

SECTION – VI

**TECHNICAL SPECIFICATIONS
FOR**

DISC INSULATORS

&

SILICON RUBBER POLYMER INSULATORS

SECTION – VI

TECHNICAL SPECIFICATION FOR DISC INSULATORS FOR USE ON TRANSMISSION LINES (120KN & 90KN EMS)

1.0 SCOPE:

1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery F.O.R. (destination) DISC INSULATORS / LONG ROD INSULATORS as per technical requirements furnished in this specification. These insulators are to be used in suspension and tension insulator strings for suspension and anchoring of conductors on EHV transmission towers of KPTCL.

1.2 The insulators shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which, in his judgment, is not in full accordance therewith.

2.0 STANDARDS

2.1 Except as modified in this specification, the disc insulators shall conform to the following Indian standards which shall mean latest revisions and amendments. Equivalent International and Internationally recognized standards to which same of these standards generally correspond are also listed below:

Sl. No.	Indian Standard	Title	International standard
1	IS: 206	Method for chemical analysis of slab zinc	
2	IS: 209	Specification for Zinc	BS:3436
3	IS:731	Porcelain insulators for overhead power lines with the nominal voltage greater than 1000 V.	BS:137 (I&II) IEC:274 IEC:383
4	IS:2071 Part(I) Part (II) Part(III)	Method of High voltage Testing	
5	IS:2121	Specification of Conductors and Earth-wire Accessories for Overhead Power lines	

	Part (I)	Armour Rods, Binding-Wires and Tapes for conductors	
6	IS:2486 Part (I) Part (II) Part (III)	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	BS:3288 IEC:120 IEC:372
7	IS:2629	Recommended practice for hot dip galvanization for iron and steel	
8	IS: 2633	Testing for Uniformity of Coating of Zinc Coated Articles	
9	IS:3138	Hexagonal bolts and nuts	ISO/R 947 and ISO/R 272
10	IS:3188	Dimensions for Disc Insulators	IEC:305
11	IS:4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R262- 1969 and R 965- 1969
12	IS:6745	Determination of weight of zinc coating on zinc coated iron and steel articles	
13	IS:8263	Methods of RIV Test of HV Insulators	IEC:437 NEMA Publication No.107/1964 CISPR
14	IS:8269	Methods for switching impulse test on HV insulators	IEC: 506
15		Thermal Mechanical performance test and mechanical performance test on string insulator units.	IEC:575
16	IEC	Long rod insulators	IEC-433

2.2

The Standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards institution, 101, Pentonville Road, N-19, ND, UK

IEC/CISPR	International Electro technical Commission Bureau Central de la Commission Electro Technique International 1, Rue de verembe Geneva Switzerland
IS	Bureau of India Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110 001 India
ISO	International Organisation for standardization Danish Board of Standardization ,Dansk Standardisering Street, Aurehoegvej – 12 DK – 2900 DENMARK
NEMA	National Electric Manufactures Association,155, East 44 th Street, New York, NY 10017 USA.
CEA	Central Electricity Authority, Sewa Bhawan, Rama Krishna Puram, Sector-1, New Delhi-110066.

2.3 Insulators conforming to any other international standards are also acceptable provided always that such standards are equivalent to or better than the corresponding standards specified in 2.1 above. However in such an event the salient points of Comparison between the standards adopted and the standards quoted herein shall be detailed in the appropriate schedule. Two copies authentic English version of such standards shall be submitted along with the offer.

3.0 PRINCIPAL PARAMETERS:

3.1 Details of disc Insulators:

Sl. No.	Type of String	Size of disc insulator (mm)	Minimum creepage distance of each disc (mm)	No. of Standard discs	EMS of Insulator string in KN
220 KV					
01	single Suspension	255/x 145	320	13	90
02	Double Suspension	255/x145	-do-	2x13	2x90
03	Single Tension	255x145	320	15	120
04	Double Tensile	-do-	-do-	2x15	2x120
110 KV					
01	single Suspension	255x145	320	7	90
02	Double Suspension	-do-	-do-	2x7	2x90
03	Single Tension	255x145	320	8	90
04	Double Tensile	-do-	-do-	2x8	2x90
66KV					
01	single Suspension	255x145	320	4	90
02	Double Suspension	-do-	-do-	2x4	2x90
03	Single Tension	255x145	320	5	90
04	Double Tensile	-do-	-do-	2x5	2x90

3.1.1 The insulator strings shall consist of standard discs for a three phase. 50 HZ, effectively earthed 220KV or 110KV or 66KV transmission system in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type.

3.1.2 The Size of disc 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 shall be as follows:

4.0 GENERAL TECHNICAL REQUIREMENTS:

4.1 PORCELAIN:

The porcelain used in the manufacture of the shells shall be ivory white, nonporous, of high dielectric, mechanical and thermal strength, free from internal stresses, blisters, laminations, voids, foreign matter, imperfections or other defects which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by

climatic conditions, ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by thorough verification.

4.2 PORCELAIN GLAZE:

Surface to come in contact with cement shall be made rough by sand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature co-efficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the colour of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

4.3 METAL PARTS:

4.3.1 CAP AND BALL PINS:

Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable, cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

4.3.2 SECURITY CLIPS:

The security clips shall be made of phosphor bronze or of stainless steel.

4.3.3 FILLER MATERIAL:

Cement to be used, as a filler material shall be quick setting, fast curing port-land cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contact with it and its thickness shall be as small and as uniform as possible.

4.4 MATERIAL DESIGN AND WORKMANSHIP:

4.4.1 GENERAL:

- i. All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials quality control and to stage testing / quality control during manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission Lines.
- ii. The design, manufacturing, process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish, elimination of sharp edges and corners to limit corona and radio interference voltages.

4.4.2 INSULATOR SHELL:

The design of the insulator shells shall be such stresses due to expansion and contraction in any part the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature test followed by mallet test. Shells shall dried under controlled conditions of humidity temperature.

4.4.3 METAL PARTS:

- i. The Pin and cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of string or when a string is placed in position.
- ii. Metal caps shall be free from cracks, seams, shrinks, air holes, blow holes and rough edges. All metal surfaces shall be perfectly smooth with no projecting parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

4.4.4 GALVANISING:

All ferrous parts shall be hot dip galvanized in accordance with IS:2629. The zinc to be used for galvanizing shall conform to grade

Zn 99.5 as per IS-209. The zinc coating shall be uniform, smoothly adherent, reasonably bright, continuous and free from impurities such as flux, ash, rust strains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

4.4.5 CEMENTING:

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. A zinc sleeve measuring 5mm thick and 20mm length shall be provided on the pin as shown in the drawing Section-XII.

4.4.6 SECURITY CLIPS (LOCKING DEVICES):

The security clips to be used as locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS:2468 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall be resilient, corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50N (5 Kg) or more than 500 N (50 Kg).

4.5 BALL AND SOCKET DESIGNATION:

The dimensions of the balls and sockets for 90KN discs shall be of 16mm and for 120KN discs shall be of 20mm designation in accordance with the standard dimensions state in IS:2486 (Part – II).

4.6 DIMENSIONAL TOLERANCE OF INSULATOR DISCS:

It shall be ensured that the dimensions of the insulators are within the limits specified below:

- a. diameter of Disc (mm)

	Standard	Maximum	Minimum
120 kN Disc	255	266	244
90 kN Disc	255	266	244

b. Ball to Ball spacing between discs (mm)

	Standard	Maximum	Minimum
120 kN Disc	145	149	141
90 kN Disc	145	149	141

4.7 INTERCHANGEABILITY:

The insulators inclusive of the ball and socket fit shall be of standard design suitable for use with ware fittings of any make conforming to relevant standards.

4.8 CORONA AND RIV PERFORMANCE:

All surfaces shall be even, smooth, without cuts, sions or projections. No part shall be subject to excessive localized pressure. The metal parts and lain shall not produce any noise generating corona at all operating conditions.

4.9 SUITABILITY FOR LIVE LINE MAINTENANCE:

The insulators shall be compatible for use wit line or live line maintenance technique that usual hot line operations can be out with ease, speed and safety.

4.10 FREEDOM FROM DEFECTS:

Insulators shall have none of the following defects:

- i. Ball pin shake
- ii. Cementing defects near the pin like small blow holes, small hair cracks, lumps, etc.
- iii. Sand fall defects on the surface of the insulator.

4.11 INSULATOR STRINGS:

4.11.1 TYPE AND RATING:

The insulator strings shall be formed with standard discs described in this specification for use on 3 phase, 220/110/66KV, 50 Hz effectively earthed systems in an with pollution level as indicated in project synopsis atmosphere. Suspension insulator strings for use with suspension / tangent towers are to be fitted with discs of 90 KN

EMS rating while tension insulator strings for use with Anchor / Tension towers are to be fitted with discs of 120/90 KN EMS rating.

4.11.2 STRING SIZE:

The size of the disc insulator, the number to be used in different types of strings, their Electro-mechanical strength and minimum nominal creep age distance shall be as given in clause 3.1.2.

4.12 STRING CHARACTERISTICS:

The characteristic of the complete sting shall be as follows:

	Suspension			Tension		
	220KV	110KV	66KV	220KV	110KV	66KV
i. Lightning Impulse withstand voltage (dry) KV peak.	1050	550	325	1050	550	325
ii. Power frequencies withstand voltage (wet) KV r.m.s.	460	230	140	460	230	140
	176	-	-	176	-	-
iii. Corona extinction voltage – KV (rms).	500	-	-	500	-	-
iv. Max. RIV for complete string including corona rings, arcing horns, clamps etc, at 1.1 times maximum line to ground voltage (micro-volts)	120	90	90	120	90	90
	-	-	-	-	-	-
v. Mechanical failing load for each sting KN.	13%	13%	13%	13%	13%	13%
vi. No deformation load for each string Kgf.						
vii. Max. voltage across any disc.						

4.12.1 Insulator units after assembly shall be concentric coaxial within limits as permitted by Indian standards

4.12.2 The string design shall be such that when units coupled together there shall be contact between shell of one unit and metal of the adjacent unit.

5.0 TECHNICAL DESCRIPTION OF PORCELAIN LONG ROD INSULATORS.

5.1 DETAILS OF PORCELAIN LONG ROD INSULATORS:

5.1.1 The Insulator string shall consists of standard long rod insulators with normal sheds for three phase 50 Hz, effectively earthed 220/110/66kv transmission system in a lightly/medium polluted atmosphere. The insulators shall be long rod type with Ball & Socket connection.

5.1.2 Insulator shall have normal sheds/alternate sheds with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendations of IEC-815

5.1.3 Supplier quoting for long rod insulators made of electro porcelain shall also supply intermediate ball pins and intermediate arcing horns along with long rod insulators.

5.1.4 The prices of these items shall be considered as included in the price of long rod insulators.

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

5.3 STRING CHARACTERISTICS:

The Characteristics of the complete string with long rod insulators shall be as follows.

