



## SECTION – 1

### 1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Disc Insulators & String Hardware to site.

This section covers the scope and quantities of Disc Insulators & String hardware. The Specific Technical Requirements for the above item as specified by the customer (PGCIL) are given in Section-2. The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

In case of any discrepancies between the requirements mentioned under Section-1/Section-2 and those specified in the Section-3, the specifications given under Section-1/Section-2 shall prevail and shall be treated as binding requirements.

The equipment is required for the following project at 3 different Sites :

Name of the Customer : POWER GRID CORPORATION OF INDIA LIMITED (PGCIL)  
Name of the Project : 400/220kV AURANGABAD (PG) S/s, Extn of 400kV WARDHA S/s  
& EXTN OF 400kV AURANGABAD (MSETCL) S/s.

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

### 1.2 SPECIFIC TECHNICAL REQUIREMENTS

All equipment shall perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

The equipment shall also comply to the following:

- a) To facilitate erection of equipment, all items to be assembled at site shall be “match marked”.

Equipment and system shall be designed to meet the following major technical parameters as brought out hereunder.

**Bharat Heavy Electricals Limited**400kV/220kV S/S AURANGABAD(PG),EXTN OF 400kV Wardha  
and Extn of 400kV Aurangabad(MSETCL) S/s Project

Technical Specification for Disc Insulators &amp; String Insulator Hardware

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Sl. No.	Particulars	400kV	220kV
1.	System Operating Voltage	400kV	220kV
2.	Maximum Operating voltage of the system (rms)	420kV	245kV
3.	Rated Frequency	50Hz	50Hz
4.	No of phase	3	3
5.	Rated Insulation Levels		
i)	Full Wave impulse withstand voltage (1.2/50 microsec.)	1550 kVp	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	1050 kVp	-
iii)	One minute power frequency dry withstand voltage (rms)	680 kV	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	-	460kV
6.	Corona Extinction voltage	320 kV	156 kV
7.	Max. radio interference voltage for frequency between 0.5MHz and 2 MHz at 508 kV rms for 765kV, 266kV rms for 400kV system and 156kV rms for 220kV system.	1000 micro volts	1000 micro volts
8.	Minimum creepage system (25mm/kV)	10500 mm	6125 mm
9.	Min. Clearance		
i)	Phase to Phase	4000mm (for conductor-conductor)	2100mm (for conductor-conductor)

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		configuration) 4200mm (for rod- conductor configuration)	configuration) 4200mm (for rod-conductor configuration)
ii)	Phase to earth	3500 mm	2100 mm
iii)	Sectional Clearances	6500 mm	5000 mm
10.	Rated short circuit current for 1 sec duration	50kA	50kA
11.	System neutral earthing	Effectively earthed	Effectively earthed

**1.3 BILL OF QUANTITIES****As per Annexure A.****1.4 TYPE TESTING**

Bidder shall submit valid type test reports of the Disc Insulator along with offered make of String Insulator Hardware (as per relevant IEC/IS Standard) for approval. The type test reports submitted shall be of tests conducted within last 10 years prior to the date of bid opening i.e. 26.08.11. The bidder should have conducted type test on identical or similar equipment/components to those offered. In case type test reports are found to be technically unacceptable to BHEL/PGCIL, the type test shall be conducted without cost and delivery implication to BHEL.

**1.5 QUALITY PLAN**

Bidder to follow valid PGCIL approved Quality Plan as per PGCIL procedure. In case the bidder don't have PGCIL approved QP, it will be the bidder's responsibility to get its QP approved directly from the ultimate customer.

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<b>Project: 400kV/220kV S/S Aurangabad(PG), EXTN. of 400kV Wardha &amp; Extn. of 400kV Aurangabad (MSETCL) S/S Project</b>					
<b>BOQ FOR DISC INSULATORS AND STRING INSULATOR HARDWARE</b>					
<b>Site: 400kV/220kV S/S Aurangabad(PG)</b>					
Sl. No.	Item Description	Qty.of string hardware	Spare Qty(5%) hardware	Total (Qty ) of hardware	
1	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with turn Buckle	66	4	70	18
2	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with out turn Buckle	54	3	57	8
3	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with drop clamp	42	3	45	16
4	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with turn Buckle	24	2	26	11
5	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with out turn Buckle	18	1	19	10
6	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with drop clamp	24	2	26	14
7	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with straight clamp	6	1	7	15
8	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with turn Buckle	75	4	79	5
9	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor without turn Buckle	63	4	67	4
10	220kV Single suspension insulator string comprising 1x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with drop clamp	36	2	38	6
11	220kV Single suspension insulator string comprising 1x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with straight clamp	30	2	32	7
12	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Quad ACSR Bersimis conductor with turn Buckle	36	2	38	3
13	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Quad ACSR Bersimis conductor without turn Buckle	36	2	38	2
Disc Insulator for Aurangabad (PG) Total qty of disc insulators 5% spare for disc Insulators <b>Total Qty for Disc Insulators (Main +spare)</b>		17190 860 <b>18050</b>			

