

SECTION – IX

TECHNICAL SPECIFICATIONS

FOR

**HARDWARE FOR DISC / LONG ROD/ SILICON RUBBER
COMPOSITE INSULATORS**

SECTION – IX

TECHNICAL SPECIFICATION FOR INSULATOR HARDWARE FOR TRANSMISSION LINES

1.0 SCOPE:

1.1 This specification provides for design, manufacture, inspection and testing before dispatch packing and delivery F.O.R. (destination) of hardware fittings required for 220KV & 66KV transmission line insulator strings as per the requirement furnished in Bid proposal sheets. The hardware shall be suitable for the type of insulator Viz., Porcelain Disc insulator or Long rod insulator or Silicon rubber composite insulator in all respect.

1.2 The hardware shall conform in all respects to high standards engineering, design, workmanship and latest revision 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, the hardware fittings shall conform to the following Indian Standards, which shall mean latest revisions and amendments thereof. Equivalent International and Internationally recognized standards to which these standards generally correspond are also listed below:

Sl. No.	Indian Standard	Title	International Standard
1	IS:206	Methods for Chemical Analysis of Slab Zinc	
2	IS:209	Specification for zinc	BS:3436
3	IS:731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V	BS:137 (I&II) IEC:274 IEC:383
4	IS:1570	Schedules for wrought steels for general engineering purposes (amendment No.1&3)	
	(Part-I)	Steel specified by tensile and/ or yield properties	
5	IS:1573	Electroplated coatings of zinc on iron and steel	
6	IS:2004	Carbon Steel forging for general engineering purposes	
7	IS:2071	Methods of High Voltage Testing	
8	IS:2121	Specification of conductor and Earthwire Accessories for overhead power lines	
9	IS:2486	Specification for Insulator fittings for overhead Power lines with a nominal voltage Greater than 1000 V	
	Part-I	General Requirements & tests	BS:3288
	Part-II	Dimensional Requirements	IEC:120
	Part-III	Locking Devices	IEC:372
10	IS:2629	Recommended practice for Hot Dip Galvanisation for Iron and Steel	
11	IS:2633	Testing for Uniformity of coating of zinc coated articles	
12	IS:3138	Hexagonal Bolts and Nuts	ISO/R 947 and ISO/R 272
13	IS:3188	Dimensions for Disc Insulators	IEC:305
14	IS:4172	Dimensions for heads of bolts and screws	
15	IS:4206	Dimensions for nominal lengths and thread length for screws and studs (with amendment No.I)	

16	IS:4218	Metric Screw Threads	ISO/R-68-1969 R-26-1963, R-262-1969 & R-965-1969
17	IS:6603	Stainless steel bars and flats	
18	IS:6639	Hexagonal bolts for steel structures	ISO/R-2/2-1968
19	IS:6745	Determination of weight of zinc coating on zinc coated Iron and Steel articles	
20	IS:7814	Phosphor Bronze sheet, strip and foil	BS:2870
21	IS:8263	Methods of RIV Test of HV Insulators	IEC:437 NEMA Publication
22	IS:8269	Method for switching impulse test on HV Insulators	CISPR IEC:506
23	ASTM-D-1171 & ASTM-D-573		

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-NO UK.
IEC/CISPR	International Electrotechnical Commission Bureau Central de la commission Electro Technique International, 1, Rue de Verembe Geneva, SWITZERLAND
IS	Bureau of Indian Standards, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi-110 001, INDIA
ISO	International Organization for Standardization, Danish Board of Standardization Aurehoegvej-12 DK-2900 Hellestrup DENMARK
NEMA	National Electric Manufacturers Association 155, East 44 th Street New York, NY USA, 10017
CEA	Central Electricity Authority, Sewa Bhawan, Rama Krishna Puram, Sector-1, New Delhi-110066.

2.3 Hardware fittings conforming to any other or 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 at authentic English version of such standards shall be submitted the offer.