Sl No	Line KV	Type of String	Length of the string with long rod ins.(Cap to Cap) (mm)	Min. Creep age distance	No.of individual units / string	EMS of Insulator (KN)
1	220Kv	Single Suspn	1885	7595	1	1x90
		Single Tension	2175	7595	1	1x120
		Double Suspn	1885	7595	2	2x90
		Double Tension	2175	7595	2	2x120
3	110kv	Single Suspn	1015	3751	1	1x90
		Single Tension	1160	3751	1	1x90
		Double Suspn	1015	3751	2	2x90
		Double Tension	1160	3751	2	2x90
4	66kv	Single Suspn	580	2248	1	1x90
		Single Tension	725	2248	1	1x90
		Double Suspn	580	2248	2	2x90
		Double Tension	725	2248	2	2x90

Sl. No	Particulars	220 KV	110 KV	66 KV
1	Lightning Impulse withstand voltage (dry) KV peak	1050	550	325
2	Power frequency withstand voltage (wet) KV rms	460	230	140
3	Corona extinction voltage – KV (rms)	176	-	-
4	Max. RIV for complete string including corona rings, arcing horns, clamps etc., at 1.1 times maximum line to ground voltage (micro-volts)	500	-	-

6.0 GENERAL TECHNICAL REQUIREMENTS:

6.1 PORCELAIN

The porcelain used in the manufacture of the shells shall be ivory white, nonporous, of high dielectric, mechanical and thermal strength, free from internal stresses, blisters, laminations, voids, foreign matter, imperfections or other defects which might render it in any way unsuitable for insulator shells. Porcelain shall remain unaffected by climatic conditions, ozone, acid, alkalis, zinc or dust. The manufacturing shall be by the wet process and impervious character obtained by through verification.

6.2 PORCELAIN GLAZE:

Surface to come in contact with cement shall be made rough by sand glazing. All other exposed surfaces shall be glazed with ceramic materials having the same temperature co-efficient of expansion as that of the insulator shell. The thickness of the glaze shall be uniform throughout and the color of the glaze shall be brown. The glaze shall have a visible luster and smooth on surface and be capable of satisfactory performance under extreme tropical climatic weather conditions and prevent ageing of the porcelain. The glaze shall remain under compression on the porcelain body throughout the working temperature range.

6.3 METAL PARTS:

6.3.1 CAP AND BALL PINS:

Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel,

drop forged and heat-treated. The caps shall be cast with good quality black heart malleable, cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The bidder shall specify the grade, composition and mechanical properties of steel used for caps and pins.

6.3.2 METAL PARTS:

- i. The Pin and cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of string or when a string is placed in position.
- ii. Metal caps shall be free from cracks, seams, shrinks, air holes, blow holes and rough edges. All metal surfaces shall be perfectly smooth with no projecting parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

6.3.3 SECURITY CLIPS:

The security clips shall be made of phosphor bronze or of stainless steel.

6.4 FILLER MATERIAL:

Cement to be used as a filler material shall be quick setting, fast curing port-land cement. It shall not cause fracture by expansion or loosening by contraction. Cement shall not react chemically with metal parts in contact with it and it's thickness shall be as small and as uniform as possible.

7.0 MATERIAL DESIGN AND WORKMANSHIP:

7.1 GENERAL:

- i. All raw materials to be used in the manufacture of these insulators shall be subject to strict raw materials quality control and to stage testing / quality control during

manufacturing stage to ensure the quality of the final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory performance on Transmission Lines.

- ii. The design, manufacturing, process and material control at various stages be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish, elimination of sharp edges and corners to limit corona and radio interference voltages.

7.2 INSULATOR SHELL:

The design of the insulator shells shall be such stresses due to expansion and contraction in any part the insulator shall not lead to deterioration. Shells with cracks shall be eliminated by temperature test followed by mallet test. Shells shall dried under controlled conditions of humidity temperature.

7.3 METAL PARTS:

i) The Pin and cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric and of such design that it will not yield or distort under loaded conditions. The head portion of the pinball shall be suitably designed so that when the insulator is under tension the stresses are uniformly distributed over the pinhole portion of the shell. The pinball shall move freely in the cap socket either during assembly of a string or during erection of string or when a string is placed in position.

ii) Metal caps shall be free from cracks, seams, shrinks, air holes, blow holes and rough edges. All metal surfaces shall be perfectly smooth with no projecting parts or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids.

7.4 GALVANISING:

All ferrous parts shall be hot dip galvanized in accordance with IS: 2629. The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS-209. The zinc coating shall be uniform, smoothly adherent, reasonably bright, continuous and free from impurities such as flux, ash, rust strains, bulky white deposits and blisters.

Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

7.4.1 CEMENTING

The insulator design shall be such that the insulating medium shall not directly engage with hard metal. The surfaces of porcelain and coated with resilient paint to offset the effect of difference in thermal expansions of these materials. A zinc sleeve measuring 5mm thick and 20mm length shall be provided on the pin as shown in the drawing Section-XII.

7.5 SECURITY CLIPS (LOCKING DEVICES):

The security clips to be used as locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS:2468 (Part-IV). The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall be resilient, corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50N (5Kgs) or more than 500 N (50 Kgs).

7.6 BALL AND SOCKET DESIGNATION:

The dimensions of the balls and sockets for 90KN Long Rod shall be of 16mm and for 120KN Long Rod shall be of 20mm designation in accordance with the standard dimensions state in IS:2486 (Part – II)

7.7 DIMENSIONAL TOLERANCE OF INSULATOR UNITS:

It shall be ensured that the dimensions of the insulators are within the limits specified below:

+ $(0.04d + 1.5)$ mm when $d < 300$ mm

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

Where d being the dimensions in millimeters for diameter, length or creep age distance as the case may be.

However, no negative tolerance shall be applicable for creep age distance.

7.8 INTERMEDIATE BALL PIN DESIGNATION

The dimensions of the intermediate ball pin shall be in accordance with standard dimension stated in IEC 471

7.9 INTERCHANGEABILITY:

The long rod insulator with ball and socket connection shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant IS/IEC standards.

8.0 TESTS:

8.1 The following tests shall be carried out on the insulator string and unit insulators.

8.2 TYPE TESTS:

This shall mean those tests, which are to be carried to prove the design, process of manufacture and conformity of the material and product with the insulator of this specification. These tests shall be conducted on representative number of samples prior to commencement of commercial production. The bidder shall indicate his schedule for carrying out these tests.

8.3 ACCEPTANCE TESTS:

This shall mean these tests, which are to be carried on samples taken from each lot offered for pre-dispatch inspection for the purpose of acceptance of the lot

8.4 ROUTINE TEST:

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

8.5 TESTS DURING MANUFACTURE:

Stage tests during manufacture shall mean those, which are to be carried out during the process of manufacture to ensure quality control such that the product is of the designed quality conforming to intent of this specification.

8.6 TEST VALUES:

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

8.7 TEST PROCEDURES AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian standard or other internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and norms according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms and procedure for the same shall be as specified in annexure IV attached hereto or as mutually agreed to between the supplier and the purchaser in the Quality Assurance program.

8.8 TYPE TESTS:

The following type tests shall be conducted on a suitable number of individual discs, components, materials or complete strings.

8.8.1 on unit Disc Insulators:

- a) Verification of dimensions : IS:731
- b) Thermal mechanical
Performance test : IEC:575
- c) Power frequency voltage
withstand and flashover
(i) dry (ii) wet : BS:137
- d) Impulse voltage withstand
Flashover test (dry) : IEC:383
- e) Visible Discharge test (dry) : IS:731
- f) RIV test (dry) : IS:8263

8.8.2 on Porcelain Long Rod Insulator unit.

- g) Verification of dimensions : IEC -383
- h) Thermal mechanical
Performance test : IEC:575
- i) Power frequency voltage
withstand and flashover
(i) dry (ii) wet : IEC-383
- j) Impulse voltage withstand
Flashover test (dry) : IEC:383
- j) Visible Discharge test (dry) : IS:731
- k) RIV test (dry) : IS:8263

8.8.3 On the complete insulator string with hardware fittings:

- a) Power frequency voltage withstand) BS:137(Part-I)
test with corona control rings)
and under wet condition)
- b) Switching surge voltage withstand)
test under wet condition)
(400KV only))
- c) Impulse voltage withstand test) IEC:383
under dry condition.)
- d) Impulse voltage flashover test)
under dry condition)
- e) Voltage distribution test)
- f) Corona and RIV test under) As per this
dry condition) Specification
- g) Mechanical strength test)
- h) Vibration)

8.8.4 On the complete porcelain long rod insulator string with hardware fittings :

- i) Power frequency voltage withstand) IEC-383
test with corona control rings)
and under wet condition)

- j) Switching surge voltage withstand test under wet condition (400KV only)))
- k) Impulse voltage withstand test under dry condition.) IEC:383)
- l) Impulse voltage flashover test under dry condition))
- m) Voltage distribution test)
- n) Corona and RIV test under dry condition) As per this Specification)
- o) Mechanical strength test)
- p) Vibration)

8.8.5 All the type tests given under clause No.6.8.1 shall be conducted on Single suspension and Double tension Insulator strings along with hardware fittings.

8.9 ACCEPTANCE TESTS:

8.9.1 For Disc Insulators:

- a) Visual Examination : IS:731
- b) Verification of Dimensions : IS:731
- c) Temperature cycle test IS:731
- d) Galvanizing test
- e) Mechanical performance test : IEC:575
- f) Test on locking device for ball and socket coupling Eccentricity test (As per this specification)) IEC: 372)
- h) Electro – mechanical strength test) IS:731)
- g) Puncture test

8.9.2 For Porcelain Long rod Insulator:

- a) Visual examination As per IEC 383
- b) Verification of dimensions As per IEC 383
- c) Temperature cycle test) IS:731/IEC-383)

- h) Galvanizing test)
- i) Mechanical performance test : IEC:575
- j) Test on locking device for ball and socket coupling : IEC: 372
- Eccentricity test) As per this
) specification/IEC 383
- n) Electro – mechanical strength test)
) IS:731/IEC 383
- k) Puncture test)
)
- l) Porosity test)

8.10 ROUTINE TEST :

8.10.1 For Disc Insulators:

- a) Visual Inspection)S:731
- b) Mechanical Routine Test)
- c) Electrical Routine Test) IEC:383

8.10.2 For Porcelain Long rod Insulators:

- d) Visual Inspection)
) IS:731/IEC 383
- e) Mechanical Routine Test)
- f) Electrical Routine Test) IEC:383

8.11 TESTS DURING MANUFACTURE:

On all components as applicable

- a) Chemical analysis of zinc used for galvanizing)
)
- b) Chemical analysis, mechanical and metallographic test and magnetic particle inspection for malleable castings.)
)
- c) Chemical analysis, harness test and magnetic particle inspection) As per the
) Specification

for forgings

- d) Hydraulic Internal pressure test)
on shell
- e) Crack detection test for metal parts)

8.12 ADDITIONAL TEST:

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier or at any other recognized laboratory / research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the materials complies with the intent of this specification.

8.13 CO-ORDINATION FOR TESTING:

For insulator strings, the supplier shall arrange to conduct testing of their disc insulators with the hardware fittings to be supplied to the Purchaser by other suppliers. The supplier is also required to guarantee overall satisfactory performance of the disc insulator with the hardware fittings.

NOTE:

In respect of electrical test on a complete string consisting of insulators and hard wares guarantee of values and responsibility of testing shall be with hardware manufacturer for RIV, corona and voltage distribution test and with insulator manufacturer for all other tests.