<b>Site: Extn. of 400kV Wardha</b>				
<b>Sl. No.</b>	<b>Item Description</b>	<b>Qty.of string hardware</b>	<b>Spare Qty(5%) hardware</b>	<b>Total (Qty ) of hardware</b>
1	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with turn Buckle	18	1	19
2	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with out turn Buckle	12	1	13
3	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with drop clamp	18	1	19
4	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with straight clamp	6	1	7
<b>Disc Insulator for Wardha Extn.</b>				
No. of Disc Insulators		2100		
5% Spare		105		
<b>Total Qty. of disc Insulators</b>		<b>2205</b>		
<b>Site: Extn. of 400kV Aurangabad(MSETCL)</b>				
<b>Sl. No.</b>	<b>Item Description</b>	<b>Qty.of string hardware</b>	<b>Spare Qty(5%) hardware</b>	<b>Total (Qty ) of hardware</b>
1	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for <b>twin INVAR</b> conductor with turn Buckle	6	1	7
2	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for <b>twin INVAR</b> conductor with out turn Buckle	6	1	7
3	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for <b>twin INVAR</b> conductor with drop clamp	10	1	11
4	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for <b>Quad Bersimis</b> conductor with turn Buckle	6	1	7
<b>Disc Insulator for Aurangabad (MSETCL) Extn.</b>				
<b>Total Qty. of Disc Insulators</b>		<b>1000</b>		
5% spare		50		
<b>Total Qty. of Disc Insulators</b>		<b>1050</b>		
OD of ACSR Bersimis conductor=35.05mm OD of INVAR conductor = 31.77mm				

## SECTION – 2

### **2.1 String Insulators & Hardware**

The Insulators for suspension and tension strings shall conform to IEC-60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to IS:2486.

#### **2.1.1 Construction Features**

##### **2.1.1.1 for Porcelain Insulators**

- a) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength marking on porcelain printed and applied before firing.
- b) Porcelain used in insulators manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- c) Glazing of the porcelain shall be uniform brown colour, free from blisters, burrs and other similar defects.

##### **2.1.1.2 for Glass Insulators**

It shall be made of toughened glass. Glass used for the shells shall be sound, free from defects, flows bubbles, inclusions, etc and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.

**2.1.1.3** When operating at normal rated voltage there shall be no electric discharge between conductor and insulator which would cause corrosion or injury to conductors or insulators by the formation of substances due to chemical action. No ratio interference shall be caused when operating at normal rated voltage.

**2.1.1.4** The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with latest edition of IS: 2629. The zinc used for galvanized shall be of grade Zn-99.95 as per IS-209. 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.

**2.1.1.5** Bidder shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string insulator, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for

meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

- 2.1.1.6** Clamps for insulator strings and corona Control rings shall be of aluminium alloy as stipulated for clamps and connectors.
- 2.1.1.7** Insulators hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No Part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.
- 2.1.1.8** The tension Insulator hardware assembly shall be designed for minimum 12000 kg tensile load. Earth wire tension clamp shall be designed for minimum 1000 kg tensile load with a factor of safety of two (2).
- 2.1.1.9** The tension string assemblies shall be supplied along with suitable turn buckle Sag compensation spring if required may also be provided.
- 2.1.1.10** All hardware shall be bolted type.

## **2.2 Long Rod Insulators**

- 2.2.1** As an alternative to disc insulator, Bidder can offer long rod porcelain/composite insulator strings, with suitable hardware. The combination should be suitable for application specified and should offer the identical/equivalent parameters as would be available from insulator string comprising disc insulators and hardware combination.
- 2.2.2** All constructional features specified at Clause 1.1.1 of this Section shall also apply to the rod insulator String.

## **2.3 Tests**

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

- 2.3.1** Type Tests on Insulator Strings: The test reports for following type tests shall be submitted for approval as per clause 9.2 of section – GTR.
- a) Power frequency voltage withstand test with corona control rings under wet condition as per IEC-60383

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- b) Switching surge voltage withstand test (400 kV and above class only) under wet condition as per IEC-60383
- c) Lightning Impulse Voltage withstand test with corona control rings under dry condition as per IEC-60383
- d) Voltage distribution test (Dry)

The Voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 6.5% for 765 kV Suspension and tension insulator strings, 9% and 10% for 400KV suspension string and tension insulator string respectively.
- e) Corona Extinction Voltage test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not 320kV (rms) for 400kV line to ground and 156kV (rms) for 220kV line to ground under dry condition. There shall be no evidence on Corona on any part the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.
- f) RIV Test (Dry)

Under the conditions as specified under (e) above the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 microvolts at 1 MHz when subjected to 50Hz AC line to ground voltage of 320kV for 400kV string and 156kV for 220kV string under dry conditions. The test procedure shall be in accordance with IS 8263/IEC 60437.
- g) Mechanical strength test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps 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 dismantle 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.

### 2.3.2 Type Tests on Insulators

Type test report for Thermal Mechanical Performance tests as per IEC 60575, Clause 3 / IEC: 61109, clause 5.1 (for composite long rod insulators) shall be submitted for approval as per clause 9.2 of Section GTR.

### 2.3.3 Acceptance Tests for Insulators:-

- a) Visual examination as per IEC-60383/ IEC-61109 clause no. 7.2 (for composite long rod insulators).
- b) Verification of Dimensions as per IEC-60383.
- c) Temperature cycle test as per IEC-60383.
- d) Puncture Test as per IEC-60383 (Applicable only for porcelain insulators)
- e) Galvanizing Test as per IEC-60383.
- f) Mechanical performance test as per IEC-60575 Cl. 4 / IEC-61109 clause no. 7.2 (for composite long rod insulators).
- g) Test on locking device for ball and socket coupling as per IEC-60372 (2)
- h) Porosity test as per IEC- 60383 (Applicable only for porcelain insulators).
- i) Thermal shock test as per IEC-60383 (Applicable only for glass insulators).

