PORCELAIN LONG ROD INSULATOR

(for Overhead Transmission Line)

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Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড

(পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ)

Regd. Office: VidyutBhawan, Block – DJ, Sector-II, Bidhannagar, Kolkata – 700091.

CIN: U40101WB2007SGC113474; Website: www.wbsetcl.in

TECHNICAL SPECIFICATION FOR PORCELAIN LONG ROD INSULATOR

SCOPE:

This specification covers design, manufacture, testing at manufacturer's works before dispatch and supply of Porcelain long rod insulator as per the requirements for use in for 132/220 KV Transmission Lines.

DEVIATIONS:

Normally the offer should be as per Technical Specification without any deviation. But any deviation felt necessary to improve performance, efficiency and utility of equipment must be mentioned in the 'Deviation Schedule' with reasons duly supported by documentary evidences and advantages of such deviation. Such deviation suggested may or may not be accepted. But deviations not mentioned in 'Deviation Schedule' will not be considered afterwards.

1.1 Details of Long Rod Insulators

1.1.1 The insulators of the strings shall consist of standard long rod insulators with normal sheds for a three phase, 50 Hz, effectively earthed 220 kV/ 132 kV transmission system in a lightly polluted atmosphere. Insulators shall be long rod type with Ball and socket connections.
1.1.2 Insulators shell has normal sheds/alternate sheds with good self-cleaning properties. Insulator shed profile; spacing projection etc. shall be strictly in accordance with the recommendation of IEC-815.
1.1.3 Supplier quoting for long rod insulators made of electro porcelain shall also supply intermediate ball pins along with long rod insulators.The price of these items shall be considered as including in the price of long rod insulators.
1.1.4 The size of long rod insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware fittings shall be as follows:
Description of long rod insulator string (equivalent to standard disc insulator)
A) For 220 kV Transmission Line

Sl. No.	Type of string	Size of long rod insulators (mm)	Minimum creep age distance of each unit (mm)	No. of individual units per string	Electro-mechanical strength of long rod insulator unit(KN)	Mechanical strength of insulator string along with hardware fittings (KN)
1.	Single 'I' suspension	60-75	2240	1 x 2	70	70
2	Double 'I' suspension	60-75	2240	2X2	70	2x70
3	Single suspension Pilot	60-75	2240	1 x 2	70	70
4	Single	60-75	2400	1 x 2	120	120

	Tension					
5	Double Tension	60-75	2400	2 x 2	120	2 x 120

B) for 132 kV Transmission Line

Sl. No.	Type of string	Size of long rod insulators (mm)	Minimum creep age distance of each unit (mm)	No. of individual units per string	Electro-mechanical strength of long rod insulator unit(KN)	Mechanical strength of insulator string along with hardware fittings (KN)
1.	Single 'I' suspension	60-85	2880	1 x 1	70	70
2.	Double 'I' suspension	60-85	2880	2 x 1	70	2 x 70
3	Single 'I' suspension Pilot	60-85	2880	1 x 1	70	70
4	Single Tension	60-85	3200	1 x 1	120	120
5.	Double Tension	60-85	3200	2 x 1	120	2 x120

Note : (i) Bidders may quote for the relevant strings.
Length of long rod insulator strings shall be matching with the corresponding disc insulator strings.
The cost of intermediate Ball pin shall be considered as including in the price of long rod insulators.

2.2 Pin and Cap

2.2.1 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, of such design that it will not yield or distort under load conditions.

2.2.2 The pin ball shall move freely in the cap socket but without danger of accidental uncoupling during erection or in position. The design of the long rod should be such that stresses due to expansion or contraction in any part of the insulator shall not lead to deterioration.

2.3 Ball and Socket Designation

The dimensions of the balls and socket shall be of following designation for different for long rod insulators in accordance with the standard dimensions stated in IS 2486-(Part-II)/IEC:120:-

Sl. No.	Rating of Insulators	Designation of Ball & socket as per IEC: 120
i)	70 KN	16 mm
iii)	120 KN	20 mm
iv)	160 KN	20 mm

2.4 Dimensional Tolerance

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

± (0.04 d + 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 creepage distance as the case may be.