8.14 TEST CHARGES AND TEST SCHEDULE:

8.14.1 TYPE TESTS:

The disc insulators offered shall be fully type tested as per these specifications. The bids offering Disc Insulators not type tested will be rejected. These tests must not have been conducted earlier than **ten** years from the date of bid opening. In case the equipment of the type and design offered has already been type tested, the bidder shall furnish four sets of type test reports along with the offer. In case the type tests are conducted earlier than **ten** years all type tests as per the relevant standards shall be carried out by the successful bidder in the presence of purchaser's representative at free of cost. The purchaser reserves the right to demand repetition of any or all the type tests in the presence of his representatives. For this purpose, the bidder may quote relevant rates for carrying out each type test. The prices quoted by the bidder towards conductance of type test shall **not** be taken into consideration for bid evaluation.

For any change in the design / type already type test and the design / type offered against this specification the purchaser reserves the right to demand repetition tests without any extra cost.

NOTE: The Type Test / Special Tests, if repeated at the insistence of owner, the applicable testing charges shall be paid by the successful Bidder upfront to the laboratory and the same shall be reimbursable by KPTCL as per actuals on submission of Bills along with proof of payment and on successful completion of all the Type Tests, specified and on approval of the same by the owner.

In case equipment/material fails in the type tests during testing then the testing charges paid by the Bidder to the laboratory will not be reimbursed by KPTCL.

The above clause is applicable for all the equipments / materials, in case, the Type Test/Special Tests, are repeated at the insistence of owner (KPTCL).

8.14.2 ACCEPTANCE AND ROUTINE TESTS:

All acceptance and Routine tests as stipulated here shall be carried out by the supplier in the presence purchaser's representative.

8.14.3 Immediately after finalization of the programme of type / acceptance / routine testing, the supplier shall give sufficient advance intimation to the Owner; enable him to depute his representative for witness the test.

8.14.4 For type tests involving tests on a complete insulator string with hardware fittings, the Purchaser will advice the supplier of the hardware fittings to provide the necessary fittings to the place of the test.

8.14.5 In case of failure of the complete string in any type tests, the manufacturer whose product has failed in type tests, shall get the tests repeated at his cost. In case of any dispute, assessment of the Purchasers to the items that has caused the failure in any of the type tests shall be final and binding.

9.0 INSPECTION:

9.1 i. Purchaser and its representative shall at a times be entitled to have access to the works and to all places of manufacture where insulators are manufactured and the supplier shall afford all

facilities to them for unrestricted inspection of the works, inspection of materials, inspection of manufacturing process of insulators for conducting necessary tests and specified herein.

ii. The supplier shall keep the Purchaser informed in advance of the time of starting and progress of manufacture of insulators in various stages so that arrangements could be made for inspection.

iii. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv. The acceptance of any quantity of insulators shall in no way relieve the supplier of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such disc insulators are later found to be defective.

9.2 IDENTIFICATION MARKING:

9.2.1 Each disc insulator shall be legibly and indelibly marked with the trademark of the supplier, the year of manufacture, the guaranteed combined mechanical and electrical strength in Kilo-Newton abbreviated by 'KN' to facilitate easy identification and proper use.

9.2.2 The marking shall be on porcelain for porcelain insulators. The marking shall be printed and not impressed and the same shall be applied before firing.

9.3 Quality assurance plan:

9.3.1 The bidder hereunder shall invariably furnish following information's along with his offer, failing which the offer shall be liable for rejection.

- i. Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standard, according to which the raw materials are tested, list of tests, normally carried out on raw material in presence of Bidder's representative, copies of test certificates.
- ii. Information and copies of test certificates as in (i) above in respect of bought out material.
- iii. List of manufacturing facilities available.
- iv. Level of automation achieved and list of areas where manual processing exists.
- v. List of areas in manufacturing process, where stage inspections are normally carried out in quality control and details of such tests and inspections.

- vi. Special features provided in the equipment to make it maintenance free.
- vii. List of testing equipment available with the Bidder for final testing of equipment specified and test plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

9.3.2 The supplier shall within 30 days of placement of order submit the following information to the owner.

- i. List of raw materials and the names of sub-suppliers selected from those furnished along with the offer.
- ii. Type test certificates of the raw material and bought out accessories.
- iii. Quality assurance plan (QAP) with hold points for purchasers inspection. The QAP and purchaser's hold points shall be discussed between the Owner and the supplier before the QAP is finalised.

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

10.0 Documentation:

10.1 The bidder shall furnish full description and illustrated catalogues of insulators offered along with the offer.

10.2 TEST REPORTS:

- i. Four copies of type test reports shall be furnished to the purchaser's within one month conducting the tests. One copy will be return duly certified by the purchaser's to the supplier within three weeks there afterwards and receipt of the same supplier shall commence with the commercial production of the concern material.
- ii. Four copies of acceptance test reports shall furnished to the purchaser's. One copy will returned, duly certified by the purchaser's and only there after shall the materials be dispatched.
- iii. All records of routine test reports shall maintained by the supplier at his works for periodic inspection by the purchaser's.
- iv. All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

11.0 PACKING & FORWARDING:

- i. All disc insulators shall be packed in strong seasoned wooden crates. The gross weight of the crates along with disc insulators shall not normally exceed 200 kg. to avoid handling problem. Suitable lifting lugs shall be provided on the crates in order to facilitate handling by cranes.
- ii. The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.
- iii. Suitable cushioning, protective padding, Dunn age or spacers shall be provided to prevent damage or deformation during transit and handling.
- iv. All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case / crate shall have all the markings stenciled on it in indelible ink.

TEST DETAILS

1.0 TESTS ON COMPLETE STRING WITH HARDWARE FITTINGS:

1.1 VOLTAGE DISTRIBUTION TEST:

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage and proportionate correction be applied as to give a total of 100% distribution. The voltage across any disc shall not exceed the values given in clause 4-12.1

1.2 CORONA EXTINCTION VOLTAGE TEST (DRY):

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than the value specified at clause 4.12.1 (iv) under dry condition. There shall be no evidence of corona on any part of the sample when all possible source of corona are photographed in a darkened room.

1.3 RIV TEST (DRY):

Under the conditions as specified in (2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 500 micro volts at one MHz when subjected to 50 Hz AC voltage of 1.1 times maximum line to ground voltage under dry condition. The test procedure shall be in accordance with IS:8263/IEC:437

1.4 MECHNICAL STRENGTH TEST:

The complete insulator string along with its hardware fitting excluding arcing horn corona controlling/grading ring and suspension assembly/dead end assembly shall be subject to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at steady rate to 68% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing loads reached and the value recorded.

1.5 **VIBRATION TEST:**

The suspension string shall be tested in suspension mode and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspensions string a load equal to 600 Kg. Shall be applied along with the axis of the suspensions string by means of turn buckle. The insulators string along with hardware fittings and two sub conductors throughout the duration of the test vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulator string (more than 10HZ) by means of vibration inducing equipment. The amplitude of vibration at the antipode point nearest to the string shall be measured and the same shall not be less than 120.4 being the frequency of vibration. The insulator strings shall be vibrated for five million cycles then rotated by 90 deg and again vibrated for 5 million cycles without any failure, after the test the disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware fittings shall be examined to fatigue fatter and mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test. The insulators shall be subjected to the following tests as per relevant standards.

<u>Test</u>	<u>%age of units to be tested</u>	
	Disc.	Long Rod
a. Temperature cycle test followed by mechanical performance test.	60	100
b. Puncturetest	40	-
(for porcelain insulator only)		

2. **ON DISC INSULATOR UNITS/PORCELAIN LONG ROD UNITS (As applicable):**

2.1 **Steep Wave Front Test (For Disc Insulator only):**

Test following test shall be performed on 10 insulator units in case of disc insulators selected at random from the lot offered for selection of sample for type test.

- a. Each insulator unit shall be subjected to five successive positive and negative impulse flashovers with a wave having minimum effective rate of rise of 2500 KV per micro seconds.

- b. Each unit shall then be subjected to three dry power frequency voltage flashovers.

Acceptance Criteria:

An insulator shall be deemed to have met the requirement of this test if, having been successfully subjected to the ten impulse flashovers, the arithmetic mean of the three subsequent dry/power frequency voltage flashover values equals or exceeds 95% of the rated dry power frequency flashover voltage.

An insulator shall be deemed to have failed to meet the requirement of above testing if,

- a) It has not flash over when the oscillogram or peak voltage indicator shows a marked reduction in voltage.

or

- b) Any one of the subsequent three dry power frequency voltage flashover value is less than 80% of the value specified.

Failure of any one unit either in the steep wave front or subsequent low frequency voltage test shall cause for testing on double number of units.

2.2 Polarized Light Inspection (only for Glass Disc Insulator):

The disc insulator shall be held over a polarized light source and the stress lines viewed thereon. There shall be no uneven stress distribution in the toughened glass insulators. This shall be carried out on 100% glass shells.

2.3 Hydraulic Internal Pressure Test on Shells (only for Disc Insulator):

The test shall be carried out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the Supplier and Purchaser in Quality Assurance Programme.

2.4 Thermal Mechanical Performance Test:

Thermal Mechanical Performance Test shall be performed in accordance with IEC-60383-1 Clause 20 with the following modifications:

- 1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.

- 2) The acceptance criteria shall be
 - a) X greater than or equal to $R + 3S$.

Where

X = Mean value of the individual mechanical failing load.

R = Rated electro-mechanical/mechanical failing load.

S = Standard deviation.

- b) The minimum sample size shall be taken as 20 for disc insulator units and 5 units for long rod units.
- c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

2.5 Electromechanical/Mechanical Failing load Test:

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance.

- i) X greater than or equal to $R + 3S$

Where

X = Mean value of the individual mechanical failing load.

R = Rated electro-mechanical/mechanical failing load.

S = Standard deviation.

- ii) The minimum sample size shall be taken as 20 for disc insulators units and 5 for long rod units. However, for larger lot size, IEC591 shall be applicable.
- iii) The individual electro-mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.

2.6 Residual Strength Test (For Disc Insulators only):

The above test shall be performed as per clause 4.4 and 4.5 of IEC 797 preceded by the temperature cycle test, on both glass and porcelain disc insulators. The Sample size shall be 25 and the evaluation of the results and acceptance criteria shall be as per clause No.4.6 of IEC:797.

2.7 IR Measurements:

IR Measurement shall be carried out by the instrument operating at 1 KV DC. IR value when measured under fair weather condition, shall not be less than 50 M-ohm.

2.8 Impact Test:

The Impact test shall be carried out in accordance with ANSI-C-29.2 Clause 8.2.8 with the following modification.

The breaking point of the pendulum shall be so adjusted that, when released the copper nose will strike the outer rim of the shell or the most protruded rim of the shell squarely in direction parallel to the axis of the unit and towards the cap.

The test specimen shall receive an impact of 7 N-m for 120 kN Disc & 10N-m for 160 kN Disc releasing the pendulum.

3 TESTS ON ALL COMPONENTS (As applicable)

3.1 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING:

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

3.2 TEST FOR FORGINGS:

The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the international/recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

3.3 TEST ON CASTINGS:

The Chemical analysis mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally recognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the supplier and purchaser in quality assurance programme.

3.4 HYDRAULIC INTERNAL PRESSURE TEST ON SHELLS:

The test shall be carried out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the suppliers and purchaser in quality assurance programme.

3.5 THERMAL MECHANICAL PERFORMANCE TEST:

The thermal mechanical performance test shall be carried out on minimum 15 number of disc insulators units as per the procedure given in IEC 575. The performance of the insulator unit shall be determined by the same standard.