### 2.3.4 Acceptance Test on Hardware Fitting :-

- a) Visual Examination as per Cl. 5.10 of IS: 2486 (Part-1).
- b) Verification of Dimensions as per Cl. 5.8 of IS: 2486 (Part-1).
- c) Galvanizing/Electroplating tests as per Cl. 5.9 of IS: 2486 (Part-1).
- d) Slip strength test as per Cl. 5.4 of IS: 2486 (Part-1).
- e) Shore hardness test for the Elastometer (if applicable as per the value guaranteed by the Bidder).
- f) Mechanical strength test for each component (including corona control rings and arcing horns).  
 The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 1.2.13.1 (g) above should be followed.
- g) Test on locking devices for ball and socket coupling as per IEC – 60372 (2).

### 2.3.5 Routine Test on Insulator

- a) Visual Inspection as per IEC- 60383
- b) Mechanical Routine Test as per IEC – 60383
- c) Electrical Routine Test as per IEC – 60383

### 2.3.6 Routine Test on hardware Fittings

- a) Visual examination as per Cl. 5.10 of IS: 2486 (part-I) / IEC-61109 (for composite long rod insulators).
- b) Mechanical strength Test as per Cl. 5.11 of IS: 2486 (part-I) / IEC-61109 (for composite long rod insulators).

### 2.3.7 Test during manufacture on all components as applicable on Isolator:

- a) 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%
- b) Chemical Analysis, Mechanical hardness tests and magnetic particle inspection for Malleable casting:-  
The chemical analysis, hardness tests and magnetic particle inspection for malleable casting 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 tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Program.

### 2.3.8 Test during manufacture on all components as applicable on hardware fittings:

- a) 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%
- b) Chemical Analysis, hardness tests and magnetic particle 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 tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Program.
- c) Chemical Analysis, Mechanical hardness tests and magnetic particle inspection for fabricated hardware:

The chemical analysis, hardness tests and magnetic particle inspection for fabricated hardware 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 tests will be as discussed and mutually agreed to by the Contractor and Owner in Quality Assurance Program.

## 2.4 Parameters

### 2.4.1 Disc Insulators

- a) Type of insulators : Anti Fog type
- b) Size of insulator units (mm) : 255×145 or 280×145
- c) Electro mechanical strength : 120 KN
- d) Creepage distance of individual insulator units (minimum and as required to meet total creepage distance) : 430 mm
- e) Markings
- 1) For Porcelain insulators : Markings on porcelain shall be printed and applied before firing
- 2) For toughened glass insulators : Markings shall be done on initial parts
- f) Power frequency puncture Withstand voltage : 1.3 times the actual wet flashover voltage.

\*Long rod porcelain/composite insulators should conform to equipment electrical and mechanical parameters.

### 2.4.2 INSULATOR STRING

Sl. No.	Description	220 kV	400kV
a)	Power frequency withstand voltage of the complete string with corona control ring (wet)-kV rms	460	680
b)	Lightning impulse withstand Voltage of string with corona control rings (dry) –kVp	±1050	±1550
c)	Switching surge withstand voltage of string with corona control rings (wet) –kVp	NA	±1050
d)	Minimum corona extinction voltage level of string with Corona Control rings (dry) –kV rms	156	320
e)	Maximum RIV level in micro volts of string with Corona Control rings at 508 kV (rms) for 765 kV, 320 kV (rms) for 400 kV string across 300 Ohms resistor at 1 MHz	1000	1000
f)	Minimum total creepage distance of the insulator string (mm)	6125	10500
g)	Total no. of discs per strings	15	25

For tension application, double insulator strings and for suspension purpose single suspension insulator string shall be used for 400 kV and 220 kV systems.

### SECTION-3

#### PROJECT DETAILS & GENERAL SPECIFICATION

##### SITE INFORMATION

	Particular	Details
a)	Customer	<b>Power Grid Corporation of India Limited</b>
b)	Project Title	400/220kV Aurangabad (PG) S/S, Extn. of 400 kV Wardha S/S & Extn. of 400 kV Aurangabad (MSETCL) S/S
c)	Location	Aurangabad/ Wardha (Maharashtra)
d)	Transport Facilities	By Road/By Rail

##### SITE CONDITIONS

a)	Altitude above sea level	Less than 1000m
b)	Ambient air temp. (Max)	50°C
c)	Average Humidity	Max. 100%
d)	Special corrosion conditions	No
e)	Solar Radiation	1.2 kW/sq mtr
f)	Atmospheric UV radiation	High
g)	Seismic Acceleration	0.3g horizontal
h)	Pollution Severity	High Pollution level (25mm/kV)

##### WIND DATA

a)	Wind velocity	As per IS
b)	Average No. of thunderstorm days per annum	As per IS

#### 1.0 GENERAL

This Chapter covers Technical Requirements and requirements of auxiliary items.