3.0 **PRINCIPAL PARAMETERS:**

3.1 **DETAILS OF HARDWARE FITTINGS:**

3.1.1 The hardware fittings shall be as per the specification drawings for hardware fittings attached herewith. Hardware fittings shall be suitable for single/double suspension insulator strings and single/double tension insulator strings for 220 kV & 66KV transmission lines.

3.1.2 Each hardware fitting shall be supplied complete in all respect and shall include all components indicated in the specification drawings.

3.2 **INSULATOR STRING CHARACTERISTICS:**

Sl. No.	Characteristics	Single/Double Suspension			Single/Double tension			Strain Clamps	
		220 kV	110 kV	66 kV	220 kV	110 kV	66 kV	33 kV	11k V
1	No. of standard discs	1x13 2x13	1x7 2x7	1x4 2x4	1x15 2x15	1x8 2x8	1x5 2x5	1x3 2x3	1x1 --
2	Size of each disc (Dia x height)	<-----255 x 145----->							
3	Power frequency with-stand voltage (wet) kV rms	460	230	140	460	230	140	75	35
4	Lightning impulse with stand voltage (dry) (kVp)	1050	550	325	1050	550	325	170	75
5	Power frequency with stand voltage (dry) kVp	510	265	165	510	265	165	95	55
6	Mechanical failing load (KN)	90/ 180	90/ 180	90/ 180	120/ 240	90/ 180	90/ 180	90	90
7	Pollution	<-----Refer Part-III----->							

4.0 **GENERAL TECHNICAL REQUIREMENTS:**

4.1 **DIMENSIONS OF INSULATOR STRING ALONG WITH HARDWARE FITTING:**

4.1.1 Fabrication drawings shall be prepared by the supplier.

- 4.1.2 The dimensions shall be suitably selected by the supplier while preparing the fabrication drawings.
- 4.1.3 The fabrication drawings shall be submitted to the purchaser for scrutiny and approval.
- 4.1.4 Dimensional tolerances as per relevant ISS only shall be allowed.

4.2 **CORONA AND RI PERFORMANCE:**

Sharp edges, scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The Bidder must give suitable assurance about the satisfactory corona and radio interference performance of the materials offered by him.

4.3 **BALL AND SOCKET FITTINGS:**

The dimensions of the ball and socket shall be of 16 mm & 20 mm designation for suspension and tension string respectively in case of 220 kV line assembly in accordance with standard dimensions stated in IS:2486 (Part-II).

4.3.1 **BALL FITTINGS:**

Ball fittings shall be made of class IV steel as per IS:2004 or steel of equivalent grade forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings. Before galvanization of ball fittings, all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the requirements.

4.3.2 **SOCKET FITTINGS:**

Socket fittings shall be made of class-IV steel as per IS: 2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings.

4.3.3 **DIMENSIONS AND TOLERANCES:**

- 4.3.3.1 The dimensions and tolerances of pin balls and socket ends shall conform to IS:2486, Part-II and shall be checked by the gauge therein after galvanizing.
- 4.3.3.2 The pinballs be checked with the applicable 'GO' gauges in at least two directions, one of which shall be across the line of die flashing, and the other 90⁰C to this line. "NO GO" gauges shall not pass in any direction.
- 4.3.3.3 The bearing surfaces of balls and machined sockets, before galvanizing shall not have surface roughness more than 250 micron.
- 4.3.3.4 The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contour of the socket ends shall be concentric with the axis of fittings. The axis of the bearing surface of socket ends shall be coaxial with the axis of fittings with no appreciable tilting.

4.3.4 **SECURITY CLIPS FOR SOCKET FITTINGS:**

- 4.4.4.1 Socket fittings shall be provided with R-shaped security clip in accordance with IS:2486 (Part-III) to provide positive locking against unintentional disengagement of socket from the ball of the insulator. The security clip shall be humped to maintain the clip in the locked position and shall have both prongs spread to prevent complete withdrawal from the socket. The clip end shall not project outside the recess of socket when the clip is in locked position.
- 4.4.4.2 The hole for the security clip shall be on the side of the socket opposite to the socket opening. The hole for the clip shall be counter sunk. The clip eye shall be of such design that the same may be engaged by a hotline clip puller to provide for disengagement under energized conditions.