3.6 ECCENTRICITY TEST:

The insulator shall be vertically mounted on a fixture using dummy pin and socket. A vertical scale with horizontal slider shall be used for the axial run out. The pointer shall be positioned in contact with the bottom of the outermost petticoat of the disc. The disc insulators shall be rotated with reference to the fixture and the slider shall be allowed to move up and down on the scale but always maintaining contact with the bottom of the outer most petticoats. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

Similarly using a horizontal scale with vertical slider the radial run out shall be measured. The slider shall be positioned on the scale to establish contact with the circumference of the disc insulator and disc insulator rotated on its fixture always maintaining the contact. After one full rotation of the disc the maximum and minimum position the slider has reached on the scale can be found out. Difference between the above two readings shall satisfy the guaranteed value for axial run out.

3.7 CRACK DETECTION TEST:

Crack detection test shall be carried out on each ball and pin before assembly of disc unit. The supplier shall maintain complete record of having conducted such tests on each and every piece of ball pin. The bidder shall furnish full details of the equipment available with him for crack test and also indicate the test procedure in detail.

PART – II
SECTION – VI A

**TECHNICAL SPECIFICATIONS
FOR
SILICON RUBBER COMPOSITE INSULATOR**

VOLUME II
SECTION – VI A

**TECHNICAL SPECIFICATION FOR SILICON RUBBER COMPOSITE
INSULATORS FOR USE ON TRANSMISSION LINES**

(120KN & 90KN EMS)

1.0 SCOPE:

1.1 This specification provides for design, manufacture, engineering, inspection and testing before dispatch, packing and delivery F.O.R. (destination) of **SILICON RUBBER COMPOSITE** as per technical requirements furnished in this specification. These insulators are to be used in suspension and tension insulator strings for suspension and anchoring of conductors on EHV transmission towers of KPTCL.

1.2 The insulators shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which, in his judgment, is not in full accordance therewith.

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

2.0 PRE- QUALIFYING REQUIREMENT:

NIL

3.0 STANDARDS

3.1 Except as modified in this specification, the **SILICON RUBBER COMPOSITE** insulators shall conform to the following Indian standards which shall mean latest revisions and amendments. Equivalent International and Internationally recognized standards to which same of these standards generally correspond are also listed below:

Sl. No.	Indian Standard	Title	International standard
1		International Electro-technical Vocabulary	IEC 60050 – Chapter 471 Insulators
2	IS: 206	Method for chemical analysis of slab zinc	
3	IS: 209	Specification for Zinc	BS:3436
4		Composite insulators for A.C. Overhead power lines with the nominal voltage greater than 1000 V.	IEC:61109-1992
5	IS:2071 Part(I) Part (II) Part(III)	Method of High voltage Testing	IEC:60060-1 - General definition& test requirements. IEC:60060-2 – Measuring systems.
6	IS:2121 Part (I)	Specification of Conductors and Earth-wire Accessories for Overhead Power lines Armour Rods, Binding-Wires and Tapes for conductors	
7	IS:2486 Part (I) Part (II) Part (III)	Specification for Insulator fittings for overhead power lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	IEC: 575 BS:3288 IEC:6020 IEC:60372
8	IS:2629	Recommended practice for hot dip galvanization for iron and steel	ISO:1459 ISO:1460 ISO:1461
9	IS: 2633	Testing for Uniformity of Coating of Zinc Coated Articles	
10	IS:3138	Hexagonal bolts and nuts	ISO/R 947 and ISO/R 272
11	IS:3188	Dimensions for Disc Insulators	IEC:60305- Characteristics of insulator units for O/H lines with

			nominal Voltage above 1000 Volts.
12	IS:4218	Metric Screw Threads	ISO/R 68-1969 R 26-1963, R262-1969 and R 965-1969
13	IS:6745	Determination of weight of zinc coating on zinc coated iron and steel articles	BS: 443-1969 ISO:1460
14	IS:8263	Methods of RIV Test of HV Insulators	IEC:60437 NEMA Publication No.107/1964 CISPR
15	IS:8269	Methods for switching impulse test on HV insulators	IEC: 60506
16		Thermal Mechanical performance test and mechanical performance test on string insulator units.	IEC: 60575
17	IEC	Long rod insulators	IEC-433
18		Salt Fog Pollution Voltage Withstand Test.	IEC-60507
19		Residual strength of string Insulator Units of Glass Or Ceramic Material for Over head lines after Mechanical damage of the Di-electric.	IEC- 60797
20		Guide for the Selection of insulators in respect of polluted conditions.	IEC- 60815
21		Tests for insulators of Ceramic materials or Glass for Over head lines with a nominal Voltage greater than 1000V.	IEC- 60363.Part-1- Ceramic & Glass Units for a.c.system- Definitions, Test methods & acceptance criteria. & Part 2- Insulator strings and sets for a.c system.

22		Instruments & Software used for measurement in high Voltage Impulse test – Requirements of Instrumrnts	IEC :61083-1
23		Impulse Puncture testing in air – for Ceramic or Glass or Composite insulator for O/H lines with nominal voltage greater than 1000v.	IEC- 61211.

3.2 The Standards mentioned above are available from:

Reference Abbreviation	Name and Address
BS	British Standards, British Standards institution, 101, Pentonvile Road, N-19, ND, UK
IEC/CISPR	International Electro technical Commission Bureau Central de la Commission Electro Technique International 1, Rue de verembe Geneva Switzerland
IS	Bureau of India Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi – 110 001 India
ISO	International Organisation for standardization Danish Board of Standardization Dansk Standardisering Street, Aurehoegvej – 12 DK – 2900 DENMARK
NEMA	National Electric Manufactures Association 155, East 44 th Street, New York, NY 10017 USA.

3.3 Insulators conforming to any other international standards are also acceptable provided always those standards are equivalent to or better than the corresponding standards specified in 2.1 above. However in such an event the salient points of Comparison between the standards adopted and the standards quoted herein shall be

detailed in the appropriate schedule. Two copies authentic English version of such standards shall be submitted along with the offer.

4.0 SERVICE CONDITIONS:

Composite Insulators are to be for lines located near thermal power stations using Coal, near sea coast which are getting polluted by certain deposits from the sea, salt deposits in the water vapour from cooling towers, coal dust & cement/fly ash. The lines covered under this contract are to run in plains / undulating hilly terrain (Western Ghats)/coastal areas/Polluted areas in the vicinity of Cement factories, of Karnataka and shall be suitable for the hot and humid tropical climatic conditions prevailing in the State. These are furnished here below:

- a) Peak ambient day temperature in still air – 50°C.
- b) Minimum night temperature – 10°C.
- c) Average maximum ambient day temperatures.
 - i. June to January – 35°C.
 - ii. February to May – 45°C.
- d) Relative humidity maximum – 90 % in coastal area; minimum – 10 % in the Western Ghats and plains.
- e) Maximum rainfall – 200 mm in the plains/6000 mm in the coastal areas and the Western Ghats.
- f) Average number of rainy days:- 120 between April and November.
- g) Average number of thunderstorm days/annum – 50 between April and November.
- h) Altitude above Mean Sea level – MTr..
 - i. Varying from 0 to 250 m in the coastal areas.
 - ii. Varying from 250 to 1000 m in the plains.
 - iii. 500 m in the Western Ghats.
- i) Maximum wind speed.

- i. 39 m/sec in the coastal areas, the Western Ghats and the plains of northeastern Karnataka (Bidar, Gulbarga & Raichur).
 - ii. 33 m/sec in the plains of northwestern and southern Karnataka.
- j) Seismic level i.e Earthquake Accelaration.
- a) Horizontal Seismic Co-efficient
(acceleration)- g (Zone – 5).
 - b) a) Horizontal Seismic Co-efficient
(acceleration)- g (Zone – 5).

5.0 BASIC TECHNICAL PARAMETERS OF THE LINES:

A) Electrical System Data:			
a) System Voltage (kV rms)	220	110	66
b) Maximum Voltage (kV rms)	245	123	72.5
c) Lightning impulse withstand voltage (dry & wet) (kVp)	1050	550	325
d) Power frequency withstand voltage (wet) (kVp)	460	230	140
e) Power frequency withstand voltage (dry) (kVp)	510	265	165
f) Short circuit level (KA)/duration	40/1 Sec	31.5/1 Sec	31.5/1 Sec
B) Line Data:			
i) Conductor:	ACSR	ACSR	ACSR
a. Name	DRAKE	LYNX	COYOTE
b. Conductor per phase	Single	Single	Single
c. Spacing between the conductors of same phase (Vertical) mm	4900	3100	2100
a) Configuration			
i. Single Circuit	Delta	Right angled Triangle	Right angled triangle
ii. Double Circuit	Vertical	Vertical	Vertical
b) Minimum ultimate tensile strength (kg)	14175	7950	4625

c) Conductor tension at 32°C without external load i. Initial unloaded tension ii. Final unloaded tension	35% 25%	35% 25%	35% 25%
C) <u>Galvanized Steel Earthwire Ground Wire</u>):			
a) Size (strands and wire diameter) (mm)	7/3.15	7/3.15	7/3.15
b) Location of earth wire	One continuous earth wire to run horizontally on the top of the towers and conductors		
c) System of Grounding	Solidly earthed	Solidly earthed	Solidly earthed
d) Progressive shielding angle	30°	30°	30°
e) Isokeraunic level	50	50	50
f) Tensile load in each earth wire	The tension of earth wire & power conductor are so co-ordinated such that the earth wire Sag shall not be more than 90% of the corresponding Sag of power conductor under still air condition for the entire specified temperature range.		
D) <u>Towers</u>:			
a) Span length in metres:	320	320	275
b) Wind span in meters	320	320	275
c) Wind Load (Kg/sq.m)	104	104.5	85
d) Suspension Towers	2°		
Tension Towers	15°	30°	60°
E) <u>Insulators</u>:			
a) Type of Insulators	SILICON RUBBER COMPOSITE INSULATOR		
b) Lightning protection to insulator	Arcing horns both on the conductor side and cross arm side		
	B) <u>Line Data</u>:		
i) Conductor: a. Name	ACSR Panther		
b. Conductor per phase	Single		
c.Spacing between the conductors of same phase (Vertical) mm	3900		
b) Configuration iii. Single Circuit	Delta		
iv. Double Circuit	Vertical		
b) Minimum ultimate tensile strength (KN)	89.67		

c) Conductor tension at 32°C without external load	
iii. Initial unloaded tension	35%
iv. Final unloaded tension	25%

6.0 PRINCIPAL PARAMETERS:

6.1 Details of Silicon Rubber Composite Insulators:

GENERAL REQUIREMENT

The design, manufacturing, processes, tolerances and inspection of composite insulators shall confirm to the following.

Language and units:

- i. All correspondence, literature, drawings and markings shall be in the English language.
- ii. Dimensioning shall be in the SI (Metric System) units. Manufacturer should mention the standard adopted for Dimensioning & tolerance principals considered for design.
- iii. The insulator shall consist of standard module for a three phase. 50 HZ, effectively earthed 220 or 110KV or 66KV transmission system in a moderately polluted atmosphere. The insulator shall be therefore suitable for satisfactory operation under the tropical climatic conditions listed in the relevant clause. The applicable design particulars of the insulator to be used on these lines are furnished in the 'System particulars'.
- iv. The end fitting of the Composite Insulators shall be ball and socket type with necessary coupling arrangement such that the Pin shall move freely in the sockets but they do not get disengaged while in service under various operating and atmospheric conditions. The length and other dimensions should be such that it should be substituted by other conventional type Porcelain insulators. The Composite Insulator Units shall have '**Ball**' fitting on the line side and '**Socket**' fitting on the tower side.
The insulator shall be suitable for being installed in air supported on suspension insulator hardware or anchored through tension insulator hardware at the power cross arm of single circuit, double circuit or multi-circuit line towers , as such it should be substitution for the conventional porcelain insulators.
- v. The insulators shall have sheds of open aerodynamic profile with good self cleaning properties. Insulator shed profile, spacing, projection etc shall be strictly in accordance with the recommendations of IEC:60815.