- a) Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes unless included in the list of exclusions.
- b) Material and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.
- c) Whenever a material or article is specified or described by the name of a particular

brand, manufacturer or vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.

d) In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements(DRS),test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.

e) Auxiliary supplies as described below would be available at site: -

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
415V	± 10%	50 ± 5%	3/4 Wire	Solidly Earthed.
240V	± 10%	50 ± 5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	-	Isolated 2 wire System
48V	-	DC	-	2 wire system (+) earthed

NOTE: Combined variation of frequency and voltage shall be limited to ±10 %.

f) The Bidder shall clearly indicate in the bid, the specific standards in accordance with which the works will be carried out.

g) The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.

h) All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.

i) The requirement regarding external RIV as specified for equipment shall include the terminal fittings and the equipment shall have been tested preferably with fittings, if any.

j) All drawings, schedules, Annexure appended to this specification shall form part of the specification.

k) The enclosure of the control cabinets, junction Boxes and Marshalling boxes, panels etc. to be installed shall provide degree of protection as detailed under

- Outdoor IP-55
- Indoor in air conditioned area IP31

- In covered area: IP-52
- Indoor in non air-conditioned area where possibility of entry of water is limited IP-41
- For LT switchgear (AC & DC distribution Boards) IP-52

## **2.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

- a) The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, re-strike etc.
- b) The equipment shall be able to withstand forces due to wind load, short circuit, system over voltages, fluctuations, frequency variations etc., all forces considered together.

## **3.0 SUPPORT STRUCTURES**

- a) The support structures should be hot dip galvanised with minimum 610 gram/m<sup>2</sup> net of zinc.
- b) The design calculations taking into account the environmental conditions of the substations shall be furnished for sizing of the structures.

## **4.0 STANDARDS**

- a) The equipment to be furnished under this specification shall conform to latest issue with all amendments of standard specified under respective Chapters of this Specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other. The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.
- b) Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted.
- c) In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in additional information schedule along-with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Employer's approval.

## **5.0 ENGINEERING DATA AND OTHER REQUIREMENTS**

- 5.1 The furnishing of engineering data by the Contractor shall be in accordance with the Schedule for each set of equipment as specified in this Technical Specification and the data furnished under the Schedule of Data Requirements (DRS). The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect overall layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.
- 5.2 All engineering data submitted by the bidder after final process including review and approval by POWERGRID/BHEL shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise explicitly requested by the Employer in Writing.
- 5.3 The equipment offered shall also comply to the following:-
- a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
  - b) Four (4) copies of all test reports shall be submitted for approval before shipment of equipment. The reports shall indicate clearly the standard values specified for each test, to facilitate checking of the test reports. Six (6) bound copies of test reports shall be submitted after approval of test results.
  - c) Six (6) copies of documentation of test certificate/ test result along-with the relevant drawing (wherever applicable) from the raw material stage to final stage as per approved Quality Plan (QP) will be furnished by supplier for each and every equipment immediately after shipment of equipment.
  - d) 1 RTF and 8 copies of all drawings for each substation plus 6 copies and one RTF of each drawing for corporate office shall be furnished after approval of drawings 6 copies of instruction/operation manuals for each substation and corporate centre shall also be furnished after approval of manuals.
  - e) The following program shall be followed for approval of drawings/manuals :
    - i) Initial comments/approval by Employer within 4 (four) weeks of receipt of drawings.
    - ii) Resubmission of drawings/manuals within 4 (four) weeks of comments (including both ways postal time).

- iii) Approval of drawings/manuals within 3 weeks of receipt of resubmission. Within 21 days of approval, stipulated number of copies and re-producible in case of drawings shall be furnished by Contractor.

NOTE: The contractor may please note that all resubmissions must incorporate all comments given in the prior submission by the Employer failing which the submission of documents is likely to be returned.

- f) Six (6) No. of copies of drawings, Schedule of Data Requirements (DRS) and other documents shall be sent for approval. First submission shall be made within 4 weeks of LOA.
- g) All exposed ferrous parts shall be hot dip galvanised as per IS: 2633 & IS: 4579.
- h) All current making and breaking contact surfaces shall preferably be silver plated.
- i) The equipment name plate/wiring diagram plate should preferably be of stainless steel. In case of aluminum it should be at least 2 mm thick. The inscription on the name plate/wiring diagram plate shall be engraved and no punching shall be accepted except for equipment Sr. No. and year of manufacture.
- j) Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- k) Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Employer, if so required.
- l) All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing of work by the engineering shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

**6.0 SYSTEM PARAMETERS**

S. N.	Description of parameter	400kV	220kV
1	System Operating Voltage	400kV	220kV
2	Max. operating Voltage of the system (rms)	420kV	245kV
3	Rated Frequency	50Hz	50Hz
4	No. of Phases	3	3

5	Rated Insulation level		
i)	Full wave impulse withstand voltage(1.2/50 micro sec)	1550Vp	1050kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec)	1050kVp	--
	Dry and wet		
iii)	One minute power frequency dry withstand voltage (rms)	630	--
iv)	One minute dry and wet withstand voltage (rms)	---	460kV
6	Corona extinction voltage	320kV	156kV
7	Max. Radio interference voltage for frequency between 0.5Mhz and 2 MHz at 266kV rms for 400kV and 156kV rms for 220kV system	1000microvolts	1000microvolts
8	Minimum creepage distance (25mm/kV)	10500mm	6125mm
9	Min. Clearance		
i)	Phase to phase	4000mm (for conductor-conductor) configuration 4200mm (for rod-conductor configuration)	2100mm
ii)	Phase to Earth	3500mm	2100mm
iii)	Sectional clearance	6500mm	5000mm
10	Rated short circuit current for 1 sec duration	40kA/50kA (as applicable)	40kA/50kA (as applicable)
11	System neutral earthing	Effectively earthed	Effectively earthed.