4.4.4.3 The force required to pull the clip to its unlocked position shall not be less than 50 N or more than 500 N.

4.4.4.4 The security clip shall be made of stainless steel of type AISI 302 or 304 or phosphor bronze as per IS:7814.

4.4 **YOKE PLATE/LINK PLATE:**

4.4.1 The yoke plate/link plate shall be made of mild steel plate as per IS:226 or equivalent standards. Shearing/cutting of the plates shall be clean without drawn or ragged edges. If the plates are flame cut, mechanical guides shall be used. It shall be ensured that the grain flow of the yoke plate shall be in the direction of the tensile load.

4.4.2 Holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

4.4.3 All the corners and edges should be rounded off with a radius of at least 3 mm.

4.5 **ARCING HORNS:**

4.5.1 Arcing horns shall be provided on the line side as well as tower side of various locations. It may be essential to reduce the insulation near the substation ends up to a length of 1.6 KM on either side in order to arrive at a good coordinated design. The spark gap shall be so spaced as to ensure effective operation under actual conditions. The range settings and dry, wet and impulse flashover values shall be as given in the tender. The arcing horns shall be provided with two bolts instead of one bolt to fix it to the main laviwave in order to prevent it from sliding or tilting.

4.6 **SAG ADJUSTMENT DEVICE:**

Not applicable.

4.7 **SUSPENSION ASSEMBLY:**

4.7.1 The suspension assembly shall be suitable for AAAC 'MOOSE' conductor in case of 220 kV lines,

4.7.2 The suspension assembly shall include one armour - grip suspension clamps except for pilot insulator string for which one/two suitable envelope type suspension clamps shall be used.

4.7.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

4.7.4 The suspension clamp along with standard preformed armour rods set shall have a slip strength between 20 to 29 KN.

4.7.5 The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections ridges or excrescence which might damage the conductor.

4.7.6 **ARMOUR GRIP SUSPENSION CLAMP (AGS):**

Clause not used as this is not proposed to be used.

4.7.7 **AGS PREFORMED ARMOUR RODS:**

4.7.7.1 The AGS Preformed Armour rod set suitable for AAA 'MOOSE' conductor (as the case may be) shall be used to minimize the stress developed in the conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent span and broken wire conditions. It shall also withstand power arcs, chafing and abrasion from suspension clamp and localized heating effect due to resistance losses of the conductor.

4.7.7.2 The performed armour rod set shall have right hand lay and the inside diameter of the hole shall be less than the outside diameter of the conductor to grip the same tightly. The surface of the armour rod when

fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

4.7.7.3 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the conductor layer of AAA 'MOOSE' conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

4.7.7.4 The length and diameter of each rod shall be as per the drawing enclosed. The tolerance in length of the rods in completed set should be within 13 mm between the longest and shorter rod. The ends of armour rod shall be parrot billed.

4.7.7.5 The number of armour rods in each set shall be twelve. Each rod shall be marked in the middle with paint for easy applications on the line.

4.7.7.6 The armour rod shall not lose their resilience even after applications.

4.7.7.7 The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed copper Standard (IACS).

4.7.8 **ENVELOPE TYPE SUSPENSION CLAMP:**

4.7.8.1 The seat of the envelope type suspension clamp shall be smoothly rounded and suitably curved at the ends. The lip edges shall have rounded head. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp. The clamp body and keeper piece shall be cast out of aluminium alloy of type LM-6 or equivalent.