- vi. The color of housing material shall be Dark Brown, uniform and consistent.
- vii. The insulator shall be designed to withstand high pressure (3800KPa)/ (550psi) water washing from a 6mm diameter nozzle from a distance of 3 meter between nozzle to Polymer insulator,
- viii. The track resistance of the material used in the manufacture of housing and weather sheds shall meet the requirements of IEC 587 class 1A4.5 or 1B4.5.
- ix. The end fittings shall be free from defects like pitting, scaling, laps, folds. Cracks, shrinks, blow holes. Burrs or rough edges etc. The fittings shall be attached to the core through crimping process (controlled compression technique) and shall be designed to transmit the mechanical load to the core and develop uniform and consistent mechanical strength of insulators. The metal surfaces shall be perfectly smooth with no projecting parts or irregularities which may cause Corona .Ball pins shall not show any microscopically visible cracks inclusions and voids. The end fittings shall not contain parts of pieces joined together, welded, shrink fitted or manufactured by any other process from more than one piece of material.
- x. The ball and socket fittings shall be designed to transmit the mechanical stresses to the core and develop uniform mechanical strength in the insulator . The socket shall be circular with the inner and outer surfaces Concentric and of such design that it will not yield or distort under loaded conditions. The ball shall move freely in the socket either uring assembly of a string or during erection of a string or when a string is placed in position.
- xi. The Design, manufacturing Process and material control ay various stages shall be such as to give maximum working load, highest mobility. best resistance to corrosion, good finish, elimination of sharp edges and corners to limit Corona and Radio interference voltages. The design of the insulator string shall be such that all the stresses due to expansion or contraction in any part of the insulator under rapid temperatures fluctuation, which may be created due to variation in the loads or fault of any nature , while in service shall not lea to any type of deterioration. Flat surfaces and corners shall not be allowed and shall be completely rounded off.
- xii. All raw materials to be used in the manufacture of insulators shall be subject to strict raw material quality Control and to stage testing during manufacturing stage to ensure the quality of the

final end product. Manufacturing shall conform to the best engineering practices adopted in the field of extra high voltage transmission. Bidders shall therefore offer insulators as are guaranteed by them for satisfactory lifetime performance on transmission lines.

- xiii. For reference the Size of conventional Disc insulator, Section length of 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 shall be as indicated in Table-1 and Table-2.

TABLE:1

Sl. No	Type of String	Size of disc insulator (mm)	Minimum creepage distance of each disc (mm)	No. of Standard discs	Electro-mechanical Strength of Insulator string in KN
220 KV					
01	Single Suspension	255x 145	320	13	90
02	Double Suspension	255x145	-do-	2x13	2x90
03			320	15	120
04	Single Tension	255x145			
	Double Tensile	-do-	-do-	2x15	2x120
110 KV					
01	Single Suspension	255x145	320	7	90
02	Double Suspension	-do-	-do-	2x7	2x90
03		255x145	320	8	90
04	Single Tension	-do-	-do-	2x8	2x90
	Double Tensile				
66KV					
01	Single Suspension	255x145	320	4	90
02		-do-	-do-	2x4	2x90

03	Double Suspension	255x145	320	5	90
04	Single Tension	-do-	-do-	2x5	2x90
	Double Tensile				

ELECTRICAL STRING CHARACTERISTICS FOR DISC INSULATOR STRING:

TABLE -2

i. Lightning Impulse withstand Voltage (dry) KV peak.	1050	550	325	1050	550	325
ii. Power frequency withstand Voltage (wet) KV r.m.s.	460	230	140	460	230	140
iii. Corona extinction voltage – KV (rms)	176	-	-	176	-	-
iv. Max. RIV for complete string including corona rings, arcing horns, clamps etc, at 1.1 times maximum line to ground voltage (micro-volts)	500	-	-	500	-	-
v. Mechanical failing load for each sting KN.	120	90	90	120	90	90
vi. No deformation load for each string Kgf.	-	-	-	-	-	-
vii. Max. voltage across any disc.	13%	13%	13%	13%	13%	13%

XIV. Section length of Silicon rubber Composite insulator string, minimum creepage distance required, no. of units per string & EMS of each unit is tabulated in Table -3.

TABLE-3

S1 No	Line KV	Type of String	Section length of insulator (Soket to Ball pin) (mm)	Min. Creepage distance (31mm/K V)	No.of Standard individual units / string	EMS of Insulator (KN)
1	220kV	Single Suspn				
		Single	1885	7595	1	90
		Tension	2175	7595	1	120
		Double	1885	7595	1 X 2	90 x 2
		Suspn	2175	7595	1 X 2	120 x 2
3.	110kV	Double Tension				
		Single Suspn				
		Single	1015	3751	1	90
		Tension	1160	3751	1	90
		Double	1015	3751	1 X 2	90 x 2
4.	66kV	Suspn	1160	3751	1 X 2	90 x 2
		Double Tension				
		Single Suspn				
		Single	580	2248	1	90
		Tension	725	2248	1	90
		Double	580	2248	1 X 2	90 x 2
		Suspn	725	2248	1 X 2	90 x 2
		Double Tension				
		Single Suspn				
		Single				

Note: The section length of insulators mentioned above is the required length of insulator corresponding to equivalent length of disc insulator string. The bidder may offer insulator varying in length with that mentioned above. However, in such a case the total length of string

including hardware fittings shall be within the maximum and minimum limits specified in the drawing (inclusive of tolerances on hardware and insulator) attached to this specification.

6.2 STRING CHARACTERISTICS:

The Electrical String Characteristics of the complete string with long rod insulators shall be as tabulated in Table – 4.

TABLE-4

Sl No	Particulars	220 KV	110 KV	66 KV
1	Lightning Impulse withstand voltage (dry) KV peak	1050	550	325
2	Power frequency withstand voltage (wet) KV rms	460	230	140
3	Corona extinction voltage – KV (rms)	176	-	-
4	Max. RIV for complete string including corona rings, arcing horns, clamps etc., at 1.1 times maximum line to ground voltage (micro-volts)	500	-	-

6.3 DRAWINGS:

6.3.1 The General arrangement drawings in respect of 220KV, 110KV & 66KV strings mentioned above are enclosed at the end of this specification. These drawings are attached only for the information and guidance of the manufacturer.

6.3.2 The manufacturer shall furnish outline drawing of the insulator and component drawing of end fittings, Corona control ring indicating all dimensions. All drawings shall be neatly arranged and all drafting and lettering shall be standard and legible. Dimensions shall be in SI units. The drawings shall give the following information.

- 1) The bill of material indicating quantity, nature grade and reference standard of the material used for various parts,

- 2) Technical details like Section length of insulator, dry arcing distance, creepage distance, ball and socket designation, identification mark on the insulator.
- 3) Mechanical characteristics like specified mechanical load (SML), Routine test load (RTL) and weight of insulator.
- 4) Electrical characteristics like One minute Power frequency withstand voltage under dry and wet conditions, lightening impulse withstand voltage, Switching surge impulses withstand voltage, Corona inception and extinction voltage.
- 5) After award of contract the bidder shall submit 3 sets of drawings to CEE (P&C), Kaveri Bhavan, Bangalore, giving details as mentioned above for scrutiny and approval. Once the drawings have been approved no alteration or modification will be carried out without prior approval of the purchaser.

6.4 GALVANIZING:

All ferrous parts shall be hot dip galvanized in accordance with IS: 2629/ASTM A 153 to resist corrosion. The Zinc to be used for galvanizing shall conform to grade Zn 98 (purity = 99.95%) of IS: 209. The Zinc coating shall be uniform, smooth, reasonably bright continuous and free from impurities such as flux, ash, rust, stains, bulky white deposits and blisters. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the shall be carefully removed without reducing the designed dimensional requirements,

The Galvanised end fittings shall withstand 4 one minute dips in standard CuSO₄ solution as per IS: 2633. The mass of Zinc coating shall not be less than 610gm/m² (86 micro m)

7.0 SPECIFIC TECHNICAL REQUIREMENTS:

DESIGN, WORKMANSHIP AND MATERIAL REQUIREMENT

7.1 GENERAL:

It is not the intent to specify completely herein all details of design and construction of the insulators involved. However, the insulator shall conform, in all respects to the highest standards of engineering a workmanship and shall fulfill the anticipated performance in a manner acceptable to the purchaser who will interpret the meaning of drawings and specifications and shall have the power to reject any materials which in his judgment are not in full accordance therewith.

7.2 Design:

Silicon rubber Composite insulator shall be designed to meet the high quality, safety and reliability capable of withstanding a wide range of system and environmental conditions mentioned in section 3,4 & 5 above. Composite insulators shall consists of Three Parts, at least two of which are insulating parts:-

- a) Core- the internal insulating part designed to ensure the mechanical characteristics.
- b) Housing -the external insulating part which provides the necessary creepage distance and protects the core from weather. A shed provided in the housing is a projecting part of the housing intended to increase the creepage distance.
- c) Metal end fittings - intended to transmit the mechanical load.

7.2.1 Core:

The core shall be glass-fibre reinforced epoxy resin rod (FRP) of high dielectric and mechanical strength. Both, glass fibre and Epoxy resin matrix material shall be optimized in the FRP rod. **Process used for manufacturing should yield a uniform material structure and optimum control and regulation of the quality-influencing parameters such as homogeneity and uni-directionality of the glass fibre across the cross section of the rod.** Glass fibers with low content in alkalies shall be boron free 'E'glass or Boron free **Electrically corrosion resistance** (ECR) glass. Use of resin with hydrolysis trend due

to water penetration should be prevented i. e. matrix of the FRP rod shall be Hydrolysis resistant. Suitability of Epoxy matrix as well as interface between matrix and fibres is to be considered as design parameter to prevent brittle fracture. The FRP rod should be void free and shall be manufactured through Pultrusion process and **shall not be of draw forming process.**

7.2.2 Housing:

The core of the composite insulator shall be completely covered by a continuous housing consisting of a seamless sheath & -weathershed of silicon rubber compound. For moulding of entire weather shed structure on to the rod, a one shot moulding process or extruded process shall be employed to avoid multiple interfaces i.e. the housing shall consist of one piece of housing using injection moldings principle consisting of seamless silicon rubber sheath with sheds to cover the entire core, to protect the rod against environmental influences like Hydrolysis, U.V radiations, Corona & Ozone degradation, and also to external Pollution and humidity. The interface between the housing and the Fiber reinforced glass rod shall be chemically bonded to prevent contaminations and moisture ingress. The strength of the bond shall be greater than the tearing strength of composite insulating material used. The manufacturer shall follow non-destructive technique (N.D.T) to check the quality of jointing of the housing interface with the core. The technique being followed with detailed procedure and sampling shall be furnished along with the bid. Hardware i. e. metal fittings may be installed on the rod prior to moldings of the shed controlling moldings lines. The base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers. The housing and weather sheds shall have Silicon contents of minimum of 30% to 40% by weight. The Shore 'A' hardness of Silicon rubber used in the manufacture of housing and weather sheds shall not be less than 60.