However, no negative tolerance shall be applicable to creepage distance.

2.5 Intermediate Ball Pin Designation

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

2.6 Total Effective Arcing Distance

2.6.1 The total effective arcing distance shall be 1800 mm for 220 kV line and 1200 for 132 kV line under nominal dimensions of insulator.

2.6.2 The spark gap shall be so adjusted to ensure effective operation under actual field coordination.

2.7 Inter Changeability

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

2.8 Corona and RI Performance

All surfaces shall be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localised 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.

2.9 Maintenance

2.9.1 The long rod insulators offered shall be suitable for employment of hot line maintenance techniques so that usual hot line operations can be carried out with ease, speed and safety.

2.9.2 All insulators shall be designed to facilitate cleaning and insulators shall have the minimum practical number of sheds and grooves. All grooves shall be so proportioned that any dust deposit can be removed without difficulty either by wiping with a cloth or by remote washing under live line condition.

2.10 Materials

2.10.1 Porcelain

The porcelain used in the manufacture of long rods shall be aluminous type. It shall be sound, free from defects and thoroughly vitrified and smoothly glazed.

2.10.2 Glaze

The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator and shall have a good lusture, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not be cracked or chipped by aging under the normal service conditions. The glaze shall have the same co-efficient of expansion as of the porcelain body throughout the working temperature range.

2.10.3 Insulator Cap

The caps of long rod insulator units shall be of malleable cast iron or other suitable material, duly hot dip galvanised and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material. The design of the unit shall be such that stresses due to expansion and contraction of any part of the insulator shall not lead to deterioration.

2.10.4 Intermediate Ball Pin

The intermediate ball pin shall be made of drop forged steel, duly hot dip galvanised and shall not be made by jointly welding, shrink filling or any other process from more than one piece of material.

2.10.5 Cement

Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing.

2.11 Workmanship

2.11.1 All the materials shall be of latest design and conform to the best modern practices adopted in the extra high voltage field. Bidders shall offer only such insulators as are guaranteed by him to be

satisfactory and suitable for 220 kV /132 kV transmission lines (as applicable) and will give continued good service.

2.11.2 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.

2.11.3 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

2.11.4 Metal caps shall be free from cracks, seams, shrinks, air holes and rough edges. All surfaces of the metal parts shall be perfectly smooth with the projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

2.11.5 All ferrous parts shall be not dip galvanized to give a minimum average coating of zinc equivalent to 600 gm/sq. mm. and shall be in accordance with the requirement of IS: 2629 and shall satisfy the tests mentioned in IS : 2633. The zinc coating shall be uniform, adherent, smooth, reasonably bright continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. the galvanised metal parts shall be guaranteed to withstand at least six successive dips each lasting for one (1) minute duration under the standard preece test. The galvanising shall be carried out only after any machining.

2.11.6 The design of the insulators shall be such that the porcelain shall not engage with hard metal.

2.11.7 Insulator units after assembly shall be concentric and co-axial within limits as permitted by the relevant international standard.

3.0 Equipment Marking

3.1 Each insulator disc/long rod unit shall be legibly and indelibly marked with the trade mark of the manufacturer, name of WBSETCL and month & year of manufacture. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word ‘kN’ to facilitate easy identification and to ensure proper use.

3.2 For porcelain insulator, the marking shall be on porcelain. The marking shall be printed, not impressed and shall be applied before firing. For toughened glass insulators the marking shall be on the metal parts.

4.0 Bid Drawings

4.1 The Bidder shall furnish full description and illustration of the material offered.

4.2 The Bidder shall furnish along with the bid the outline drawing (6 copies) of each insulator unit including a cross sectional view of the insulator shell. The drawing shall include but not limited to the following information:

(a) Shell diameter and ball to ball spacing with manufacturing tolerances
(b) Minimum Creepage distance with positive tolerance
(c) Protected creepage distance
(d) Eccentricity of the disc
(i) Axial run out
(ii) Radial run out
(e) Unit mechanical and electrical characteristics
(f) Size and weight of ball and socket parts
(g) Weight of unit insulator disc/long rod units
(h) Materials
(i) Identification mark
(j) Manufacturer's catalogue number

4.3 After placement of award, the Supplier shall submit full dimensioned insulator drawings containing all the details as given in Clause No. 4.11.2 above, in four (4) copies to Owner for approval. After getting approval from Owner and successful completion of all the type tests, the Supplier shall submit 20 more copies of the same drawing to the Owner for further distribution and field use at Owner's end.