4.8 **DEAD END ASSEMBLY:**

4.8.1 The dead end assembly shall be suitable for TWIN AAA 'MOOSE' conductor.

4.8.2 The dead end assembly shall be of compression type with provision for compressing jumper terminal at one end for 220 kV lines. The Bidder

may offer compression type as an alternative. The angle of jumper terminal to be mounted should be 30^0 with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on the conductor shall not be more than 75% of the resistance of equivalent length of conductor.

4.8.3 Die compression length shall be clearly marked on each dead end assembly designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. It shall bear identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks, showing the end of the zones. Tapered aluminium filler plugs shall also be provided at the line of demarcation between compression and non-compression zone. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensions and dimensional tolerances of the cross section of aluminium and steel dead ends shall be as per the specification drawings.

4.8.4 The assembly shall not permit slipping of, damage to or failure of the complete conductor or any part thereof at a load less than 95% of the minimum UTS of the conductor i.e. 153 KN.

4.8.5 The outer sleeve shall be made out of EC grade aluminium. The steel sleeve shall be made of mild steel rod.

4.9 **BALANCING WEIGHTS:**

4.9.1 The balancing weights shall be made of cast iron/machined mild steel and consist of four weights weighing 50 Kg each. The balancing weights shall be connected to the yoke plate of pilot suspension string

by means of eye bolt and shackle arrangement. The bottom weight shall be provided with recess to shield the ends of eyebolts.

4.10 **FASTENERS:**

- 4.10.1 All fasteners shall conform to IS:6639. All fasteners except spring washer shall be hot dip galvanized. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square shank, which must be perfectly straight.
- 4.10.2 Fully threaded bolt shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.
- 4.10.3 All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but not further. It shall be ensured that the threaded portion of the bolt protrudes not less than 5 mm and not more than 10 mm when fully tightened.
- 4.10.4 Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Thickness of washers shall conform to IS:2016. Spring washers shall be of rectangular cross section.
- 4.10.5 To obviate bending stress in bolt, it shall not connect aggregate thickness more than three times its diameter.
- 4.10.6 Bolts may have either rolled or cut threads. Nuts may be threaded after galvanizing to ensure clean threads but bolts shall not be threaded or re-threaded after galvanizing. Nut threads shall be tapped oversize to closely fit those of the galvanized bolt, with no unnecessary looseness but free enough to permit the nut to be turned freely with fingers over the entire threaded length.

4.11 **FORGED COMPONENTS:**

Forged components other than those covered in the clauses mentioned herein above shall be made out of class-IV steel as per IS:2004 or equivalent.

The items shall be normalized to achieve the required tensile properties. The forged components shall not have sharp corners and edges so as to affect corona and RIV performance.

4.12 **MATERIALS:**

The materials of the various components shall be as specified in clauses mentioned herein above. However, components made of alternative materials giving equivalent or better performance shall also be considered. The Bidder shall indicate the material proposed to be used for each and every component of hardware fittings stating clearly the class, grade or alloy designation of the material and the reference standards. However, the critical dimensions of components shall not be changed in relation to selection of different material.

4.13 **GALVANISING:**

4.13.1 Galvanizing shall satisfy the tests mentioned in IS:2633. No material shall be galvanized until all shop operations have been completed except that the nuts may be threaded and oiled after galvanizing. Minimum weight of zinc coating shall be 300 g/sq.m for fasteners and 600 g/sq.m for all other hot dip galvanized articles.

4.13.2 Fasteners shall withstand four dips while spring washers shall withstand three dips each of one minute duration in the standard preece test. Other galvanized material shall withstand minimum six dips each of one minute duration in the standard preece test.

4.13.3 The zinc coating shall be perfectly adherent, of uniform thickness, smooth reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters.

4.13.4 The zinc used for galvanizing shall be grade 99.95% as per IS:209.

4.14 **WORKMANSHIP:**

4.14.1 All the hardware fitting shall conform to the best modern practices adopted in the extra high voltage field.

4.14.2 The manufacturing process and quality control of all the materials shall be such as to give maximum possible working load, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

4.14.3 Castings shall be uniform without sharp edges or corners, free from all defects like shrinkage, inclusion, blowholes, cracks etc. Pressure die-casting shall not be used for casting of components with thickness more than 5 mm.