The thickness of compounding material on core should be minimum 3 mm. The weather-sheds of the insulators shall be of alternate shed profile. The weather shed shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature and high pressure. Any seams/ burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed shall be class 1A 4,5 according to IEC 60587. Manufacturer should furnish a description of its Quality Assurance Programme including fabrication, testing and inspection for any material (i.e. rubber), components(i.e. rod) or hardware (i.e. end fittings). If the manufacturer has got fabricated or manufactured components of insulator by others, the same should also be included. Manufacturing methods and material composition documentation will be a part of Technical Bid to be submitted along with offer. Insulator should have hermetically sealed structure in which the housing material is molded to cover the interface between the end fittings and the FRP rod. This seal should never be broken during testing or otherwise.

7.2.3 End fittings:

The composite insulators shall be socket and ball type with the necessary coupling arrangement such that pin shall move freely in the cap socket either during assembly of a insulators or during erection of insulators or when a insulators is placed in position but do not get disengaged while in service under various operating and atmospheric conditions.

The socket & ball type metal end fittings shall be designed to transmit the mechanical stresses to the to the core & the end fittings by compression and develop uniform mechanical strength in the insulator Material and methods used in the fabrication of metal parts shall be selected to provide

good toughness and ductility. Metal end fittings shall be made from a quality malleable cast iron or forged steel with high tensile quality and shall be hot dipped galvanized in accordance with IS 2629 & ASTM A-153. Ball pins shall be made with drop forged steel and caps with malleable cast iron. They shall be in one single piece and duly hot dip galvanized. They shall not contain parts or pieces joined together, welded, shrink fitted or by any other process from more than one piece of material. The pins shall be of high tensile steel, drop forged and heat-treated. The caps shall be cast with good quality black heart malleable, cast iron and annealed. Galvanizing shall be by the hot dip process with a heavy coating of zinc of very high purity. The dimensions of the end fittings of insulators shall be in accordance with the standard dimensions stated in IEC:60210/IS:2486-Part-II.

The attachment to the FRP rod shall be performed with a symmetrically controlled crimping method control by acoustic method such as Co-axial Compression process that compresses the metal radially onto the rod without damage to the individual rod fiber or resin matrix or causing crack the rod, while providing a strength equal to or greater than the defined and specified ultimate strength to the insulator. The manufacturer shall have in-process Acoustic emission arrangements to ensure that there is no damage to the core during crimping. The verification shall be in-process and done on each insulator. The Compression technique used shall make the insulator fittings relatively insensitive to dynamic stresses which, for example, are caused by conductor vibrations. The interface point of the housing and the metal end fittings shall be sealed by a flexible silicon elastomeric, metastable compound or Silicone alloy compound sealant. The system of attachment of the end fittings to the rod shall provide superior sealing performance between housing and metal connection. The sealing must be humidity proof and durable with time.

The material used in fittings shall be corrosion resistant. Nominal dimensions of the pin, ball and socket interior shall be in accordance with the standard shown at Clause No. 2.0 of this Specification. No joints in ball & socket will be allowed. Outer portion of ball or socket should be Zinc sleeved with minimum 99.95% purity of electrolytic high grade Zinc. Before ball fittings are galvanized, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the designed dimensional requirements.

The bidder shall specify the grade, composition and mechanical properties of steel used for fittings.

The surface shall not crack or get chipped due to ageing effect under normal and abnormal service conditions or while handling during transit or erection.

The design of the fittings and the insulators shall be such that there is no local corona formation or discharges likely to cause the interference to either sound or vision transmission.

7.2.4 INTERPHASE ZONES:

Every insulator has, depending on the design and manufacturing process, various inter face zones between the individual components of the insulator, as well as within the composite material, the RBGF or FRP rod. In all the zones the best possible bonding must be achieved at the interface surface of the materials being bonded so that no voids are created which can lead to the occurrence of partial discharges in service, causing ageing and damage to the insulation. As silicon does not readily bond to other substrates, the composite surface shall be sprayed evenly with a primer on a silicon basis before the silicone weathershed is poured. In this way no additional layer is formed between the reinforced epoxy –resin rod and the silicon weathershed. The process should be such that, from both an electrical and a mechanical view no problems concerning interface surfaces and intermediate layers should occur.

In load transfer area, the metal fittings shall be given silicon covering. This will ensure and guarantee insulators resistance to hydrolysis at the ends for a long period so that no moisture is able to penetrate into the insulator and which otherwise leads to the well known negative effects on the fiber glass rod.

7.2.5 SECURITY CLIPS (LOCKING DEVICES):

The security clips to be used as locking device for ball and socket coupling shall be 'R' shaped hump type to provide for positive locking of the coupling as per IS:2486 (Part-IV)/ IEC: 60372. The legs of the security clips shall allow for spreading after installation to prevent complete withdrawal from the socket. The locking device shall be resilient, corrosion resistant and of sufficient mechanical strength. There shall be no possibility of the locking device to be displaced or be capable of rotation when placed in position and under no circumstances shall it allow separation of insulator units and fittings. 'W' type security clips are also acceptable. The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of the clip may be engaged by a hot line clip puller to provide for disengagement under energized conditions. The force required for pulling the clip into its unlocked position shall not be less than 50N (5 Kg) or more than 500 N (50 Kg).

7.2.6 GRADING RINGS:

Grading rings shall be provided when system voltages are equal to or greater than 220 KV. For 220 KV transmission, grading ring is to be provided at energized end only. For 400 KV transmission grading ring is to be provided at both ends of a insulator.

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

hot line tools without disassembling any other part of the insulator assembly. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/Corona cutting/ exceeding of permissible electrical stresses of material in the vicinity of the end fittings and shield the end fittings preventing Corona inception at 115% of the nominal line to ground voltage. The supplier shall furnish calculations along with the proposed placement and design of corona ring in support of the above.

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

8.0 VERIFICATION OF HOUSING MATERIAL

The manufacturer should provide written verification about housing material, for which base polymer shall be 100% Silicon Rubber prior to the addition of reinforcing fillers considered will provide satisfactory performance in the particular environment mentioned at Cl.No.3 & 4.

It shall meet following requirements:

- Be homogenous, impermeable, with no fissures, bubbles and strange Materials inclusions.
- Be designed in order to avoid formation of localized discharges and to prevent interfaces humidity penetration.

- Be resistant to corona, UV radiation, ozone, atmospheric contamination, water penetration and power arcs.

9.0 BALL AND SOCKET DESIGNATION

The dimensions of the Ball and Socket shall be 16mm designation for 90KN and 20mm designation for 120KN insulators in accordance with the standard dimensions stated in IEC: 60120/IS:2486(Part-II)

10.0 DIMENSIONAL TOLERANCE OF COMPOSITE INSULATORS:

The tolerance on all dimensions e.g. diameter, length and creepage distance shall be allowed as follows:

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

$\pm (0.025 d + 6)$ 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.

11.0 INTERCHANGEABILITY:

The composite insulators including the ball socket connections shall be standard design suitable for use with the hardware fittings of any make conforming to relevant Indian standards.

The length and other dimensions should be such that it should be substituted by other conventional type Porcelain insulators.

12. SUITABILITY FOR LIVE LINE MAINTENANCE

The insulators shall be compatible for use wet line or live line maintenance technique that usual hot line operations can be carried out with ease, speed and safety.

13. 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.

14.0 WORKMANSHIP:

- 1.1 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.
- 1.2 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 to limit Corona and Radio interference..
- 1.3 The design of insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 1.4 The core shall be sound and free from cracks and voids that may adversely affect the insulators.
- 1.5 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.
- 1.6 Metal end fittings surfaces shall be uniform, perfectly smooth with no projecting parts or irregularities, without sharp edges or corners which may cause corona and shall be free of cracks, seams, air holes, blow holes and rough edges , flakes, slivers, slag, shrinkage defects and localized porosity. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses

uniformly. Pins shall not show any microscopically visible cracks, inclusions and voids. End fittings should be effectively sealed to prevent moisture ingress, effectiveness of sealing system must be supported by test documents.

- 1.7 All ferrous parts shall be hot dip galvanized to give a minimum average coating of Zinc equivalent to 610gm/sqm or 87 micrn thickness and shall be in accordance with the requirements of IS:2629/ISO 1461(E) . The zinc to be used for galvanizing shall conform to grade Zn 99.5 as per IS-209. The zinc coating shall be uniform, smoothly adherent, reasonably bright, continuous and free from impurities such as flux, ash, rust strains, 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 galvanization shall be carried out only after any machining.

15. MARKINGS:

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

- a. Name or trademark of the manufacturer.
- b. Voltage and Type.
- c. Month and year of manufacturing.
- d. Minimum failing load/guaranteed mechanical strength in kilo Newton followed by the work 'KN' to facilitate easy identification.
- e. Country of manufacturer.

16.0 PACKING:

All insulators shall be packed in strong corrugated box of minimum 7 ply duly platted or wooden crates. The gross weight of the crates along with the material shall not normally exceed 100 kg to avoid hackling problem. The crates shall be suitable for outdoor storage

under wet climate during rainy season. The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field. Suitable cushioning, protective padding, or Dunn age or spacers shall be provided to prevent damage or deformation during transit and handling. 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.

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

17.0 INSPECTION, TESTS AND STANDARDS:

17.1 INSPECTION:

Inspection includes the performance of acceptance, type and design tests. KPTCL reserves the right to carry out design and type tests to check conformity of the material with the proto type unit previously approved.

Inspection includes the performance of acceptance, type and design tests. KPTCL reserves the right to carry out design and type tests to check conformity of the material with the proto type unit previously approved.

KPTCL reserves the right to attend the tests and perform inspections in any stage of the supply, appointing its inspectors and following the approved manufacturing schedule. Inspection and tests scheduled to happen during manufacture shall have their dates informed to KPTCL at least 10 days in advance.

The manufacturer shall assure KPTCL's inspector the right to being fully acquainted with installations and apparatus, check calibrations, be present at the tests, check results and in case of doubt, perform new inspections and claim the repetition of any test.

17.2 TESTS:

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 and type test reports submitted shall not be more than 5 years old.

No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected, tested, and necessary dispatch instructions are issued in writing, except for the cases where waiver of inspection is granted by competent authority of the Purchaser, and even in this case also written dispatch instructions will be issued. Any dispatches before the issue of Dispatch Instructions in writing will be liable for rejection and non-acceptance of the materials by the consignee.

The acceptance of any quantity of material shall in no way relieve the Bidder of any of his responsibilities for meeting all requirements of the specification, and shall not prevent subsequent rejection if such material is later found to be defective.

The sample taken from any numbers of crates for carrying out any type of tests will be to the suppliers account.

17.3 The following tests shall be carried out on the composite insulators.

17.3.1 DESIGN TEST:

The design tests are intended to verify the suitability of the design, materials and method of manufacture (Technology), i.e., to prove the design, process of manufacture and conformity of the core material, housing material, core assembly (core & end fittings), interfaces and connections of sample insulators and product with the insulator of

this specification. These tests shall be conducted on representative number of samples prior to commence of commercial production. The bidder shall indicate his schedule for carrying out these tests. When a composite insulator is submitted to the design tests the results shall be considered valid for the whole class of insulators which are represented by the one tested and having the following characteristics.