4.4 After placement of award the Supplier shall also submit fully dimensioned insulator crate drawing for different type of insulators.

4.5 After placement of award, the Supplier shall submit full dimensioned manufacturing drawing of insulator cap, pin and insulator shell in six (6) copies to the Owner for reference and record.

5.0 Standard Technical Particulars

5.1 The guaranteed technical particulars to be adhered by the contractor/ manufacturer are furnished in Annexure-B of this section.

6.0 Tests and Standards

6.1 Type Tests

The following type tests shall be conducted on a suitable number of individual standard long rod units, components, materials or complete strings:

6.1.1

a)	Verification of dimensions	:As per IEC :60383
b)	Power frequency voltage withstand and flashover test under (i) dry & (ii) wet condition	:As per IEC : 60383
c)	Impulse voltage withstand and flashover test (dry)	:As per IEC : 60383
d)	Visible Discharge test (dry)	:As per IS:731, Cl. 10.2
e)	RIV test (dry)	:As per IEC:60437
g)	Thermal mechanical performance test	:As per Annexure-A

6.1.2 On the complete Insulator String with Hardware Fittings

a)	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	: As per IEC:383
b)	Switching surge voltage withstand test under wet condition (for 400 kV & above voltage level line only)	: As per IEC:383
c)	Impulse voltage withstand test under dry condition	: As per IEC:383
d)	Impulse voltage flashover test under dry condition	: As per IEC:383
f)	Corona and RIV test under dry condition (for 400 kV & above voltage level line only)	: As per Annexure-A
g)	Mechanical Strength test	: As per Annexure-A
h)	Vibration test	: As per Annexure-A

Note:

1) All the type test given in Clause No. 6.1.2 shall be conducted on following insulator string along with hardware fittings:-

On insulator strings along with hardware fittings for 220 kV line:-
Single 'I' suspension &
Single Tension insulator string.

On insulator strings along with hardware fittings for 132 kV line:-
Single 'I' suspension &
Single Tension insulator string.

2)All the type tests given under Clause No. 6.1.2 (a) to (g) shall also be conducted on following insulator string along with hardware fittings:-

On insulator strings along with hardware fittings for 220 line:-
Single suspension Pilot insulator string,
Double 'I' suspension insulator string &
Double Tension insulator string.
On insulator strings along with hardware fittings for 132 line:-
Double 'I' suspension insulator string &
Double Tension insulator string.

6.1.3 Type tests specified under Clause 6.1.1 (a) to (f) and 6.1.2 shall not be required to be carried out if a valid test certificate is available for a similar design The test certificate shall be considered valid if,

i) Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC vide 25/17025 or EN 45001 by the National accreditation body of the country where laboratory is located or witnessed by the representative(s) of any Indian power utility in last Ten years.

ii) Tests mentioned at 6.1.2 (e) to (h) and have been conducted within 10(Ten) years prior to the date of bid opening.

In case the tests have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test not applicable due to any design/manufacturing change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the Supplier at no extra cost to the Purchaser.