**132kV, 66kV,33kV & 11kV system**

S. N.	Description of parameters	132kV system	66kV system	33kV system	11kV system
1	System operating Voltage	132kV	66kV	33kV	11kV
2	Max. operating Voltage of the system (rms)	145kV	72.5kV	36kV	12kV
3	Rated frequency	50Hz	50Hz	50Hz	50Hz
4	No. of Phases	3	3	3	3
5	Rated Insulation level				
i)	Full wave impulse withstand voltage(1.2/50 microsec)	650kVp	325kVp	170kVp	75kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	70kV	28kV
6	Corona extinction voltage	105kV	----	---	--

7	Max. Radio interference voltage for frequency between 0.5Mhz and 2 MHz at 266kV rms for 400kV and 156kV rms for 220kV system	500micro volts			
8	Minimum creepage distance (25mm/kV)	3625mm	1813mm	900mm	300mm
9	Min Clearance				
i)	Phase to phase	1300mm	750mm	320mm	280mm
ii)	Phase to Earth	1300mm	630mm	320mm	140mm
iii)	Sectional clearance	4000mm	3000mm	3000mm	3000mm
10	Rated short circuit current for 1 sec duration	31.5kA	31.5kA	25kA ( for 3 sec)	25kA ( for 3 sec)
11	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Note: The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.

**Major Technical parameters of bushings/hollow Colum/support insulators:**

**400 & 220kV System**

S. N.	Parameters	400kV	220kV
a	Max. System Voltage Um (kV)	420kV	245kV
b	Impulse withstand voltage (dry and wet) (kVp)	±1425	±1050
c	Switching surge withstand voltage (dry & wet) (kVp)	±1050	---
d	Power frequency withstand voltage (dry and wet) (kV rms)	630	460
e	Total creepage distance (min) mm	10500	6125
f	Insulator shall also meet requirement of IEC-60815 for 420kV and 245kV systems, as applicable having alternate long & short sheds.		

**132kV, 66kV,33kV & 11kV System**

S. N.	Parameters	132kV	66kV	33kV	11kV
a	Max. System Voltage Um (kV)	145	72.5	36	12
b	Impulse withstand voltage (dry & wet) (kVp)	±650	±325	±170	±75
c	Power frequency withstand voltage (dry and wet)(kV rms)	275	140	75	28

d	Total creepage distance (Min) mm	3625	1813	900	300
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**7.0 DESIGN IMPROVEMENTS**

- 7.1 The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes, the specification shall be modified accordingly.
- 7.2 The Bidder should however note that changes proposed by him will have to be supported with applicable type test reports.
- 7.3 If any such agreed change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

**8.0 QUALITY ASSURANCE PROGRAMME**

- 8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Employer's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following :
  - a) His organisation structure for the management and implementation of the proposed quality assurance programme.
  - b) System for Document and Data Control.
  - c) Qualification and Experience data of Bidder's key personnel.
  - d) The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
  - e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
  - f) System for Control of non-conforming products including Deviation Dispositioning, if any and system for corrective and preventive actions based on the feed back received from the Customers and also internally documented system for Customer complaints.
  - g) Inspection and test procedure both for manufacture and field activities.

- b) The work shall be performed under the direction and supervision of the Engineer. The scope of the duties of the Engineer, pursuant to the contract, will include but not be limited to the following :
- i) Interpretation of all the terms and conditions of these documents and specifications ;
  - ii) Review and interpretation of all the Contractor's drawings, engineering data etc. ;
  - iii) Witness or authorise his representative to witness tests and trial either at the manufacturer's works or at site, or at any place where work is performed under the Contract ;
  - iv) Inspect, accept or reject any equipment, material and work under the Contract ;
  - v) Issue certificate of acceptance and/or progressive payment and final payment certificates ;
  - vi) Review and suggest modifications and improvements in completion schedules from time to time ; and
  - vii) Supervise the quality Assurance programme implementation at all stages of the Works.

## 11.0 TESTS

### 11.1 Charging

- a) On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Engineer and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in Chapt-TST and shall be included in the Contractor's quality assurance programme.

The pre-commissioning checks for various Switchyard Equipment shall be in line with the Pre-Commissioning checklist, Document code no. OS/T&C/BAY/95 (Rev. 0). Further, as regards to pre-commissioning checks for Series Capacitors and the overall system including Series Capacitor and other equipment, protection etc., shall be mutually discussed and agreed upon.

- b) The Contractor's commissioning engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests. On completion of inspection and checking and after the pre-

commissioning tests are satisfactorily over, the complete equipment shall be placed on Initial Operation during which period the complete equipment shall be operated integral with sub-systems and supporting equipment as a complete substation.

### 11.2 Commissioning Tests

- a) The available instrumentation and control equipment will be used during such tests and the Engineer will calibrate, all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Engineer, for the requirement of these tests.
- b) Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- c) The specific tests to be conducted on equipment have been brought out in the Chapter-TST.