4.14.4 Forgings shall be uniform in quality and condition, without sharp edges or corners, free from cracks, flakes or seams, laps, slag, silvers, scabs, rolled-in scale and fissures.

4.14.5 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

4.14.6 No item shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation, which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent damage of the contact surface and to maintain good electrical contact under service conditions.

4.14.7 All fasteners shall have suitable corona free locking arrangement and shall not loosen under vibration conditions.

4.14.8 Welds shall be clean, sound, smooth uniforms without overlaps, properly fused and completely sealed. There shall be no cracks, voids, incomplete penetration, incomplete fusions; undercutting or inclusions. Porosity shall be minimized so that mechanical properties of the aluminium alloys are not affected. All welds shall be properly finished as per good engineering practices.

4.15 **MARKINGS:**

Each component of hardware shall be marked with the trademark of the supplier. Marks shall be forged or stamped with a steel die before galvanizing. The marks shall be distinct, durable, and conspicuous.

4.16 **BID DRAWINGS:**

4.16.1 The Bidder shall furnish insulator string drawings along with component drawings in accordance with specifications.

4.16.2 The Bidder shall furnish fabrication drawings with all additional dimensions along with the critical dimensions specified in the specifications/ISS.

4.16.3 Material specifications, details of applicable standards and heat treatment details shall also be furnished.

4.16.4 The details of manufacturing process also shall be furnished along with the component drawings.

4.16.5 The details of trademark to be provided on the components shall also be furnished.

5.0 **TESTS:**

The following tests shall be carried out on the hardware fittings.

5.1 **TYPE TESTS:**

These are those tests, which are to be carried out to prove the design, process of manufacture and general conformity of the material in accordance with the specifications. The Contractor shall furnish type test certificates not older than 7 years. In case the same is older than 7 years then these tests shall be carried out on samples prior to commencement of commercial production against this specification at his own cost. The bidder shall indicate his schedule for carrying out these tests.

5.2 **ACCEPTANCE TESTS:**

These are those tests, which are to be carried out during inspection prior to despatch for the purpose of acceptance of that lot.

5.3 **ROUTINE TESTS:**

These are those tests, which are to be carried out on each hardware fitting to check the requirements, which are likely to vary during production.

5.4 **TEST DURING MANUFACTURE:**

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

5.5 **TESTING VALUES:**

For all type and acceptance tests, the acceptance values shall be those value guaranteed by the bidder in the Guaranteed Technical Particulars or the acceptance values specified in the relevant standard whichever is more stringent for that particular test. The norms and procedures of sampling for these tests will be as per the Quality Assurance Programme to be mutually agreed to by the supplier and the purchaser.

The standards and norms to which these tests will be carried out are listed against them. Where a particular test is a specific requirement of this specification, the norms and procedures of these shall be as specified in Annexure-III of this volume or as mutually agreed to between the supplier and the purchaser in the Quality Assurance Programme.

5.6 **TYPE TESTS:**

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

5.6.1 On the complete insulator string with hardware fittings (Please also refer Clause 5.10.3)

a) Power frequency voltage withstands test with arcing horns.	BS:137 (Part-I)
b) Switching surge voltage withstands test under wet condition	IEC:383
c) Impulse voltage withstands test under dry condition	IEC:383
d) Impulse voltage flashover test under dry condition	IS-731/1971
e) Voltage distribution test	
f) Mechanical strength test for complete string	
g) Vibration test	

NOTE: For electrical tests, the insulator string shall be mounted on a simulated tower.