- Same materials for the core and sheds and same methods of attachment.
- Same material of the fittings, the same design and the same method of attachment.
- * Same or greater layer thickness of the shed material over the core (including a sheath where used)
- same or smaller ratio of the highest system voltage to insulation length.
- * same or smaller ratio of all mechanical loads to the smallest core diameter between fittings highest system voltage to insulation length.
- * same or greater diameter of the core.

the tested composite insulator shall be identified by a drawing giving all the dimensions with the manufacturing tolerances. Subsequently, if there are small variations in the design data of not more than 15% for characteristics marked with “*”, the design tests shall not be repeated.

17.3.2 PROTO TYPE or TYPE TESTS:

This shall mean those tests, which are to be carried to verify the main characteristics of a composite insulator, which depend mainly on its shape and size. Type tests shall be applied to composite insulators, the class of which has passed the design tests. They shall be repeated only when the type or material of the composite insulator is changed.

17.3.3 ACCEPTANCE /SAMPLING TESTS:

The sampling tests are for the purpose of verifying other characteristics of composite insulators, including those which depend on the quality of manufacture and on the materials used. This shall mean these tests which are to be carried on insulator samples taken at random from each lot offered for pre-dispatch inspection for the purpose of acceptance of the lot

17.3.4 ROUTINE TEST:

The aim of these tests is to eliminate composite insulators with manufacturing defects. This shall mean those tests, which are to be carried out on each insulator offered for acceptance to check the requirements are likely to vary during production.

17.3.5 TESTS DURING MANUFACTURE:

Stage tests during manufacture shall mean those which are to be carried out during the process of manufacture to ensure quality control such that the product is of the designed quality conforming to intent of this specification.

17.3.6 TEST VALUES:

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

17.3.7 TEST PROCEDURES AND SAMPLING NORMS:

The norms and procedure of sampling for the above tests shall be as per the relevant Indian standard or other internationally accepted standards. This will be discussed and mutually agreed to between the supplier and purchaser before placement of order. The standards and norms according to which these tests are to be carried out are listed against each test. Where a particular test is a specific requirement of this specification, the norms and procedure for the same shall be as specified in annexure IV attached hereto or as mutually agreed to between the supplier and the purchaser in the Quality Assurance program.

17.4 DESIGN TESTS:

The design test are performed only once and results are recorded in a test report as per IEC 1109 latest edition. Each part of the four tests enlisted can be performed independently on new test specimens when appropriate. The composite insulator of a particular design will be qualified only when all insulator or test specimens pass the design tests, in the given sequence defined as under clause 5.1,5.2,5.3 and 5.4 of IEC 1109 an as per Annexure-A,C & D of IEC:61109.

The summary of this tests.

Sl No	Description of the Type Test	Relevant standard/ test procedure.
1	Tests on interface and connections of metal fittings	As per clause 5.1 of IEC 61109 1992 and as per Annexure-D of IEC 61109..
	Test specimens and preliminary tests.	As per clause 5.1.1 of IEC 61109 1992.
	Dry Power frequency tests	As per clause 5.1.2 of IEC 61109 1992.
	Pre-stressing.	As per clause 5.1.3 of IEC 61109 1992.
	Sudden load release test.	As per clause 5.1.3.1 of IEC 61109 1992.
	Thermal- mechanical test	As per clause 5.1.3.2 of IEC 61109 1992.
	Water immersion test	As per clause 5.1.3.3 of IEC 61109 1992.
	Verification tests.	As per clause 5.1.4 of IEC 61109 1992.
	Visual examination	As per clause 5.1.4.1 of IEC 61109 1992.
	Steep-front impulse Voltage test.	As per clause 5.1.4.2. of IEC 61109 1992.
	Dry Power frequency Voltage test.	As per clause 5.1.4.3 of IEC 61109 1992.
2	Assembled Core load-time test:	As per clause 5.2 of IEC 61109 1992 and as per Annexure –A & D of IEC:61109
	Test Specimens	As per clause 5.2.1 of IEC 61109 1992.

	Mechanical Load test	As per clause 5.2.2 of IEC 61109 1992.
	Determination of average failing load of the core of the assembled insulator,	As per clause 5.2.2.1 of IEC 61109 1992.
	Control of slope of the strength-time curve of the insulator.	As per clause 5.2.2.2 of IEC 61109 1992.
3	Test of Housing : Tracking and erosion test & Multi stress test :	As per clause 5.3 of IEC 61109 1992 and as per Annexure-D of IEC 61109..
	Test Specimens.	As per clause 5.3.1 of IEC 61109 1992.
	Test procedure.	As per clause 5.3.2 of IEC 61109 1992.
	Test conditions.	As per clause 5.3.3 of IEC 61109 1992.
	Evaluation of the tests.	As per clause 5.3.4 of IEC 61109 1992.
4.	Tests for the core material	As per clause 5.4 of IEC 61109 1992 and as per Annexure-D of IEC 61109..
	Dye penetration test.	As per clause 5.4.1 of IEC 61109 1992.
	Test specimens	As per clause 5.4.1.1 of IEC 61109 1992.
	Performance of the test	As per clause 5.4.1.2 of IEC 61109 1992.
	Acceptance criterion.	As per clause 5.4.1.3 of IEC 61109 1992.
	Water diffusion test	As per clause 5.4.2 of IEC 61109 1992
	Test Specimens	As per clause 5.4.2.1 of IEC 61109 1992
	Prestressing	As per clause 5.4..2.2 of IEC 61109 1992
	Voltage test	As per clause 5.4.2.3 of IEC 61109 1992
5	Flammability test	As per clause 5.5 of IEC 61109 1992
	Test Specimens.	As per clause 5.5.1 of IEC 61109 1992
	Evaluation of the tests.	As per clause 5.5.2 of IEC 61109

Additionally following tests shall be carried out or reports for the tests shall be submitted after award of contract.

- 1) Pollution test for composite insulator as per IEC-507.
- 2) Power arc test.
- 3) Brittle fracture test.
- 4) Radio interference test.
- 5) Torsion withstand test for insulators whose coupling do not give total rotational freedom.

17.5 TYPE TESTS:

One insulator type is Electrically defined by arcing distance, creepage distance, Shed inclination, Shed diameter and shed spacing. The Electrical type test shall be performed only once on the insulator satisfying the above criteria for one type and shall be performed with arcing devices, if they are an integral part of the insulator type.

The Electrical type tests shall be repeated only when one or more of the above characteristics is changed.

One insulator type is Mechanically defined by the Core diameter and the method of attachment of the metal fittings. The mechanical type tests shall be performed only once on insulators satisfying the above criteria for each type. They shall be repeated only when one or both of the above characteristics is changed.

Unless otherwise agreed, a tolerance of

$\pm (0.04 d + 1.5)$ mm. when $d < \text{or} = 300$ mm.

$\pm (0.025 d + 6)$ mm. when $d > 300$ mm with a maximum of 50mm.

is allowed on all dimensions for which specific tolerance are not requested (d being the dimension in millimeter).

Following Type tests shall be conducted on the complete Long Rod Composite insulator with Hardware Fittings

Sl No	Description of the Type Test	Relevant standard/ test procedure.
1	<u>ELECTRICAL TESTS:</u> Dry Lightning Impulse voltage withstand test	As per IEC 61109 (Clause 6.1) Test procedure according to clause and sub clauses 7,9,10,14,15.1,15.2, 17,18.1.2, 18.2,19 and 20 of IEC 383.
2	Wet Power frequency test	As per IEC 61109 (Clause 6.2) Test procedure according to clause and sub clauses 7,9,12,13,14,15.1,17,18.1.2, 18.2,19 and 22 of IEC 383.
3	Wet Switching impulse withstand Voltage test	As per IEC 61109 (Clause 6.3) Test procedure according to clause and sub clauses 7,9,11, 13,14,15.1,17,18.1.3, 18.2,19 and 21 of IEC 383.
4	<u>Mechanical Tests</u> Mechanical Load- time test <ul style="list-style-type: none"> • Long time mechanical withstand • Short time mechanical withstand 	As per IEC 61109 (Clause 6.4) Annexure -A and as per amendment of IEC:6110-9 1995 Clause 6.4
5	Radio interference test	As per IEC 61109 (Clause

		6.5) amendment -1 1995
6	Chemical composition test for Silicon content	
7	Brittle fracture resistance test -	Annexure-A
8	Ageing test under operating Voltage simulating weather conditions (Accelerated Ageing Test of 5000 hours)	Annexure C of IEC 61109
10	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	-IEC:383-1993
11	d) Vibration test	-IEC:383-1993- Annexure-A
12	Recovery of Hydrophobic test	-Annexure-A

All the above type test shall be conducted on Single 'T' suspension and

Double tension insulator along with hardware fittings.

- i) Grading device test
- ii) Electrical Field Modeling test(EFM)

The bidder shall submit type test reports as per IEC 61109 along with the bid Additional type tests required if any shall be carried out by the manufacturer, after award of contract for which no additional charges shall be payable. In case, the tests have already been carried out, the manufacturer shall submit reports for the same.

17.6 Sample Tests (Acceptance Tests) –

When specified on a purchase order, sample tests shall be performed as per ANSI C29.11& IEC:61109-1992.

Sl No	Description of the Type Test	Relevant standard/ test procedure.
1	Verification of Dimensions	Clause 7.2 of IEC:61109
2	Verification of Locking System-applicable only in the event ball and socket insulators is specified.	Clause 7.3 of IEC:61109
3.	Verification of tightness of the interface between end fittings and insulator housing	Clause 7.4 of IEC:61109
4.	Mechanical Load test: Verification of the specified Mechanical Load (SML)	Clause 7.4 of IEC:61109 and as per amendment of IEC:61109 1995 clause 7.4
5.	Galvanizing Test	Clause 7.5 of IEC:61109

If any one insulator or metal part fails to comply with the sampling tests, Re-testing procedure shall be as per Clause 7.6 IEC:61109.

17.7 Routine Tests:

The following tests shall be performed on every insulator produced as per IEC:61109-1992.

- (a) **Identification of the Composite insulators:** Each insulator shall be marked with the name or trade mark of the manufacturer and the year of manufacture. In addition, each insulator shall be marked with the Specified Mechanical Load(SML). These markings shall be legible and indelible.
- (b) **Mechanical Test:** Every insulator shall withstand at ambient temperature a tensile load equal to or greater than its Routine Test

Load (50% of the Specified Mechanical Load) for a period not less than 10 seconds

- (c) **Visual Examination:** Every insulator shall be examined to insure its conformance to the manufacturer's drawing as per Clause 8.2 of IEC:61109. Superficial polymer surface defects of an area less than 25 square millimeters (total area not to exceed 0.2% of total insulator surface area) and depth less than 1 mm shall be acceptable.

17.8 Additional Tests

The Purchaser reserves the right of getting done any other test(s) of reasonable nature carried out at Purchaser'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. In such case all the expenses will be to Suppliers account.

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 suppliers premises or at any other test centre. 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.

17.9 Tests during Manufacturing:

Following tests shall also be carried out during manufacturing on all components as applicable and the reference standards according to which the test shall be conducted are as follows.

