing methods except that RTV Silicone shall not be allowed to be used. System of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The sealing must be humidity proof.

7.6 Marking

The marking shall be put on the end fitting. Marking on the weather shed is not permitted and the characters shall be legible, durable and permanently marked as follows:

1) Manufacturer's name or trademark
2) Specified mechanical load
3) Routine mechanical load
4) Year of make and series number
5) Country of manufacture
6) Purchasers Name (AEML)

7.7 Grading Ring

Polymer insulator rated at 150 KV and above shall have grading ring(s) attached. The RIV and corona performance of insulator with corona ring(s) shall conform to the requirement specified in IEC Pub.61109 Amendment-1.

## 8 DIMENSIONS AND TOLERANCES

The Silicone Rubber Composite Insulators covered by this specification shall have the dimensions specified in Annexure-A of this specification subject to the tolerances

indicated in relevant IEC standards 61109 Edition 2.0 2008-05,62217-2005,60120,20 & 60120, 16/16A, 60815-1986, 60587 method 1, class 1A 4.5 or 1 B 4.5, 60383-1 or ANSI C29.11, 29.12,ASTM A153 with their latest amendments.

## 9 WORKMANSHIP

9.1 The insulators covered by this specification shall be of latest design and conform to the latest scientific methods and shall be suitable for use on 220 kV transmission lines, Sound design, latest manufacturing processes and proper material quality control shall be ensured at various stages. Good finish and elimination or sharp edges and corners shall also be ensured. The Silicone Rubber Composite Insulators shall be free from all sorts of defects. All exposed surfaces shall be smooth and perfect.

9.2 The forged metal sockets and shank pins shall be free from cracks, seams, shrinks, air holes and rough edges. Metal pins shall be free from laps, folds, seams, burrs and rough edges. All surfaces of metal parts shall be perfectly smooth with no projecting points of irregularities.

9.3 All the ferrous parts shall be hot dip galvanized in accordance with the latest edition of ASTM A153 and shall satisfy the tests mentioned in latest edition of ASTM A153. The zinc coating shall be adherent, smooth, reasonably bright, continuous and free from such imperfection like flux, ash rust stains, bulky white deposits and blisters. Bituminous paint coating shall be provided on the metal units after assembly shall be concentric and co-axial within the limits as permitted by the relevant standards.

9.4 The zinc used for galvanizing shall be of grade Zn.99.95 as per ASTM A153/ IEC 61109.

9.5 The manufacturer of the insulators shall guarantee an insulator failure rate not exceeding one in 10000 insulators in one year. In case the annual failure rate exceeds the above limit, the manufacturer shall supply to the owner free of cost spare insulators equal to 10 times the excess failure every year for 25 years of operation.

9.6 The bidder shall guarantee the performance of the insulator under actual use condition for 60 months from the date of commissioning and beyond which for the next 20 years, the bidder shall be responsible for replacement and rectification of latent defects in the product or for catastrophic failure of the product attributable to faulty design, workmanship or any other material related failure. Failure would also include all impending failures as per ageing, FTIR or such tests of predictive nature. The bidder shall guarantee that there shall not be any brittle fracture and breakage of insulators. In event of any brittle fracture or breakage resulting in line drop, the bidder shall have to pay Rs. 1,00,000/- (Rs. One Lakh) per dropped string towards expenditure to be incurred by the DFCCIL/R-Infra for this line repair. This damage would be concurrent to other punitive steps for failure as described.

## 10 TEST REQUIREMENTS

All polymer insulators shall have completed the following Design, Type, Sample and Routine tests procedures described in IEC Pub.61109 Edition 2.0 2008-05 & IEC Pub.62217-2005, unless stipulated otherwise in this specification.