### 11.3 Test Codes

The provisions outlines in the IS & IEC codes or other international and Indian approved equivalent shall generally be used as a guide for all the above test procedures unless otherwise specified in the Technical Specifications.

## 12.0 HANDLING, STORING AND INSTALLATION

- a) In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.
- b) Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.
- c) In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any

damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

- d) Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- e) The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- f) Where material/equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- g) Contractor shall be responsible for the proper storage and maintenance of all materials/equipment entrusted to him. He shall take all required steps to carry out frequent inspection of material/equipment stored as well as erected until the same is taken over by the Employer.
- h) The words 'erection' and 'installation' used in the specification are synonymous.
- i) Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- j) Clearances and spacings shall be provided as per relevant IS.

Bidder shall confirm in their technical offer that all clearances and spacing as stated above will invariably be provided. Even though phase to earth clearance under normal conditions will be as above at certain points where there can be bird faults (i.e. a bird sitting on the earthed metal part coming in contact with the HT terminal) adequate clearance as required shall be provided between the HT terminal and nearest grounded metal part.

### 13.0 TAKING OVER

Upon successful completion of all the tests to be performed at Site on equipment

furnished and erected by the Contractor, the Engineer shall issue to the contractor a taking over certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Engineer delay the issuance thereof on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

#### **14.0 PROTECTION**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with protecting device. All ends of equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

#### **15.0 PRESERVATIVE SHOP COATING**

15.1 All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall beforehand be treated and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scale, oxide and other coatings and prepared in the shop. The surfaces that are to be finish painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Transformers and other electrical equipment, if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel. The finished colours shall be selected and specified by the Employer at a later date.

15.2 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 deg.C. shall be selected by the Contractor, after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperatures higher than 95 deg.C. and such primers shall also be subject to the approval of the Employer.

15.3 All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.

#### **16.0 PROTECTIVE GUARDS**

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

#### **17.0 DESIGN CO-ORDINATION**

The Contractor shall be responsible for the selection and design of appropriate

equipment to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Technical Specification. The design of various components, sub-assemblies and assemblies shall be so done so that it facilitates easy field assembly and maintenance. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical at or close to the operating range of the unit.

## **18.0 DESIGN CO-ORDINATION MEETING**

The Contractor will be called upon to attend design co-ordination meetings with the Employer, other Contractor's and the Consultants of the Employer during the period of Contract. The Contractor shall attend such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

## **19.0 BUS POST INSULATORS**

The post insulators shall conform in general to latest IS: 2544, IEC-168 and IEC-815.

### **CONSTRUCTIONAL FEATURES**

- 19.1 Post type insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.
- 19.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- 19.3 Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.
- 19.4 The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC-815 for the specified pollution level.
- 19.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.
- 19.6 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.
- 19.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS:2633 and IS :4579. The zinc used for galvanising shall be grade Zn 99.95 as per IS:209. 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 metal parts shall not produce any noise generating corona under the operating conditions.

19.8 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor.

**19.9 Tests**

The post insulators shall be subject to type, acceptance, sample and routine tests as per IS: 2544 and IEC-168.

**19.10 TECHNICAL REQUIREMENTS FOR BUS POST INSULATORS**

S. No.	Parameter	Value
a)	Type	Solid Core
b)	Voltage class (kV)	420
c)	Dry & wet one minute power frequency withstand voltage (kVrms)	680
d)	Dry lightning impulse withstand voltage (kVp)	+1425
e)	Wet switching surge withstand voltage (kVp)	+1050
f)	Max. radio interference voltage (in microvolts) at voltage of 305 KVrms between phase to ground	1000
g)	Corona extinction voltage (kV rms)	320 (Min.)
h)	Total minimum cantilever strength (kg)	800
i)	Minimum torsional moment	As per IEC-273
j)	Total height of insulator (mm)	3650
k)	Pollution level as per IEC-815	Heavy (III)
l)	Minimum total creepage distance for heavy pollution (mm)	10500

**20 REQUIREMENT OF AUXILIARY ITEMS**

**20.1 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS**

- a) Bushings shall be manufactured and tested in accordance with IS : 2099 & IEC : 137 while hollow column insulators shall be manufactured and tested in accordance with IEC:233/IS: 5621/IEC:61264, as applicable. The support insulators shall be manufactured and tested as per IS: 2544/IEC: 168 and IS: 2099/IEC: 273. The insulators shall also conform to IEC: 815 as applicable.
- b) Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- c) Glazing of the porcelain shall be uniform brown in color, free from blisters, burrs and similar other defects.

- d) Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.
- e) When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.
- f) Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- g) All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

**h) TESTS:**

In accordance with the requirements stipulated, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS : 2099 & IS : 2544.

Parameters of bushings/Hollow column insulators/support insulators

S. No.	Parameter	Value
a)	Rated Voltage	420 kV*
b)	Impulse withstand voltage (Dry & wet)	± 1425 kVp*
c)	Switching surge withstand voltage(Dry & Wet)	± 1050 kVp*
d)	Power frequency withstand voltage	630 kVrms*
e)	Total creepage distance	25mm/kV*
f)	Pollution level	Class-III : Heavy (as per IEC-71)
g)	Insulator shall also meet requirement of IEC - 815, as applicable, having alternate long & short sheds.	