Sl No	Particulars of tests	Reference standards
	Raw material Inspection	
	Silicon Rubber	
1	Tensile strength & Elongation	ASTM D 412

2	Tear strength	ASTM D 624
3	Hardness	ASTM D2240
4	Resistance to track and erosion	IEC-60587
5	Di-electric strength	ASTM D 149
6	Silicone content test	Between 30% to 40%
7	Resistance to weathering and UV	ASTM G 53-93
8	Limiting Oxygen index	ASTM D 2863
	FRP rods	
1	Dimensions	As per drawing
2	Dye penetration test	As per Cl. 5.4.1 of IEC 61109
3	Water absorption test	ASTM 570
4	Water diffusion test	As per Cl. 5.4.2 of IEC 61109
5	Hardness test (Barcol)	ASTM D 2583
6	% of Glass content,	ASTM D 2584
7	Brittle fracture resistance test & Flexural test, inter laminar shear & tensile strength of FRP	
	Bonding Agent	
1	Appearance and specific gravity	Acceptance norms 0.836 to 0.880
	Galvanized condition	
1	Visual inspection & Dimension	IS:2486
2	Uniformity of Zinc coating	
3	Thickness of coating by Electrometer	
4	Chemical analysis of Zinc used for galvanization(Purity of Zinc)	As per IS: 209
	Ball end Fittings(Forged steel)	
1	Visual inspection & Dimension	IS:2486 Part II

2	Failing Load test, Yield strength test bar, Tensile strength to test bar, Hardness test	As per IS:1608
3	Chemical analysis, hardness tests and magnetic particle inspection for forging.	As per IS: 1608 & IS:3703
	Socket end fittings	
1	Visual inspection & Dimension	
2	Tensile test, Elongation , Hardness	As per IS: 14329 & IS: 1865.
3	Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings.	As per IS 3703
	Security Clip	
1	Visual inspection & Dimension	As per IEC 60372 Cl.12
2	Resistance to bending test, Hardness & Chemical analysis	As per IEC 60372 Cl.13
	Corona Ring	
1	Visual inspection & Dimension	
2	Chemical analysis	
	In process Inspection	
1	Visual inspection of Prime application	Should be uniform on the entire rod
2	Gauge checking for alignment after crimping	
3	SML check after crimping	50% of SML for 10 %

Sample Batch for Type Testing

The bidder shall offer material for sample selection for the type testing only after Quality Assurance Plan approved by the General Manager

Procurement. The Bidder shall offer at least 10% of the ordered quantity or 300 nos. whichever is higher, for selection of samples required for conducting all the type tests.

The Bidder is required to carry out all the acceptance tests successfully in the presence of Purchaser's representative before dispatch of the selected sample to the testing laboratory for type test.

18.0 TEST REPORTS

18.1 Copies of type test reports shall be furnished in at least two (2) copies along with one original. One copy shall be returned duly certified by the Purchaser only after which the material already inspected i.e. the materials manufactured for selection of sample for type test, shall be dispatched on receipt of Dispatch Instructions from the CEE(P&C),KPTCL, Kaveri Bhavan, Bangalore

18.2 Record of routine test reports shall be maintained by the Bidder at his works for periodic inspection by the purchaser's representative.

18.3 Test Certificates of test during manufacture shall be maintained by the Bidder. These shall be produced for verification as and when desired by the Purchaser.

19.0 TEST FACILITIES

The following additional facilities shall be available at Supplier's works:

- a) Calibration Reports from Government approved testing laboratory of various testing and measuring equipment including tensile testing machine, resistance measurement facilities, burette, thermometer, barometer etc.
- b) Finished insulator shall be checked for dimension verification and surface finish separately.
- c) The bidder should have all the routine and acceptance testing facilities, in house in accordance with IEC:383 & 61109.

Manufacturers of foreign origin shall, in addition to the above, also have arrangements in India, either at works of their authorized representative/licenses or in the NABL lab. like CPRI, IISC, ERDA etc. for conducting sampling test in accordance with IEC : 383 & 1109.

20.0 QUALITY ASSURANCE PLAN

20.1 The bidder shall invariably furnish following information along with his offer, failing which his offer shall be rejected.

- i) Statement giving list of important raw materials, proposed to be used in the manufacture of the insulator against this Specification, names of sub suppliers for the 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 as routine and / or acceptance during production and on finished goods, copies of test certificates.
- ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.
- iii) List of manufacturing facilities available.
- iv) Level of automation achieved and lists of areas where manual processing exists.
- v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- vi) List of testing equipment available with the Bidder for final testing of Insulator specified. In the case if the Bidder does not possess all the Routine and Acceptance testing facilities the tender will be rejected.
- vii) The Purchaser reserves the right for factory inspection to verify the facts quoted in the offer. If any of the facts are found to be misleading or incorrect the offer of that Bidder will be out rightly rejected and he may be black listed.

- viii) Special features provided to make it maintenance free.
- ix) Bidder shall also submit the Field Quality Plan (FQP) along with Technical Bid.

20.2 The bidder shall also submit following information to the purchaser along with the technical Bid. .

- i) List of raw materials as well as bought out accessories, and the name of suppliers of raw materials as well as bought out accessories.
- ii) Type test certificates of the raw material and bought out accessories.
- iii) Quality assurance plan (QAP) with hold points for purchaser's inspection.

20.3 The Bidders shall submit the routine test certificates of all the bought out items, accessories etc.

21.0 DOCUMENTATION

21.1 Two sets of type test reports, duly approved by the Purchaser shall be submitted by the Bidder, before commencement of supply. A copy of acceptance and routine test certificates, duly approved by the purchaser shall accompany the dispatch consignment.

21.2 The bidder shall submit the drawings in triplicate for the offered insulators well within the commencement period for approval. The manufacturing of the insulator shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the Purchaser. All manufacturing and fabrication work in connection with the insulator prior to the approval of the drawing shall be at supplier's risk.

21.3 Approval of drawings etc. by the purchaser shall not relieve the Bidder of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices. The insulator shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards in vogue on the day of opening

of the Technical Bid and purchaser shall have the power to reject any work or material which in his judgment is not in full accordance therewith.

21.4 In case the bidders offers Silicon rubber composite insulators tested and supplied to other utilities, and are in service, the following additional information shall be furnished along with the bid.

1. The certificates of Type test as specified conducted within 5 years from the date of enquiry.
2. Performance report from the utilities for satisfactory performance of the Composite insulator for at least 'Three' years.
3. List of similar past orders executed for insulator for the last 5 years period.
4. Quality assurance plan in prescribed proforma.

22.0 DRAWINGS

All the bidders have to submit the drawings for Composite long rod (Silicon Rubber) insulator along with the crates to be utilised for packing of the insulator, for the numbers specified in this Tender Specification along with the offer. In the event of an order the successful bidder shall submit the drawings stated above in triplicate for approval during the commencement period to CEE (P&C), KPTCL, Kaveri Bhavan, Bangalore. The set of approved drawings shall be submitted in soft copy in Auto CAD format.

23.0 DEVIATIONS

23.1 Any deviation to this tender Specification will be out rightly rejected. All the Bidders have to submit this specification duly authenticated without any alterations, additions etc. on each page along with the **Technical Bid. Any offer without this will be out rightly rejected.**

24.0 MAINTENANCE:

The insulator shall be capable of high pressure washing at a maximum nozzle pressure of 550psi. The insulators offered shall be suitable for employing Hot Line Maintenance Techniques with required speed, ease and safety.

ANNEXURE-A

1. Tests on Complete Strings with Hardware Fittings.

1.1 Mechanical Strength Test

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to, remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2 Vibration Test

The suspension string shall be tested in suspension mode and tension string in tension mode itself in laboratory span of minimum 30 Meters. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and two sub-conductors (each tensioned at 43 KN shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinodes point, nearest to the string, shall be measured and the same shall not be less

than 1000/fwhere is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for looseness if pins and cap or any crack in the cement. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to the following tests as per relevant standards :

a) Temperature cycle test followed by mechanical performance test.

1.3 Salt -fog pollution withstand test

This test shall be carried out in accordance with IEC-60507. The salinity level for composite long rod insulators shall be 80 Kg / m³ NaCl.

2.0 Composite Long rod Insulator Units

2.1 Brittle Fracture Resistance Test.

Assembled core load time test with container that contains in-HNO₃ concentric acid this is applied at the naked 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.

2.2 Recovery of Hydrophobicity Test

- (1) The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.
- (2) Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester. Holding the electrode approximately 3 mm from the sample surface slowly move the electrode over an area approximately 1" x 1". Continue treating this area for 2-3 minutes, operating the tester at maximum output.

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

3.0 Test on All components (As applicable).

3.1 Chemical Analysis of Zinc used for Galvanizing.

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

3.2 Tests for Forgings.

The chemical analysis hardness tests and magnetic particle inspection for forgings will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

3.3 Tests on Castings.

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognized Procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

4.0 Grading device test:

4.1 In addition to the electrical design tests, for 220 KV & above class insulator design with applicable grading device test, similar to the following

described test: Grading devices shall be tested using a mechanical shaker with at least a one inch stroke at the grading device and a frequency of no less than three cycles per second for duration of 2,000,000 cycles. Movement shall be along the long axis of the insulator. The grading device shall be attached to the shaker in a vertical position. The test shall be considered successful if no movement is detected in the ring with respect to the insulator and there is no physical damage to the grading device and the attachment assembly.

The manufacturer should provide with documentation that the insulator design with applicable grading devices will minimize or eliminate corona discharge activity under wet and dry conditions.

5.0 Power Arc Test:

- 5.1** Three insulators having any one design of end fittings shall be tested for power arc endurance while tensioned horizontally at 3000lb. An arc shall be initiated across the insulator by means of a Copper shorting fuse wire. The arc shall burn 15 to 30 cycles and its current magnitude is determined by ampere-time product($I \times T$) equal to a minimum of 150kA cycles. Each insulator is only acceptable if there is no exposure of the core, no mechanical separation of the insulator, and no cracks in the housing (As per IEC61467-1997)

GUARANTEED TECHNICAL PARTICULARS FOR SILICON RUBBER HOUSED COMPOSITE INSULATORS

(To be furnished by the bidder and submitted with the offer. Entering
Duplicate/overwritten data may lead to rejection of offer.)

Sl No	GTP PARTICULARS	SUSPENSION TYPE COMPOSITE INSULATOR			TENSION TYPE COMPOSITE INSULATOR		
		220KV	110KV	66KV	220KV	110KV	66KV
	GENERAL						
1	Manufacturer's name, address & country.						
2	Bidder's name, address & country						
3	Size & designation of Ball & Socket(mm)						
4	Standard to which Ball & socket will conform						
5	Section length of insulator (mm)						
6	No. of units per string						
7	Number of weather sheds per unit.(nos)						
8	Material of housing and weathershed						
9	Creepage distance of insulator in mm.						
10	Dry arc distance (mm)						
11	Specified Mechanical Load (SML) of insulator in KN						
	ELECTRICAL						
12	Dry Power frequency withstand Voltage (KV rms)						
13	Wet Power frequency withstand Voltage (KV rms)						
14	Positive Lightning Impulse withstand Voltage under Dry condition (KVp)						
15	Negative Lightning Impulse withstand Voltage under Dry condition (KVp)						
16	Dry Power frequency Flash over Voltage (KV rms)						
17	Wet Power frequency Flash						

	over Voltage (KV rms)						
18	Positive Lightning Impulse Flash over Voltage under Dry condition (KVp)						
19	Negative Lightning Impulse Flash over Voltage under Dry condition (KVp)						
20	Maximum RIV including CC rings, Arcing horns, Clamps etc. at 1.1 times maximum Corona inception Voltage (KV rms) line to ground voltage (micro volts)						
21	Corona extension Voltage (KV rms)						
22	Whether details regarding method of fixing end fitting to FRP rod, method of detecting harmful cracks on FRP rod during crimping and method of manufacturing are enclosed.						