5.6.2 On Suspension Hardware Fittings only.

a) Mechanical test	IS-2486 (Part-I)
b) Clamp slip strength for AGS clamp	As per this Specification
c) Clamp slip strength Vs torque test for suspension clamp	

5.6.3 On Tension Hardware Fittings Only:

a) Electrical resistance test for dead end assembly	IS:2486 (Part-I)
b) Heating Cycle test for dead end assembly	
c) Slip strength test for dead end assembly	
d) Mechanical tests	

5.6.4 All the type tests given under clause No.5.6.1 above shall be conducted separately on Single/Double Suspension and Single/Double tension insulator string along with hardware fittings.

5.6.5 The tests specified under clause No.5.6.1 (e) and (f), that is, the voltage distribution test and corona/RIV (Dry) test shall also be conducted on single suspension pilot insulator string along with hardware fittings.

5.7 **ACCEPTANCE TESTS/SAMPLE TESTS:**

5.7.1 On both suspension and tension hardware fittings:

a) Visual examination	IS:2486 (Part-I)
b) Verification of dimensions	IS:2486 (Part-I)
c) Galvanizing test/Electroplating	As per Specification
d) Mechanical strength test of welded joint	
e) Mechanical strength test for corona control rings/grading rings	BS: 3288 (Part-I)
f) Test on locking devices for ball and socket coupling	IEC: 372(2)

5.7.2 **ON SUSPENSION HARDWARE FITTINGS ONLY:**

a) Clamp slip strength Vs. Torque test for suspension clamp	As per specification
b) Shore hardness test of elastomer cushion for AG suspension clamp	
c) Band test for armour rod set	IS:2121 (Part-I)
d) Resilience test for armour rods set	
e) Conductivity test for armour rods set	

5.7.3 **ON TENSION HARDWARE FITTINGS ONLY:**

a) Slip strength test for dead end assembly on Neoprene	IS:2486 (Part-I)
b) Ozone test	
c) Heat Resistance test	

5.8 **ROUTINE TESTS:**

a) Visual Inspection	IS:2486 (PART-I)
b) Proof Load test	As per the specification

5.9 **TEST DURING MANUFACTURE:**

On all components as applicable:

a) Chemical analysis of Zinc used for galvanizing	As per the specification
b) Chemical analysis, hardness tests, grain size, inclusion rating and magnetic particle inspection for forgings/castings	
c) Chemical analysis, and proof load test fabricated hardware	

5.10 **TEST CHARGES AND TEST SCHEDULE:**

5.10.1 **TYPE TESTS:**

The Hardware offered shall be fully type tested as per the relevant standards. The bids offering equipment not type tested will be rejected. These tests must not have been conducted earlier than **seven** 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 the type test reports along with the offer. In case these type tests are conducted earlier than **seven** years all the 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 some or all the type tests in the presence of his representatives and these shall be conducted at no extra cost to owner. For any change in the design/type already type tested and the design/type offered against this specification, the purchaser reserves the right to demand repetition of 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).

5.10.2 **ACCEPTANCE AND ROUTINE TESTS:**

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in presence of purchaser's representative.

5.10.3 For type test, which involve the tests on the complete insulator string along with hardware fittings, the primary responsibility of conducting test lies with the disc insulator supplier. However, the hardware supplier shall make all the necessary hardware fittings for testing available to the insulator supplier at the place of testing and do all the associated co-ordination work in this regard. In respect of electrical tests on the complete insulator string consisting of insulators and hardware's for RIV, Corona and voltage distribution test and with insulator manufacturer for all other tests.