6.2 Acceptance Tests

6.3 For Porcelain Long rod Insulators

a)	Visual examination	:As per IEC : 60383
b)	Verification of dimensions	:As per IEC : 60383
c)	Temperature cycle test	:As per IEC : 60383
d)	Galvanising test	:As per IEC : 60383
e)	Mechanical performance test	:As per IEC:60575 Clause 4.0
f)	Test on locking device for ball and socket coupling	:As per IEC:60372
g)	Eccentricity test	:As per IEC : 60383-1
h)	Mechanical failing load test	:As per IEC : 60383-1
i)	Porosity test	:As per IEC : 60383
j)	Metallurgical Test (For metal fittings only in black condition) i) Grain size ii) Inclusion rating	:As per Annexure-A

iii) Chemical analysis
iv) Microstructure

6.4 Routine Tests

6.4.2 For Porcelain Long Rod Insulator Units

a) Visual Inspection :As per IEC:60383

b) Mechanical routine test) :As per IEC:60383

6.5 Tests During Manufacture

On all components as applicable

a) Chemical analysis of zinc used for galvanising :As per Annexure-A

b) Chemical analysis, mechanical, metallographic test and magnetic particle inspection for malleable castings. :As per Annexure-A

c) Chemical analysis hardness tests and magnetic particle inspection for forgings :As per Annexure-A

d) Autoclave Test on Cement :As per Annexure-A

6.6 Testing Expenses

6.6.1 For Type Tests which involves the tests on the complete insulator string with hardware fitting similar hardware fittings shall be arranged by insulator supplier at his own cost.

6.6.2 In case of failure in any type test the bidder whose material has failed is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 6.1.1 or 6.1.2 of this specifications or to repeat that particular type test at least three times successfully at his own expenses.

6.6.3 Supplier shall indicate the laboratories in which they propose to conduct the type tests. They shall ensure that adequate facilities are available in the laboratory and the tests can be completed in these laboratories within the time schedule guaranteed by them in the appropriate schedule.

6.6.4 The entire cost of testing for acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Ex-works/CIF Price.

6.6.5 In case of failure in any type test, if repeat type tests are required to be conducted, then all the expenses for deputation of Inspector/ Purchaser's representative shall be deducted from the contract price. Also if on receipt of the Supplier's notice of testing, the Purchaser's representative does not find 'plant' to be ready for testing the expenses incurred by the Purchaser for re deputation shall be deducted from contract price.

6.6.6 The Supplier shall intimate the Purchaser about carrying out of the type tests alongwith detailed testing programme at least 3 weeks in advance (in case of Domestic Supplier) and at least 6 weeks advance (in case of foreign Supplier) of the scheduled date of testing during which the Purchaser will arrange to depute his representative to be present at the time of carrying out the tests.

6.7 Sample Batch for Type Testing

6.7.1 The Supplier shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Owner. The Supplier shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Owner.

6.7.2 Before sample selection for type testing, the Supplier shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

6.8 Schedule of Testing

6.8.1 The Bidder has to indicate the schedule of following activities in their bids :

a) Submission of drawing for approval.
b) Submission of Quality Assurance Programme for approval.
c) Offering of material for sample selection for type tests.
d) Type testing.

6.9 Additional Tests

6.9.1 The Owner reserves the right of having at his own expenses any 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 himself that the material comply with the Specifications.

6.9.2 The Owner also reserves the right to conduct all the tests mentioned in this specification at his own expense on the samples drawn from the site at Supplier's premises or at any other test 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.

6.10 Guarantee

The Supplier of insulators shall guarantee overall satisfactory performance of the insulators with the hardware fittings.

6.11 Test Reports

6.11.1 Copies of type test reports shall be furnished in at least six (6) copies along with one original. One copy shall be returned duly certified by the Owner only after which the commercial production of the concerned material shall start.

6.11.2 Copies of acceptance test reports shall be furnished in at least six (6) copies. One copy shall be returned duly certified by the Owner, only after which the material shall be dispatched.

6.11.3 Record of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Owner's representative.

6.11.4 Test certificates of test during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when desired by the Owner.

6.12 Inspection

6.12.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where insulator, and its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Supplier's and sub-Supplier's works, raw materials, manufacture of the material and for conducting necessary test as detailed herein.

6.12.2 The material for final inspection shall be offered by the Supplier only under packed condition as detailed under clause for 'packing and marking' in the specification. The Owner shall select samples at random from the packed lot for carrying out acceptance tests. Insulators shall normally be offered for inspection in lots not exceeding 10,000 nos. for disc / 1300 units for long rod insulator. When more than 10,000 nos for disc/1300 units for long rod insulators are offered, then they shall be divided into optimal number of equal lots comprising 2000/260 and 10000/1300 insulators. The lot should be homogeneous and should contain insulators manufactured in 3-4 consecutive weeks.