**NOTE:** \* The equipment rating is only indicative. Appropriate rating equipment may be supplied if so required in view of the series capacitor requirement.

**21. CONTROL PANELS, RELAY PANELS, CABINETS, JUNCTION BOXES, TERMINAL BOXES, MARSHALING BOXES AND MARSHALING KIOSKS:**

- a) All types of boxes, cabinet/panels shall generally conform to IS : 5039, IS : 8623, IEC : 439, as applicable and the clauses given below :
- b) Control cabinet/panels, junction boxes, Marshaling box & terminal boxes shall be sheet steel/Al. enclosed and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled/2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of Al. enclosed box the thickness of Al. shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.
- c) The enclosures of all outdoor type control cabinets/panel, junction boxes, terminal box & marshaling boxes shall provide a degree of protection of not less than IP 55 as per IS : 13947 and the same for indoor type enclosures shall be IP 31 as per IS : 13947 and one control cabinet/panel, junction box, terminal box & marshaling box of each type shall be tested for the same, if the type test reports submitted are not to the satisfaction of the owner.
- d) Control cabinet/panels, junction boxes, marshaling box & terminal box shall be provided with padlocking arrangements.
- e) All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. The neoprene gasket shall be tested in the presence of Employer's representative.
- f) All sheet steel work shall be degreased, pickled, phosphated and then applied with two coats of zinc chromate primer and two coats of finishing synthetic enamel paint. The colour of finishing paint shall be light admiralty grey in accordance with shade No. 697 of IS: 5 outside and inside shall be glossy white.
- g) All terminal boxes, control cabinet/panels, junction boxes & marshaling boxes shall be designed for the entry of cable from bottom by means of weather proof and dust-proof connections. Boxes and cabinet/panels shall be so designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet/panel. Suitable cable gland plate on the base of the box shall be provided for this purpose. Necessary number of cable glands of suitable sizes shall be supplied and fitted on this gland plate. This removable gasketed gland plate shall have provision for spare glands to be used in future. The glands shall project at least 25 mm above the gland plate to prevent the entry of moisture in the cable crutch. The roof of the outdoor cabinet/panels/boxes shall preferably be of sloping design to prevent stagnation of water.



- h) Suitable heaters shall be provided in the cabinet/panel, junction boxes & marshaling boxes to prevent condensation. Heaters shall maintain cubicle temperature approximately 10°C above the outside air temperature. The heaters shall be suitable for 240 V AC supply voltage. On-off switch and fuse for this shall be provided.

i) **Terminal Block :**

All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of cabinet/panel, junction box, terminal box and marshaling box.

The terminal blocks shall be made of moulded, non-inflammable thermosetting plastic. The material of terminal block moulding shall not deteriorate because of varied conditions of heat, cold, humidity, dryness, etc. that would be anticipated at the location where the equipment is proposed to be installed.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The terminal blocks shall be non- disconnecting stud type equivalent to Elmex type CAT - M4/CST.

The terminal blocks shall be of extensible design.

The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be of 650 V grade and shall be rated to carry continuously the maximum current that is expected to be carried by the terminals.

The terminal blocks used for CT circuits shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

The terminals shall be provided with the marking tags for wiring identification.

All boxes shall be provided with 20 % spare terminals unless otherwise specified.

- j) There shall be a minimum clearance of 250 mm between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks or side of the box shall be a minimum of 150 mm.

- k) The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet/panel is live. Cabinet/panel wiring should be suitable for 60°C as the space heaters will keep the temperature 10°C higher than the ambient.

l) **Wiring :**

All wiring shall be carried out with 650 V grade, stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows:

- i) All circuits except CT circuits – 1.5/ 0.75.00.4 sq.mm (depending on the device current rating)
- ii) CT circuits- 4sq mm; minimum no. of strands shall be 3 per conductor.
- iii) Wrapping wires shall be used for electronic rack connection.

All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks.

All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrule purposes.

All terminals including spare terminals of auxiliary equipment shall be wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out.

A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet/panel with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

For illumination of Control cabinet/panel a 20Watts Fluorescent Tube/Incandescent Lamp shall be provided.

All control switches shall be of rotary switch type or push button type and toggle/piano switches shall not be accepted.

In accordance with the requirements stipulated under this Chapter control

cabinet/panels, junction boxes, terminal boxes & marshaling boxes shall conform to type tests and shall be subjected to routine tests in accordance with IS : 5039. In addition to the type tests, verification of the degree of protection as per IS : 13947, shall be conducted, if the type test reports submitted by the Contractor are not to the satisfaction of the owner. After protection degree tests on control cabinet/panel, power frequency voltage of 2.0 kV rms for 1 minute shall be applied for checking insulation resistance and functional test shall also be conducted.

m) **Earthing :**

Positive earthing of the cabinet/panel shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of star or self etching washers. Earthing of hinged door shall be done by using a separate earth wire.

**22 MOTORS:**

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

**23 TERMINAL CONNECTORS AND CLAMP CONNECTORS:**

The Terminal Connectors of all types shall meet the following requirements:

- a) Terminal connectors shall be manufactured and tested as per IS: 5561.
- b) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- c) No part of a clamp shall be less than 10 mm thick.
- d) All ferrous parts shall be hot dip galvanised conforming to IS: 2633.
- e) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be provided.
- f) Flexible connectors shall be made from tinned copper/ aluminium sheets or cables.
- g) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- h) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561.