- 5.10.4 In case of any failure during testing, the cause of failure shall be thoroughly investigated by the supplier in association with purchaser's engineers. In case it is established that the cause of failure is due to some defects in manufacturing process or in the material itself, then the re-testing shall be carried out by the supplier without any extra cost to purchaser. However, if it is established that the failure is due to deficiency in design itself, then the design will be suitably modified by the supplier. After incorporating the modification suggested, re-testing is to be carried out. In the latter case, the re-resting charges will be paid as per the rates quoted in the appropriate schedule of Bid Proposal Sheet for that particular test. In case of any dispute, the assessment of the purchaser as to what is the cause of failure shall be final and binding.
- 5.10.5 Supplier shall indicate the laboratories in which it is proposed to conduct the type tests. Supplier shall also ensure that the tests can be completed in these laboratories, within the time schedule guaranteed, by him in the appropriate schedule of Bid Proposal Sheet.
- 5.10.6 The entire cost of testing for acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted unit price of hardware fittings, except for the expenses of the Inspector/Purchaser's representative.
- 5.10.7 Immediately after finalization of the programme of type/acceptance/routine testing, the supplier shall give sufficient advance intimation to the purchaser, to enable to depute his representative for witnessing the tests.
- 5.11 **SAMPLE BATCH FOR TYPE TESTING:**
- 5.11.1 The supplier shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection.

5.11.2 Before sample selection, the supplier shall be required to conduct all the acceptance tests successfully in presence of purchaser's representative.

5.12 **ADDITIONAL TESTS:**

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

5.12.2 The Purchaser also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at supplier's premises or at any other test center. In case of any failure, it shall be binding on the part of supplier to replace that particular lot completely, without any extra cost to the purchaser.

6.0 **INSPECTION:**

- i) The Purchaser shall have access at all times to the works and all other places of manufacture, where the hardware fittings and its components are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplier's works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.
- ii) The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of accessories in its various stages so that arrangements could be made for inspection.
- iii) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.
- iv) The acceptance of any quantity of accessories 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 hardware fittings later found to be defective.

7.0 **QUALITY ASSURANCE PLAN:**

7.1 The bidder shall invariably furnish the following information 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 standards 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 materials.
- 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 for quality control and details of such tests and inspections.
- 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.

7.2 The supplier shall within 30 days of placement of order, submit the following information to the purchaser:

- i) List of raw material as well as bought out accessories and the names of sub-suppliers selected from there furnished along with the offer.
- ii) Type test certificates of the raw material and bought out accessories.
- iii) Quality Assurance Plan (QAP) withhold points for purchaser's inspection. The QAP and hold points shall be discussed between the Purchaser and the Supplier before the QAP is finalized.

7.3 The supplier shall submit the routine test certificates of bought out items and raw materials at the time of routine testing of the fully assembled hardware fittings.

8.0 **DOCUMENTATION:**

8.1 i) The bidder shall furnish along with the bid the dimensional drawings of all types of hardware fittings:

ii) These drawings shall include the following information:

- a) Dimensions.
- b) Tolerance on dimensions.
- c) Material designation used for different components with reference to standards.
- d) Fabrication details such as welds, finishes and coatings.
- e) Catalogue or part numbers for each component and the total assembly with bill of materials.
- f) Identification marking.
- g) Weight of individual components and total assembled weight.

iii) The assembly drawings shall include the following:

- a) Brief installation instructions.
- b) Design installation torque for the bolt or cap screw.
- c) Withstand torque that can be applied to the bolt or cap screw without failure of components or parts thereof.
- d) Compression die number with recommended compression pressure.
- c) Relevant technical details of significance.

8.2 **TEST REPORTS:**

i) Four copies of type test reports shall be furnished to the purchaser within one month of conducting the tests. One copy will be returned duly certified by purchaser to the supplier within three weeks there afterwards and on receipt of the same supplier shall commence with the commercial production of the concerned material.

ii) Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only there after shall the materials be despatched.

- iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- 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.

9.0 **PACKING AND FORWARDING:**

- i) All hardware fittings shall be packed in suitably sized strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems. Suitable lifting lugs shall be provided on the crates in order to facilitate handling by cranes.
- ii) Suitable cushioning, protective padding or spacer shall be provided to prevent damage to or deformation of the hardware's during transit and handling.
- iii) All identical items shall be despatched to destination duly assembled and packed. Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be taken to prevent their transit loss.
- iv) Each component part shall be legibly and indelibly marked with the trademark of the supplier and year of manufacture.
- v) All packing cases shall be marked legibly and correctly so as to ensure their safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty or eligible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

DETAILS OF TESTS:

1.0 VOLTAGE DISTRIBUTION TEST:

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted in to percentage and proportionate correction applied so as to give a total of 100% distribution. The voltage distribution across any disc shall not exceed the values specified in clause 3.2.