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

6.12.4 No material shall be dispatched from its point of manufacture before it has been satisfactorily inspected and tested unless the inspection is waived off by the Owner in writing. In the latter case also the material shall be dispatched only after satisfactory testing for all tests specified herein have been completed.

6.12.5 The acceptance of any quantity of material shall be no way relieve the Supplier of his responsibility for meeting all the requirements of the specification and shall not prevent subsequent rejection, if such material are later found to be defective.

6.13 Packing and Marking

6.13.1 All insulators shall be packed in strong seasoned wooden crates. The gross weight of the crates along with the material shall not normally exceed 200 Kg to avoid handling problem. For marine transportation crates shall be palleted.

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

6.13.3 Suitable cushioning, protective padding, or dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

6.13.4 All packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly dispatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

6.14 Standards

The insulator strings and its components shall conform to the following Indian/ International Standards which shall mean latest revision, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

6.14.1 In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Sl. No.	Indian Standard	Title	International Standard
1.	IS:209-1992	Specification for zinc	BS:3436
2.	IS:406-1991	Method of Chemical Analysis of Slab Zinc	BS:3436
3.	IS:731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS:137- (I&II) IEC:60383
4.	IS:2071 Part (I) – 1993 (Part(II)-1991 Part(III)-1991	Methods of High Voltage Testing	IEC:60060-1
5.	IS:2486 Part- I-1993 Part- II-1989 Part-III-1991	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:60120 IEC:60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanisation for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:3188-1988	Dimensions for Disc Insulators	IEC:60305
9.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS:433-1969 ISO:1460-1973

10.	IS:8263-1990	Methods of RI Test of HV insulators	IEC:60437 NEMA Publi-cation No.07/ 1964/ CISPR
11.	IS:8269-1990	Methods for Switching Impulse test on HV insulators	IEC:60506
12.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
13.		Salt Fog Pollution Voltage Withstand Test	IEC:60507
14.		Residual Strength of String Insulator Units of Glass or Ceramic Material for Overhead Lines after Mechanical Damage of the Dielectric	IEC:60797
15.		Guide for the selection of insulators in respect of polluted conditions	IEC:60815
16.		Tests on insulators of Ceramic material or glass or glass for overhead lines with a nominal voltage greater than 1000V	IEC:60383
17.		Characteristics of string insulator units of the long rod type	IEC : 60433
18.		Standard Test Method for Autoclave Expansion of Portland Cement	ASTM C151-93-a
19.		American National Standard for Insulators wet process porcelain and toughened glass suspension type	ANSI C29-2-1992

ANNEXURE-A

1. Tests on Complete Strings with Hardware Fittings

1.1 Mechanical Strength Test

The complete insulator string along with 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 metres. 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 specified no. of sub-conductors each tensioned at 25 % of UTS of the conductor shall be secured with clamps. 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-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 antinode point, nearest to the string, shall be measured and the same shall not be less than $1000/f^{1.8}$ where f 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 of 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:

Sl. No.	Description of line	No. of sub-conductor	Tension of each sub-conductor
i)	220 kV line	1	35 KN
ii)	132 kV line	1	25 KN

Sl. No.	Tests Percentage of	Percentage of units to be tested	
		Disc insulators	Long rod insulators
a)	Temperature cycle test followed by mechanical performance test	60	100
b)	Puncture test/steep wave front test	40	-

2. On Disc Insulator Units / Porcelain long rod units (as applicable)

2.3 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.

2.4 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 electro-mechanical/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, IEC 591 shall be applicable.

(iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.

2.6 IR Measurements

IR measurement shall be carried out by the instrument operating at ±5/10 kV DC. IR value when measured under fair weather condition, shall not be less than 2000 M-ohm.

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.

3.4 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 Program.

3.5 Autoclave Test

For cement used in the assembly of the insulators six samples from different batches shall be tested in accordance with ASTM C-151. The cement shall have an expansion less than 0.12%.