**a)** Design tests

All the tests shall be performed as per clause 10 of IEC 61109 Edition 2.0 2008-05 & IEC Pub.62217-2005 (Certified test reports based on tests performed prior to award of this contract may be accepted provided that the test requirements and product design have not been changed if design is changed then tests mentioned in IEC 61109 Edition 2.0 2008-05 table 1 has to be carried out).

i. Test on Inter faces & connection of end fittings.
(As per IEC 61109 Edition 2.0 2008-05 Clause 10 & IEC Pub.62217-2005)
   a) Press stressing
   b) Water immersion pre–stressing
   c) Visual examination.
   d) Steep-front impulse voltage test.
   e) Dry power frequency voltage test.

ii. Test on shed & housing material.
(As per IEC 61109 Edition 2.0 2008-05 Clause 10 & IEC Pub.62217-2005)
   a) Hardness test.
   b) Accelerated weathering test.
   c) Tracking & Erosion test.
   d) Flammability test.

iii. Test on the core material.
(As per IEC 61109 Edition 2.0 2008-05 Clause 10 & IEC Pub.62217-2005)
   a) Dye penetration test.
   b) Water diffusion test.

iv. Assembled core load-time test.
(As per IEC 61109 Edition 2.0 2008-05 Clause 10 & IEC Pub.62217-2005)
   a) Determination of the average failing load of the core of the assembled insulator.
   b) Control of the slope of the strength-time curve of the insulator

v. Additional tests
   a) Brittle fracture resistance test
   b) Accelerated Ageing Test of 5000 hours
   c) Ozone Resistance test
   d) Energy Dispersive Analysis of X-Rays
   e) (EDAX) for element Analysis of surface
   f) Surface analysis by optical spectrograph
   g) FTIR Signature analysis

**b)** Type tests

The following tests shall be performed as per clause 11 of IEC 61109 Edition 2.0 2008-05 & IEC 60383-2: (Certified test reports (not older than 5 years) based on tests performed prior to award of this contract may be accepted provided that the test requirements and product design have not changed).

- Dry lightning impulse withstand voltage test (IEC 61109 Edition 2.0 2008-05 clause 11.1)
- Wet power-frequency test (IEC61109 Edition 2.0 2008-05 clause 11.1)

- Wet switching impulse withstand voltage test (highest voltage: above 300 KV) (IEC 61109 Edition 2.0 2008-05 clause11.1)
- Damage limit proof test & test of the interface between end fittings & insulator housing (IEC 61109 Edition 2.0 2008-05, clause 12.2)
- Radio interference voltage test (IEC 61109 Amendment 1 clause 6.5)
- Salt-fog pollution withstand test
- All the electrical tests shall be performed on insulators with grading ring (s) if applicable. The type test must have been conducted on the offered insulator from a recognized test lab not earlier than 2012. The offer received without type test report shall be treated as non-responsive.

**c)** Sample tests

As a rule, the manufacturer shall carryout sample tests as the witness test as per IEC 61109 Edition 2.0 2008-05 clause 12. The following tests shall be performed on insulators taken at random from lots offered for acceptance. (IEC 61109 Edition 2.0 2008-05 clause 12.6 is applicable to the manufacturer)

- Verification of dimensions (IEC 61109 Edition 2.0 2008-05 clause 12.2)
- Verification of the locking system (IEC 61109 Edition 2.0 2008-05 clause 12.3)
- Verification of tightness of the interface between end fittings and insulator housing (E2) and of the specified mechanical load, SML (E1) (IEC 61109 Edition 2.0 2008-05 clause 12.4) Galvanizing test (IEC 61109 Edition 2.0 2008-05 clause 12.5)

**d)** Routine tests

The following tests shall be performed on every insulator offered for acceptance.

- Mechanical routine test (IEC 61109 Edition 2.0 2008-05 clause 13.1)
- Visual examination (IEC 61109 Edition 2.0 2008-05 clause 13.2)

**e)** Tests during Manufacture

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

**f) For FTIR** Signature analysis specified, the AEML shall withdraw the insulators at some locations on a mutually agreed schedule as per International practices and sent those used insulators to the bidder for various tests to have a clear understanding of any evolving defects and more importantly to track the variation in signature values of key parameters of the product. The bidder shall associate the original manufacturers of Silicone and E-CR fiber rod and others and also share the complete report. The AEML reserves the right to witness any or all the tests. The bidder shall be responsible for performing this analysis and giving the test reports.

**g) Random Repetition of Routine and Acceptance tests**

a. The AEML may repeat any test mentioned above once for each lot by drawing random samples from the site at no extra cost. Bidder shall arrange to receive the sample and arrange for testing. The AEML shall also check the mechanical

soundness through ultrasound or other suitable techniques of 10% of the insulators selected randomly at site in coordination with the bidder.

b. E&M test on 5 nos. for composite insulator of samples from whole lot received at site shall be conducted by AEML. The bidder will give 100% co-operation in this regard. This testing will be done only when type testing is done at testing laboratory other than M/s CPRI, Bangalore.

c. In case of failure, it will be repeated on double no. of samples and if it again fails, the whole lot should be rejected and shall be replaced by the bidder. The samples have to be taken at random after segregating insulators damaged in transportation or taken at random after segregating insulators damaged in transportation or otherwise.