2.0 CORONA EXTINCTION VOLTAGE TEST:

The sample assembly when subjected to 50 Hz Power frequency voltage shall have a corona extinction voltage of not less than the value specified in clause 3.2 under dry condition. There shall be no evidence of corona on any part of the sample when all possible sources of corona are photographed in a darkened room.

3.0 RIV TEST:

Under the conditions as specified under (2) above, the insulator string along with the 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 the maximum line to ground under dry condition. The test procedure shall be in accordance with IS: 8263.

4.0 MECHANICAL STRENGTH TEST FOR COMPLETE STRING:

The complete insulator string along with its hardware fittings excluding arcing horn, corona control rings/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. This load shall be held for five minutes and then removed. After removal of the load, the string component 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 is reached 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.

5.0 VIBRATION TEST:

The suspension string shall be tested in suspension mode and tension string in tension mode itself in a laboratory span of minimum 30 meters. In the case of suspension string a load equal to 6 KN shall be applied along the axis of the suspension string by means of a turnbuckle. The insulator strings along with hardware fittings and two sub-conductors tensioned at 45 KN shall be suitably secured. The system shall be suitable to maintain constant tension on each sub-conductor throughout the duration of the test. Vibration dampers shall not be used on the test span.

Both the sub-conductor shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulator string above 10 Hz by means of vibration inducing equipment. The amplitude of vibration at the anti-node nearest to the insulator string shall be measured and the same shall not be less than $+120/f$, being the frequency of vibration. The insulator string shall be vibrated for 5 million cycles then rotated by 90^0 and again vibrated for 5 million cycles without any failure. After the test, the disc insulators shall be examined for fatigue and mechanical strength. There shall be no deterioration of properties of hardware components after the vibration tests.

6.0 GALVANISING TEST:

The test shall be carried out as per clause No.5.9 of IS: 2496 (Part-I) except that both uniformity of zinc coating and standard preece test shall be carried out and the results obtained shall satisfy the requirements of this specification.

7.0 MECHANICAL STRENGTH TEST FOR WELDED JOINT:

The welded portion of the component shall be subjected to a load of 2000 Kgs for one minute. Thereafter, it shall be subjected to die-

penetration/ultrasonic test. There shall not be any crack at the welded portion.

8.0 CLAMP SLIP STRENGTH VS TORQUE TEST AND CLAMP SLIP FOR AGSC LAMP/ENVELOPE TYPE SUSPENSION CLAMP:

The suspension clamp shall be vertically suspended by means of a flexible attachment. A suitable length of ACSR conductor shall be fixed in the clamp. The clamp slip strength at various tightening torque shall be obtained by gradually applying the load at one end of the conductor. The clamp slip strength vs. torque curve shall be drawn. The above procedure is applicable only for free center type suspension clamp. For AG suspension clamp only clamp slip strength after assembly shall be found out. The clamp slip strength at the recommended tightening torque shall be more than 20 KN but less than 29 KN.

9.0 SHORE HARDNESS TEST OF ELASTOMER CUSHION FOR AGS ASSEMBLY:

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall lie between 65 to 80.

10.0 PROOF LOAD TEST:

Each component shall be subjected to a load equal to 50% of the specified minimum tensile strength. The load shall be held for one minute and then removed. After removal of the load the component shall not show any failure or permanent deformation.

11.0 CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING:

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

12.0 TEST FOR FORGING CASTING AND FABRICATED HARDWARE:

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, casting, radio-graphical inspection for items made of aluminium alloys, chemical analysis and proof load test for fabricated hardware and ductility test on tensile test specimen shall 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 and acceptance criteria will be as per the Quality Assurance Programme agreed upon.