- i) All test/checks on terminal connectors shall be as per IS: 5561.

#### **24 AUXILIARY SWITCH :**

The type test reports or the following tests on auxiliary switch shall be furnished :

- a)Electrical endurance test - A minimum of 2000 operations for 2A DC with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/visual defects/temperature rise test.
- b)Mechanical endurance test - A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/visual examination.
- c) Heat run test on contacts.
- d) IR/HV test etc. .

**ANNEXURE- A**

**CORONA AND RADIO INTERFERENCE VOLTAGE  
(RIV) TEST**

**1. General**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132Kv & above.

**2. Test Levels:**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

**3. Test Methods for RIV:**

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

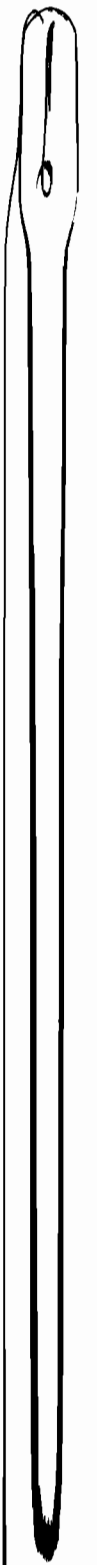
3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.



4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser’s inspector if, in his opinion, it will not prejudice other test.

**5. Test Records:**

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

**ANNEXURE – B**

**SEISMIC WITHSTAND TEST PROCEDURE**

The seismic withstanding test on the complete equipment (for 132kV and above) shall be carried out alongwith supporting structure.

The Bidder shall arrange to transport the structure from his Contractor’s premises/POWERGRID sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and

**Bharat Heavy Electricals Limited**400kV/220kV S/S AURANGABAD(PG),EXTN OF 400kV Wardha  
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Rev. 00

Technical Specification for Disc Insulators &amp; String Insulator Hardware

**GUARANTEED TECHNICAL PARTICULARS FOR DISC INSULATORS**

Sl. No.	Particulars	Unit	400kV Double Tension Insulator String	400kV Single Suspension Insulator String	220kV Double Tension Insulator String	220kV Single Suspension Insulator String
1.	Manufacturer's Name & address					
2.	Type of String : a) Single / Double b) Suspension/ Tension					
3.	Applicable Standards					
4.	Type of Insulators : a) Ball & Socket / Other b) Normal / Anti Fog					
5.	Insulation Material					
6.	No. of units per string					
7.	Size of each unit :- a) Diameter of Disc b) Spacing between adjacent units	Mm mm				
8.	Weight (Approx.) a) Each Disc b) Complete String (Insulator Only)	Kg Kg				
9.	Total Creepage distance a) Each Disc b) Complete String ( Insulators only)	Mm Mm				
10.	Power frequency withstand voltage a) Each Disc i) Dry ii) Wet b) Complete String i) Dry ii) Wet	kV kV kV kV				
11.	Impulsive withstand voltage a) Each Disc i) Positive ii) Negative b) Complete String i) Positive ii) Negative	kVp kVp kVp kVp				

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12.	Switching Surge withstand voltage a) Positive b) Negative	kVp kVp				
13.	Power frequency puncture withstand voltage of each disc	kV				
14.	Min. corona extinction voltage level : a) Each disc b) Complete String	kV kV				
15.	RIV level with corona control rings at 305kV (rms)for 400kV string at 1 MHz.	μV				
16.	Electrochemical strength : a) Each Disc b) Complete String	kN kN				
17.	Reference Drawing					
18.	Magnetic power loss of suspension and drop clamp assembly at 600 A	W				

**Project:** 400kV/220kV S/S Aurangabad(PG), EXTN. of 400kV Wardha & Extn. of 400kV Aurangabad (MSETCL) S/S Project

**BOQ FOR DISC INSULATORS AND STRING INSULATOR HARDWARE**

**Site:** 400kV/220kV S/S Aurangabad(PG)

Sl. No.	Item Description	Qty.of string hardware	Spare Qty(5%) hardware	Total (Qty ) of hardware
1	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with turn Buckle	66	4	70
2	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with out turn Buckle	54	3	57
3	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for quad ACSR Bersimis conductor with drop clamp	42	3	45
4	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with turn Buckle	24	2	26
5	400kV Double tension insulator string comprising 2x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with out turn Buckle	18	1	19
6	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with drop clamp	24	2	26
7	400kV Single suspension insulator string comprising 1x25 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with straight clamp	6	1	7
8	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with turn Buckle	75	4	79
9	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor without turn Buckle	63	4	67
10	220kV Single suspension insulator string comprising 1x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with drop clamp	36	2	38
11	220kV Single suspension insulator string comprising 1x15 discs with subconductor spacing 450mm suitable for Twin ACSR Bersimis conductor with straight clamp	30	2	32
12	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Quad ACSR Bersimis conductor with turn Buckle	36	2	38
13	220kV Double tension insulator string comprising 2x15 discs with subconductor spacing 450mm suitable for Quad ACSR Bersimis conductor without turn Buckle	36	2	38
Disc Insulator for Aurangabad (PG)				
Total qty of disc insulators		17190		
5% spare for disc Insulators		860		
<b>Total Qty for Disc Insulators (Main +spare)</b>		<b>18050</b>		