**11 INSPECTION**

The AEML's representatives shall have access to the manufacturer's works for purpose of inspection of the manufacture of the materials covered by this specification. 15 days' notice shall invariably by give to AEML for arranging inspection of the materials. AEML will not be responsible for any delay if notice of 15 days is not given. The expenditure of witnessing of Acceptance Test at manufacturer's works shall be borne by the bidder.

**12 PACKING**

All insulators shall be packed in strong seasoned wooden crates or boxes suitable for easy but rough handling acceptable for rail and sea transport and durability for short-time outdoor storage. The packaging procedure to be used shall be submitted for acceptance.

**13 GUARANTEED TECHNICAL PARTICULARS (GTP)**

The number of insulators used on suspension and tension strings and the Electro mechanical strength are given in Annexure-A. Full guaranteed particulars including dry and wet flashovers, puncture and impulse voltages, corona formation voltages, creepages, distances, length, voltage distribution on strings etc., shall be furnished.

**14 Fully dimensioned drawings shall be enclosed DRAWINGS**

a) in duplicate to the tender, otherwise tender is liable for rejection.
b) Drawing of the existing 245kV suspension & tension insulator string with end fitting are attached in Annexure B

**15 ANNEXURE-A**

**REQUIRED RATING AND ELECTRICAL CHARACTERISTICS**

| Sl. No. | Characteristics | For Silicone Rubber Composite Insulators String | |
|---|---|---|---|
| | | 220 KV | |
| | | 90 KN | 120 KN |
| 1 | Type description Silicone Rubber Composite Insulators suitable for B | Silicone Rubber Composite Insulators suitable 95 couplings at the line & tower ends. | |
| 2 | Color & surface of Rubber portion. | Grey | |
| 3 | Ferrous parts | IEC 61109 Edition 2.0 2008-05 & ASTM A 153 | |
| 4 | Check clip provided in the socket. | 'M' Clip | |
| 5 | Ball pin | Drop forged steel | |
| 6 | Socket fitting | Malleable Ductile Iron | |
| 7 | Ball pin designation | 16mm | 20mm |
| 8 | a) Diameter and spacing<br><br>b) Tolerances | AS PER IEC 61109 Edition 2.0 2008-05(As these insulators are required for the replacement of existing porcelain insulator strings. The tolerance to be kept as minimum as possible) | |
| 9 | Minimum failing Load of Insulator (strings) | >90 KN | >120 KN |
| 10 | Minimum total creepage distance in mm | 8600 | 8600 |
| 11 | Combined Mechanical and Electrical strength in KN | 90KN | 120KN |
| 12 | One minute power Frequency Withstand Voltage (kV) Dry | 460 | 460 |
| 13 | One minute power Frequency withstand Voltage (kV) Wet | 460 | 460 |
| 14 | One minute power Frequency Flashover Voltage Dry/Wet(KV) | 460 | 460 |
| 15 | i) AC wet withstand Voltage: KV<br>ii) L.I. Pos with stand Voltage: KV<br>iii) S.I. Wet WSV: KV | 460<br>1050<br>Not applicable | 460<br>1050 |
| 16 | Visible discharge Voltage (kV) | 187 | 187 |
| 17 | Impulse flash over Voltage (kV) (min):<br>Positive:<br>Negative: | <br>1050<br>1050 | <br>1050<br>1050 |
| 18 | Flashover Power Frequency voltage (kV)<br>Dry:<br>Wet: | <br>460<br>460 | <br>460<br>460 |
| 19 | Standards according to Which the rubber | IEC 61109 Edition 2.0 2008-05/ | |

| | | | |
|---|---|---|---|
| | **insulator Shall be manufactured and Tested.** | **ANSI C 29-11, 29-12** | |
| **20** | **Mechanical breakings Strength.** | **7000 Kg** | **11500 Kg** |
| **21** | **Routine Mechanical Load** | **60 KN** | **80 KN** |
| **22** | **Net weight of strings (Approx.)** | **7 KG** | **9 KG** |